eftec

In association with:

Cascade Consulting

SUPPORTING EVIDENCE ON NATURAL CAPITAL METRICS AND RISKS

REPORT TO THE NATURAL CAPITAL COMMITTEE

Final Report
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Summary

This report documents research undertaken to support the work of the Natural Capital Committee (NCC). The research was undertaken by a team from economics for the environment consultancy (eftec) and Cascade Consulting Ltd. It included the secondment of two experienced researchers to work with the NCC Secretariat. The research:

1) Developed natural capital metrics, focussing on the use of available data.
2) Developed information to present a 'risk register' for natural capital. This built on the metrics data to examine natural capital thresholds and limits.

The outputs of the work help build better understanding and measurement of when, where and how the UK's natural capital may be being used unsustainably. The methods used in this research are summarised in this report. The main outputs of the research are presented in a series of annexes and appendices.

1. Introduction

The aim of this project was to collate the evidence and material that will be used by the Natural Capital Committee to complete their second State of Natural Capital report. This document describes work to support the Committee's analysis of whether natural capital and benefits it provides are at risk. This work encompasses:

a) Developing *metrics* to define and measure changes in natural capital assets;

b) Producing a *risk register* that identifies which natural assets in England are at risk of being used unsustainably and how severe the impacts from continued depletion would be.

Following this introductory section, Section 2 presents the methods employed, and Section 3 summarises the results. The main results from the work are contained in a series of Annexes and Appendices, accompanying this document. The additional files are as follows:

Annex 1. Stage 1 White-Grey-Black Prioritisation
Annex 2. Stage 2 Risk Ratings
Annex 3. Explanation of Risk Graphics
Annex 4. Risk Rating Supporting Evidence on Status &Trend
Annex 5. Overview of 'B' and 'C' Ratings
Annex 6. Costs of Restoring or Recreating A-U's or Replacing benefit
Annex 7. Functional Relationships & White-Grey-Black Justification
Annex 8. Definitions

2. Methodology

The methods used in this research are described in this Section. The work on developing metrics and the risk register was undertaken by the two secondees to the Natural Capital Committee Secretariat. Regular reviews of method and outputs were undertaken during the project with the project managers, members of the Natural Capital Committee Secretariat, and individual Committee members.

This Section sets out a step-by-step summary of the methodology for the development of metrics and a risk register for natural capital; the objectives of which are twofold:

- Developing *metrics* to define and measure changes in natural capital assets;
- Producing a *risk register* that identifies which natural assets in England are at risk of being used unsustainably and how severe the impacts from continued depletion would be.

2.1. Explanation of Framework

The development of metrics for natural capital and to assess risk to the benefits it can provide requires an understanding of the links between natural capital, assets and the benefits it provides to people. This work adopts the emerging conceptual framework developed by the Natural Capital Committee (NCC, 2014) which in turn is based on the UK National Ecosystem Assessment (UK NEA, 2011). This framework includes a set of definitions for natural assets, major land use categories and goods:

Natural capital assets include species; ecological communities; soils; freshwaters; land; atmosphere; minerals; sub-soil assets; oceans; coasts.

Major land-use categories (MLC) are the 8 Broad Habitat types in the NEA with each containing a number of different habitat types: mountains, moors & heaths; enclosed farmland; semi-natural grasslands; woodlands; freshwaters; urban; coastal margins; marine.

Goods (from which benefits are derived): food; fibre; energy; clean water; clean air; recreation; aesthetics; wildlife; protection from hazards; equable climate. These all have values and many can be measured in monetary terms.

The NCC conceptual framework states that benefit provision is dependent upon natural capital assets and that these assets combine as underpinning inputs to the productivity of major land use categories. Therefore, changes in natural capital assets lead to changes in MLCs. The detailed definitions of MLCs, natural capital assets and goods can be found in Annex 8.

It should be noted that in certain cases, there is a need for a more specific definition of the natural capital asset, MLC and/or benefit of concern. For example, in the urban MLC, it is necessary to distinguish between urban green space and the wider built environment.

Similarly, for hazard protection benefit, the specific hazard of reference will vary depending upon the relationship of concern. Enclosed farmland influences the propensity of rivers to flood through the contribution of land drainage activities and sediment, similarly the urban environment increases flooding due to decreased permeability of surfaces. However, for upland areas (mountains, moors and heaths), hazards exist in the form of wildfires on heathland and slope stability as well as flooding.

The level of goods produced by each 'spatial (accounting) unit' will be influenced, to a greater or lesser extent, by three major characteristics (NCC, 2014):

1. Quantity the geographic extent/coverage of the MLC as a proportion of the land area in England;

2. Quality the condition of the spatial MLC in relation to the benefit being provided;

3. Spatial Configuration the 'optimal' location for the maximising the value of a specific benefit to society.

Understanding how these changes impact the provision of goods and ultimately benefits requires establishing functional relationships. The key question addressed is: "If the quantity, quality and / or spatial configuration of the spatial major land use category changes, how will this affect the benefits (goods) provided?"

Ultimately, we are concerned with identifying the benefits most at risk from unsustainable use of MLCs and the underpinning natural capital assets, over time. The identification of such high risk relationships has driven the development of the methodology, which has been iterative.

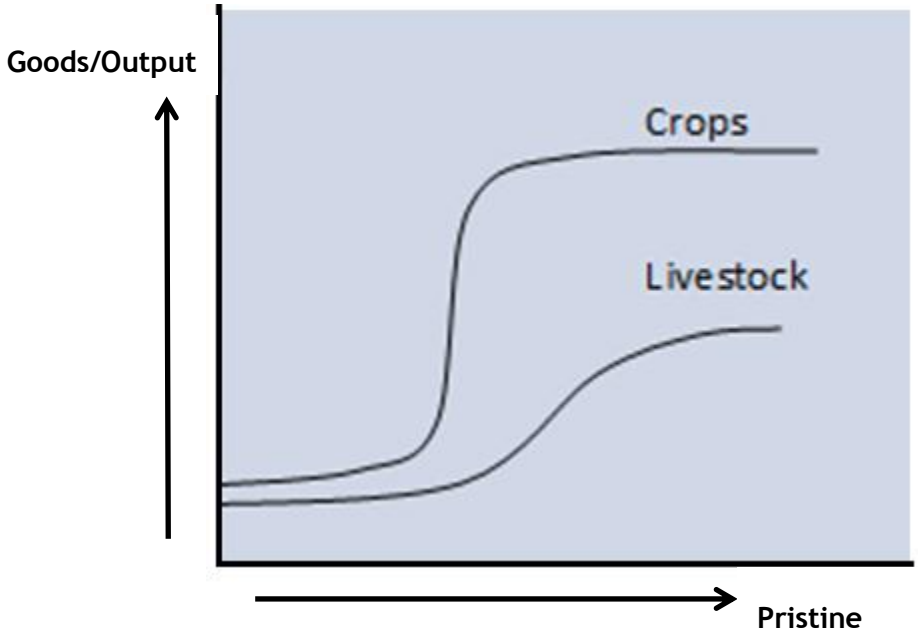
We developed (qualitative) functional relationships between human induced changes in MLCs and the provision of benefits. These are akin to production functions that show the relationship between different types of input and the resulting output. These relationships were developed for the quality, quantity and the spatial configuration of MLCs.

2.2. Quality Functions

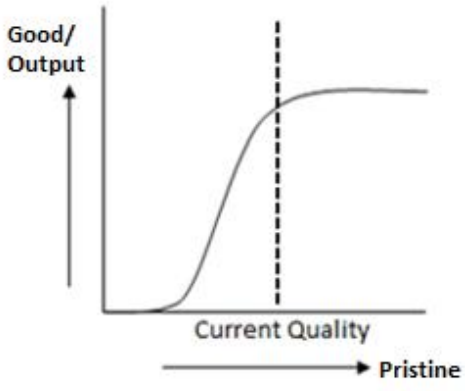
Quality refers to the condition of the spatial major land use category in relation to the benefit being provided. If plotting the relationship between the benefit (on the Y-axis) and the quality of the major land use category for that benefit (on the x-axis) then the x-axis will

vary according to the benefit. For example, take the relationship between the 'quality of Enclosed Farmland and food provision'. The benefits (expressed in £ values where possible) would be on the Y-axis and the X-axis would try to capture the full range of conditions possible (the extremes) in the context of producing 'food'. In other words, the x-axis would range from 'conditions (totally) unsuitable for agriculture' to 'conditions ideal for agricultural production. The relationship might look something like Figure 2.1 below.

Figure 2.1 Qualitative functional relationship between quality of Enclosed Farmland and food provision



In order to consider how the provision of benefits might change in response to changes in the quality of MLCs, we developed the notion of 'production functions'. This built on work undertaken by Bateman *et al* (2005) in which regression models were used to predict yield curves for Sitka spruce woodland. Box 1 illustrates how we applied this idea to the provision of a specific benefit (recreation) from Freshwater MLC.



Box 1. 'Quality' production function for recreational benefit from freshwater (non-exhaustive)

Recreation = f [**freshwater** *(size, volume, flow velocity, nutrients, bacteria, aquatic vegetation);* **land** *(gradient, altitude);* **species** *(fish; birds)* + **material capital** *(management)* - **pressures** *(point-source pollution; diffuse pollution; abstraction)*]

[N.B. list of variables in this function is non-exhaustive list.]

The production function consists of a list of relevant natural capital assets (freshwater; land; species) that contribute to the provision of the specific benefit (recreation) from that MLC (Freshwater). The accompanying brackets list the specific aspects of those natural capital assets that are important (e.g. size, volume, flow velocity, nutrients, bacteria, aquatic vegetation) to the provision of the benefit. The natural assets highlighted (in red) are those that can be influenced by society, positively or negatively.

We have included 'material capital' (including built and human capital) within the production functions because in certain circumstances the realisation of benefits from major land use categories (over some portion of the function) depends on, or is influenced by, human intervention (e.g. management of fertilisers influences eutrophic water-bodies; food from enclosed farmland requires machinery). We have also included anthropogenic actions that impede the realisation of societal welfare from major land use categories under 'pressures' (e.g. diffuse pollution; clean air from urban areas is impacted by loading of NO_X, SO_X, particulate matter etc.). In the work by Bateman et al. (2005), the sign of the coefficient for each 'natural capital asset' shows direction of relationship, size of the coefficient shows the scale of its influence on benefit provision.

The focus is on how the provision of the specific benefit of concern changes as the quality of an MLC changes. For most MLCs, this relates to the ecological functioning of each MLC, the condition of which is proportional to the productivity of the MLC.

The Urban MLC is an exception (built urban sub-component rather than greenspace sub-component) because it does not have ecological underpinnings that produce ecosystem services. Instead the urban environment negatively impacts natural capital assets. As an environment becomes more urbanised, the normal functioning of natural assets becomes compromised. This assumes that 'urbanisation' is the conversion of natural habitats to a 'typical' built urban environment (separate from urban green space) consisting of impermeable surfaces, high road traffic and population densities, air-conditioned buildings. This ignores the fact that urban planners are increasingly adopting technologies that mimic or replace the natural functioning of habitats that urban areas replace (such as through sustainable drainage systems, SUDS) which mean that urbanisation is not necessarily in line with 'typical' expansion of impermeable surfaces etc. The assumption that urbanisation does not adopt such measures was adopted, this is therefore a worst case scenario but probably reflects some current practice.

Given this definition of 'Urban', increasing the quality of this MLC refers to restoring the quality of the natural capital assets that exist in urban areas to a level closer to their natural functioning. For example, reducing the harmful impacts of vehicle emissions on the atmosphere as a natural capital asset so as to improve air quality as a good, is an improvement in the quality of the Urban MLC.

2.3. Quantity Functions

The quantity of MLC s refers to the geographic extent/coverage of the MLC as a proportion of the land area in England. The MLCs are derived from the UK NEA (2011) and represent the total land and sea area of the UK and always sum to one i.e. an expansion in one leading to a reduction in others. They are therefore mutually exclusive for the purposes of this assessment. In assessing the quantity characteristic, changes between MLCs is likely to be an important consideration. For simplicity such transfers between MLCs were not considered here.
Quantity can be influenced by humans positively (by recreating MLCs) or negatively (by destroying MLCs for example through development).

The focus in this analysis is on how the provision of the specific benefit of concern changes as the quantity/spatial coverage of an MLC changes. For most MLCs, this change will be positive, but for Urban, increasing the extent of the MLC results in a negative impact on benefits. In this case the metric on the x-axis is avoided cost as opposed to value and the relationship may be negative (e.g. increasing the quantity of urban area has a negative impact on air quality, the avoided cost at low urban extent is high and avoided costs falls as the extent of U urban areas increases).

2.4. Spatial Configuration Functions

The spatial configuration of MLCs refers to the 'optimal' location for the maximising the value of a specific benefit to society (this will change with benefit). This may refer to:

- a specific proximity to people (e.g. recreational benefits)
- the relation to other relevant areas, for example the connectivity of MLC for maximising: wildlife benefit (i.e. ecological networks); aesthetic benefits or flood protection

In other cases spatial configuration will not matter. For example, carbon sequestration contributes to a global scale benefit (equable climate benefits) and therefore location is irrelevant.

Freshwater Example

The following example illustrates the method with respect to the Freshwater MLC. The functions are based on expert opinion and with reference to UKNEA (2011) and other available information. Relationships may be:

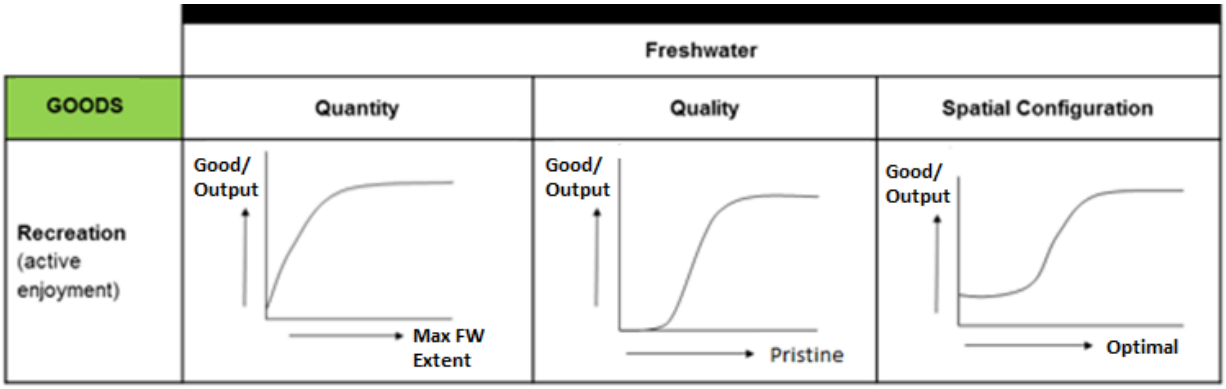
+L (positive linear)

+NL (positive non-linear)
-L (negative linear)
-NL (negative non-linear)

Where no relationship exists, or is considered to be negligible, this is stated (see Annex 7). Similarly, any uncertainty over a relationship has been explained. Where there is uncertainty, these relationships have been categorised as 'Black' to take forward to the next stage of assessment, and a '?' placed in the cell box in Annex 1 to highlight this.

Figure 2.2 sets out the hypothetical functional relationships for the provision of recreational benefit from Freshwater MLC. The spatial configuration of MLCs impacts the quality of the MLC for the provision of a benefit, but it has been considered important to identify this relationship separately, as shown in Figure 2.2 below. Further explanation of these functions is provided in Table 2.2 (see Section 2.5).

Figure 2.2 Functional Relationships for Recreational Benefit from Freshwater MLC



In order to establish how benefit provision changes following changes in the condition of MLCs, we then considered how society may influence the condition of the MLC either positively (towards 'pristine') or negatively (to 'severely degraded'/'destroyed'). The nature of the relationships has been assessed in 'marginal terms' – i.e. assuming incremental gains in quantity, quality or spatial configuration units (the x-axis).

The focus on human induced changes is relevant because the Natural Capital Committee is concerned with advising on how to prioritise action to protect and improve natural capital, so that public and private activity is focused where it will have greatest impact on improving wellbeing in our society.. This information on benefit provision and influence was noted, see Annex 3, and was important for the prioritisation of relationships (see 2.6).

In order to determine human influence some consideration was given to current risks to status of MLCs and how these can be managed. For example, the amount of recreational benefit

from the Freshwater MLC will depend on its quality, which is at risk from pollution (e.g. eutrophication) and humans can influence this.

At this stage no consideration was given to time periods. Instead we were simply concerned with determining what human induced changes to the MLC, to maximize or deplete a specific benefit, is technically feasible given socio-ecological interactions.

A number of assumptions have been made in order to develop the relationships like those displayed in Figure 2.2. One is that consideration was given to changes in quality, quantity or spatial configuration with a view to maximising the provision of a specific benefit from an MLC, holding the others constant e.g. extent and positioning of the major land-use category was assumed to stay same as changes in quality are considered.

The other is that no consideration has been given to trade-offs as major land-use categories change. In reality such trade-offs may occur within a major land-use category in terms of benefit production over time. For example, if you maximise the provision of timber from woodland you limit your ability to provide recreational value from woodland. There may also be trade-offs across major land-use categories. For example, as the extent of woodland increases, the available space for other land uses decreases. However, we are not considering dynamics across or within MLC, but instead focus on a 'snapshot' of the MLC with reference to hypothetical changes in a particular characteristic for the provision of a specific benefit. These assumptions are necessary in order to undertake this analysis.

It is important to note that at this stage the valuation scales for each function are not quantified and therefore not comparable. We are primarily concerned with determining the likely shape of the functions, which are indicative, qualitative and hypothetical. Whilst the functional relationships are qualitative, the justification for their shape was based on ecological and economic principles, see Table 2.2 in Section 2.6 for supporting justification for each of these relationships (see Annex 7 for justification for all 240 relationships).

The Freshwater example is referred to in subsequent sections to further illustrate the method.

2.5. Presenting Functional Relationships

The aim was to populate each cell of Figure 2.3 with such functional relationships. The overall purpose of this high level table is to identify the nature of the relationships between the ***benefits*** and the ***spatial major land-use categories*** and to prioritise these (in Section 2.6). These 240 functions are set out in Annex 7.

The analysis in Figure 2.3 has been completed with functional relationships for all MLCs. These indicate:

- Which benefits are produced from the eight MLCs;

- The hypothetical relationship between changes in the quantity, quality or spatial configuration of an MLC and the goods and benefits it provides;
- The potential for significant non-linear or linear changes in the provision of a benefit from an MLC; *and*
- Which are the most important natural capital assets in terms of underlying the provision of benefits from major land-use categories (from the quality production functions in supporting documentation, see Annex 4).

Figure 2.3 Linking major land-use categories to benefits

		Mountains, Moors & Heaths			Enclosed Farmland			Semi-natural Grasslands			Woodlands			Freshwaters			Urban			Coastal Margins			Marine		
		Qty	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*	*Qty*	*Qly*	*SpC*
GOODS	Food																								
	Fibre																								
	Energy																								
	Clean water																								
	Clean air																								
	Recr'tn																								
	Aesthetic																								
	Hazard Prot																								
	Wildlife																								
	Equable Climate																								

2.6. Can we prioritise these relationships?

Given time and resource constraints, it was not possible to analyse the status and trend of all 240 relationships to determine the risk that society faces from changes in them. Therefore a method of prioritisation was required which narrowed down this 240 to a manageable number for further analysis. The principles for prioritisation were based on the Committee's brief to identify and assess the greatest risks from changes in natural capital assets. Given this we focused on:

- the most highly valued[1] benefits at greatest risk from changes in MLCs;
- those relationships that we can do something about; *and*
- rapid assessment that does not rely on extensive data collection on status and trend or valuation of MLCs (as this is the more in-depth step following prioritisation).

Given these principles, we undertook an initial risk rating for all of the 240 relationships based on whether the relationship between changes in MLC and benefit provision shows that humans can have a strong impact on the benefit.

[1] Note that valuation in this sense does not mean monetary valuation. We captured the value of the benefits from each MLC based on its relative contribution to total provision of that benefit.

This is determined by two things, firstly the current level of benefit provision and secondly the potential influence of society on this in the future, as described in Table 2.1.

Table 2.1: Principles for Prioritisation

Principle for Prioritisation	Description
Current benefit Provision	This is the extent of current provision from MLC as proportion of total provision of that benefit
Potential Societal Influence	This is the likely impact of society on future benefit provision given ability to manage MLCs (both in response to human induced and/or natural changes).

The likely human influence may be positive management (e.g. where built capital is needed for realisation of benefits, managing invasive species or restoring underlying natural capital assets) or negatively degrading (e.g. degrading the atmosphere as a capital asset).

Therefore, when developing the functional relationships in Sections 2.2 – 2.5, we noted:

- the estimated current level of provision of the benefit from this MLC as a proportion of total provision; *and*
- likely future changes to MLCs from human induced impacts, either positive or negative, which will indicate the range (on the x-axis) over which we are likely to be operating in the future (and potential value that may be lost/gained) for each relationship.

We then rated each of the 240 relationships based on 'Current benefit Provision' and 'Potential Societal Influence' and categorised these based on a White-Grey-Black rating, as described in Figure 2.4.

Figure 2.4 Explanation of Ratings[2]

Rating	Potential Societal Influence on Future Benefits		Current Benefit Provision
	No ability to influence (e.g. cannot influence quantity of marine environment)	*and*	Any
	Low-Medium (<20% of future provision)	*and*	Any

[2] Note the presentation in the Natural Capital Committee's report uses different colours but adopts these ratings

	High (impact >20% of future provision)	*and*	Medium/High provision (>12.5% total provision)

If society cannot impact future provision of benefits then the relationship is rated 'White', if society could have a low-medium impact on future provision (either positively or negatively) then it is rated as 'Grey'.

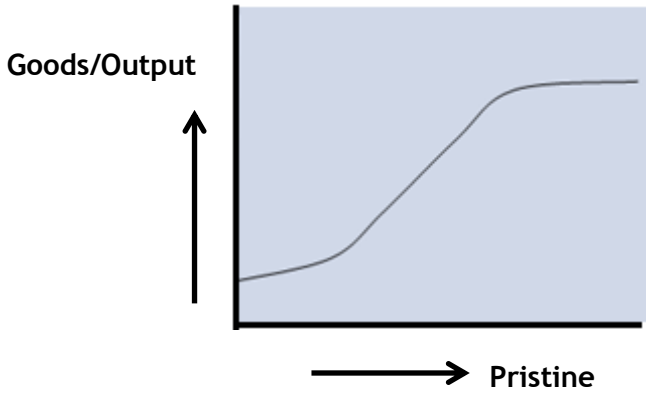
In line with the principles for prioritisation set out above, the 'Black' rated relationships are those where current provision is approximately >12.5% of total provision (by volume or value) in England (12.5% would be the level of provision across all MLCs if all 8 contributed equally to provision of a benefit) **and** where humans are able to influence provision from the MLC in the future by at least 20% (this was deemed to be an appropriate level to identify 'significant' impacts) given potential risks.

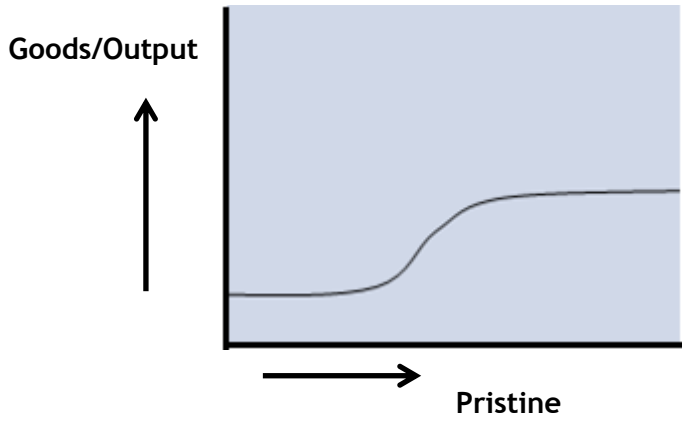
The decision on extent of current benefit provision and influence is based on expert judgement and with reference to the UKNEA. Where there was uncertainty with regard to the current benefits provided and/or ability to influence, then relationships were rated as 'Black' in order that further analysis into the importance of the relationship could be undertaken.

The intention of this was to enable a prioritisation of the 240 relationships to just focus on those of high concern. For example, based on this prioritisation, we identified the following for recreational benefit from the Freshwater MLC:

Table 2.2 Justification for White-Grey-Black Ratings for Recreational Benefit from Freshwater

Char'stic	Justification	WGB
Total benefit Provision	The recreational benefit enjoyed from Freshwater MLC as a proportion of total recreational benefit from all MLC, is currently quite high (>12.5%). This is rated as 'Red' for current provision.	n/a
Qty	Although you can change the area of some of the subcomponents e.g. wetlands, reservoirs, you cannot significantly change the total area of the MLC for a recreational benefit. Wetlands and reservoirs are normally created for another purpose (e.g. wildlife, clean water) or as a by product of other activity (aggregate extraction) and recreation is a by-product. The impact of expected changes in quantity of the Freshwater MLC by humans on the overall provision of recreational benefits was considered to be of 'low-medium' concern (i.e. <20% of total provision, see Section 2.6). The relationship is considered to be +L (none/negligible).	Grey

Qly	Quality includes the condition of the water itself which could deter contact recreation (e.g. swimming, angling) or habitat degradation (which could restrict walking opportunities), the volume of water (e.g. low volume of water/drought conditions partly due to over-abstraction, which limits potential for kayaking and angling) as well as access (e.g. rivers may be built over or reservoir may not be open to the public) In degraded/poor environment (e.g. highly polluted, no fish, no volume of water), there would be severely reduced recreation opportunities. As the quality of freshwater increases the value will also increase. However, this will only be up to a certain level of improvements and after this the marginal increase in value will become less. The relationship is considered to be +NL (major). **Figure 2.5 The functional relationship for recreational benefit associated with spatial configuration of Freshwater MLC**  The impact of change to quality of the Freshwater MLC on the overall provision of recreational benefits was considered to be of 'high' concern (i.e. over 20% of total provision, see Section 2.6). Therefore this relationship is rated as 'Black' (high concern) under the first step of prioritisation.	Black
Spatial Config	The proximity of freshwater to populations for recreation is valued. There will be a certain distance that is deemed acceptable to travel for recreation, before this point the incremental increases in proximity will be increasingly valued, beyond it the incremental increases will not be valued as greatly (i.e. there is diminishing marginal returns beyond a certain point). This is consistent with the economic valuation literature on distance decay (Haynes, 1974). The extent to which waterbodies could be created/destroyed near to populations to change total recreational value from freshwater bodies is unlikely to be significant (e.g. in theory we could create reservoirs or boating lakes near areas of high population density or build over rivers used for fishing to change proximity of freshwater for recreation and	Grey

	the marginal value could be significant but this is unlikely). The relationship is considered to be +NL (minor/moderate) as shown in Figure 2.6. The impact of potential changes to spatial configuration of the Freshwater MLC on the overall provision of recreational benefits was considered to be of 'low-medium' concern (i.e. <20% of total provision, see 2.6). Therefore this relationship is rated as 'Grey' (of concern) under the first step of prioritisation. **Figure 2.6 The functional relationship for recreational benefit associated with spatial configuration of Freshwater MLC**  	

It is important to note that we used this 'Rating' step as a prioritisation, which was necessary given time and resource constraints. Ideally, we would have assessed status and trend information for all 240 relationships.

There remains a possibility that a significant risk to society is missed in our analysis because our initial prioritisation rates the relationship as 'Grey' where society's ability to influence benefit provision is assessed as being <20% of current benefit output from the MLC), but the marginal value of this influence might be large because the status is near a threshold, especially if the trend is negative.

The likelihood of such a situation arising is increased by the broad benefit categorisations we are adopting; these are based on estimated extent of provision as opposed to value. For example, wildlife is a broad category involving many common and rare species. The value of some rare species may not be fully appreciated. Therefore although an area may not produce >12.5% of wildlife benefit, the value of these benefits may be large. We have attempted to avoid such situations arising by 'uprating' to 'Black' any uncertain relationships.

Whilst the validity of this prioritisation and/or the assumptions made to justify the White-Grey-Black ratings may be questioned and there is a possibility of overlooking 'high risk' relationships, this analysis should be viewed as a high-level, 'broad and shallow' assessment as opposed to a comprehensive, deep assessment of the state of natural capital.

The output from this step is a completed table with White-Grey-Black ratings, see Annex 2. We took forward 'Black' rated relationships to analyse information on their status and trend in order to determine the level of risk associated with them (for definition of risk, see 2.10)

2.7. What is the current status of MLCs, benefits & assets?

We sought out relevant metrics for measuring the status and trend of MLCs, benefits and/or assets and populated these with evidence. Each of these informs us in some way about the status of the capital, as conceptualised in Section 2.5 (functional relationships).

The metrics should capture the relationship between changes in a characteristic (quantity, quality, spatial configuration described in Section 2.1- 2.4) and changes in the benefits as simply as possible. In many cases different metrics are used to measure status and trend due to data limitations (status and target are always the same). For example evidence may be available on the status of the MLC (e.g. extent of equivalent SSSI habitat in favourable condition), but trend data is with regard to benefits or assets (e.g. wildlife species diversity/abundance).

Status is defined relative to targets for quality, which will vary across MLCs and benefits. Where no targets exist for quality, and ecological conditions are considered relevant, SSSI favourable condition has been adopted as an interim target. This simplifying assumption is necessary given time and resource constraints. In reality 'favourable condition' can be equated to a 'healthy' ecological condition and is likely to be a relevant target to maximise 'wildlife' benefit. A different target is likely to be relevant to maximise other benefits such as 'recreation' and 'hazard protection'.

A pragmatic approach using proxies, indicators or judgement was taken where no target exists for spatial configuration, quality or quantity. Table 2.3 below explains some of the targets used to judge the status of different relationships.

Table 2.3 Targets employed in status analysis for major land-use category-benefit relationships

Relationship	Target	Justification
Mountains, Moors and Heaths, Aesthetics, Spatial Configuration	Assumed target is met	There is no explicit policy target for this relationship. However, government acts on behalf of society to satisfy their demand for large uninterrupted

		landscapes due to market failure (i.e. national parks) and assumption that this demand is being met.
Semi-Natural Grassland, Equable Climate, Quality	Target is SSSI favourable condition	There is no target for GHG emissions from semi-natural grassland. Valuation evidence was available on the change in equable climate benefit should this MLC meet SSSI favourable condition.
Enclosed Farmland, Equable Climate, Quality	None	There is no target for GHG emissions from enclosed farmland. Instead evidence was available on marginal change in GHG emissions given trend in status and this was valued.
Woodland, Wildlife, Quantity	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Here an actual policy target exists that is relevant to the benefit of concern (i.e. the policy's intended impact is to improve this) so we have used this. Assumed that the target applies to all woodland quantity relationships.
Freshwater, Recreation, Quality	Good Ecological Status	Here an actual policy target exists that is relevant to the benefit of concern (i.e. the policy's intended impact is to improve this) so it was used.
Urban, Recreation, Quantity	UKNEA scenario for urban expansion '*Go with the Flow*' compared to a more environmentally focused scenario.	Assumption here is that the target is a more environmentally focused scenario where benefit values are greater compared to the status quo.
Coastal Margins, Aesthetics, Quality	Target is SSSI favourable condition	There is no target for aesthetic value from coastal margins. Valuation evidence was available on the change in 'sense of experience' benefit should this MLC meet SSSI favourable condition.

The assumed target for the quality of the marine environment for food provision is to return to stocking levels where catches could be the same as the average catch between the period 1938 and 1970. In this case the assumed target drives the assessment of status. Another lower level target may result in a more favourable assessment of status.

It should be noted that it is only possible to establish status of MLCs, assets and/or benefits based on the prevailing mix of political, economic, social and institutional drivers that influence them.

For example it is not possible to assess the state of:

- soil as a component of enclosed farmland quality in isolation from fertiliser usage;
- enclosed farmland quantity or quality for food production in isolation from imports; *or*
- enclosed farmland quantity or quality for all benefits in isolation from the Common Agricultural Policy and other policies.

But given that these institutions do exist, the policy relevance of such an analysis may be questioned. To accurately consider the condition of natural capital assets in England, it might be argued that the analysis should remove the 'compensating actions' that society has taken to adjust for the fact that capital in England has degraded. It would, for example, consider a scenario where we could not substitute domestic production of food with imported food and we could not substitute the natural quality of soils by applying artificial fertilisers.

2.8. What is likely to be the future status of MLCs, benefits & assets?

We gathered evidence on the trends in MLCs, benefits and/or assets using metrics developed in Section 2.5.

Only a limited literature review could be carried out within the timescales of the project and this concentrated on gathering high-level (national) evidence on status and trend of MLCs which would correlate most with the valuation work. Therefore, in order to link physical and monetary evidence in this way, an iterative approach was taken. It should be noted that this shallow review of literature also meant that in some cases the evidence was based on figures for England and Wales and others for the UK. This was deemed to be sufficient in order to get order of magnitude figures, but is clearly a weakness in the methodology.

Furthermore, in some cases, evidence is based on a mix of older and more recent figures. For example, the State of the Natural Environment report was produced in 2008 (Natural England, 2008), whereas the SSSI data from JNCC is based on the overall UK publication on Common Standards Monitoring for Designated Sites: First Six Year Report in 2006 (Williams, 2006).

The starting point/reference point on which to base the assessment of a trend is important for the conclusion on the risk associated with it. For example, an MLC may have been severely degraded over the period 1970 to 1990, after which it recovered slowly to a stable condition that is of much lower quality and productivity than prior to 1990, from 1990 onwards the status of the asset is slowly improving. In this situation, beginning a trend at 1970 will give a

significantly different assessment of trend than starting at 1990. Considering the trend between 1970 and 2013 will suggest that there is a downward trend, whereas the trend between 1990 and 2013 suggests an upward trend.

However, it is felt that this effect is mitigated by the assessment of status relative to target. So that even a strongly positive trend can be rated as 'of concern' ('Black', see Section 2.10 below) if the status is very poor relative to target. This is consistent with the risk matrix set out in Section 2.10 below.

Looking ahead to future status raises questions about thresholds/limits. The purpose of identifying thresholds and limits is that these can be used to inform the assessment of unsustainable use. In practice, the scientific evidence is sparse on the presence of thresholds and limits, and this has not contributed towards the assessment of at risk relationships in this project. Instead risk is based solely on the status and trend of MLCs and underlying natural capital assets.

2.9. Uncertainty

Uncertainty in our knowledge of the state of the environment (and the value society places on different states of the environment discussed in Section 2.11) is distinct from risks associated with changes to natural capital (which we might know a lot about).

When gathering evidence on status and trend (and valuation) we have categorised uncertainty of the information using the UKNEA approach:

		Agreement	
		High	*Low*
Robustness	*Significant evidence*	**1**	**3**
	Limited evidence	**2**	**4**

For each relationship we have produced an uncertainty rating for status, trend and valuation evidence using this scale. This provides a score between 1 and 4 for each variable, giving a total potential score of between 3 and 12. For example:

	Status	*Trend*	*Valuation*	Total
Uncertainty	1	4	4	9

This enables a high level view of uncertainty associated with each relationship by providing a total uncertainty score. It also illustrates exactly where the uncertainty lies and whether it relates to the level of agreement or the robustness of evidence. For valuation, level of agreement is with regard to the assumptions made to undertake benefits transfer as opposed to agreement on the actual value itself which will be provided by a range (£x to £y), the values themselves are assumed to be robust given peer review.

2.10. Risk of Unsustainable Use

Based on the Government's Orange Book on the management of risk (HMT, 2004), risk is defined as:

*Risk = Hazard/Impact * Probability/Likelihood*

Probability/Likelihood: The probability of risks materialising from incremental changes in (quantity, quality or spatial configuration of) MLCs (and underlying natural capital assets) will depend on a range of factors, including:

- Status (see Section 2.7)
- Trend (see Section 2.8)
- Threshold effects (Note: it has not been possible to analyse the status and trend information relative to threshold for any relationships, due to a lack of evidence and high uncertainty)

Hazard/Impact: The hazard we are concerned with is the potential loss or gain in welfare associated with marginal changes in MLC natural capital assets (see 2.11).

Therefore, the extent of the hazard/potential impact will depend on society's exposure/vulnerability to it (Foresight, 2012). In terms of natural capital, exposure/vulnerability can be viewed in terms of the extent to which society currently benefits from the asset (current benefit provision) and the trajectory of change in this, which is dependent upon the status and trend of natural capital.

We have already focused our attention on the relationships with greatest benefit provision through the prioritisation of 'Black' relationships (albeit some of high value may inadvertently fall under 'Grey' rating as explained in Section 2.6).

Under this Step we considered status (from Section 2.7) and trend (Section 2.8) information together to decide the level of risk associated with the 73 'Black' rated relationships. This decision was based on the following risk matrix:

		Status		
		A	B	C
Trend	A			
	B			
	C			

The A-C ratings were categorised in the following way:

Rating	Status	Trend
A	-30% from target	+ve (Positive) or +ve –ve (Uncertain)
B	-40% *or* unknown	-ve (Weakly negative) *or* unknown
C	>40% from target	-ve –ve (Strongly negative)

Where possible a % deficiency relative to target has been adopted for status. Where this is not possible either because there is no target or because it is not possible to express in % terms, a rating of B is assumed for status. Where large uncertainty exists for either status or trend, a rating of B is assumed. The overall rating of the relationship will be a combination of status and trend ratings, as set out in risk matrix above.

Annex 2 sets out the risk ratings associated with each of the 73 prioritised relationships, as well as the level of uncertainty associated with the underlying evidence. Uncertainty is illustrated in line with the ratings set out in Section 2.9, for status and trend, based on the following uncertainty ratings:

Circle Size	Level of Uncertainty
	2 to 3
	4 to 5
	6 to 8

Following this step the risk ratings take account of: current benefit provision; potential influence; status and trend. Those that are rated as 'C' are those relationships where: current provision of benefits is significant; society can influence future provision (positively and/or negatively) and available evidence on current status/trend strongly suggests future provision is at significant risk.

[Note we cannot distinguish in Sections 2.7 and 2.8 the impact of society's use of natural capital/ MLCs in isolation of policy (e.g. CAP and imports) or use of substitutes (e.g. fertiliser substitutes for soil quality) but can comment on this where it is significant].

2.11. Should we be concerned about risks to MLCs & benefits provided?

We gathered relevant economic valuation evidence on the (marginal) annual value of benefit that society:

- stands to lose given trends in status relative to baseline; *or*
- would gain if relevant target was met immediately, relative to baseline (will differ for each relationship e.g. GES for freshwater or favourable SSSI status for wildlife).

These values can indicate how concerned society should be about the status and trend of MLC/natural capital assets (the degree of which is informed by status and trend evidence). This provides a register of overall 'risk' = hazard (status & trend) * impact (economic valuation).

It is important to ensure that the metrics used to value marginal changes in the MLC are consistent with those used to assess risk based solely on status and trend. For example, using a marginal value for improving the status of woodland quality to SSSI favourable status for wildlife benefit, is relevant if and only if the assessment of woodland quality for wildlife benefit assumed that the target is SSSI favourable status. If the marginal change that is valued is different to the marginal change associated with assessing the status (i.e. the change in status given trend and/or movement to target), then the analysis will not be consistent. Other elements of value transfer are also relevant to consider when undertaking analysis in the context of a risk assessment for England, such as the population sample, the and the baseline conditions assumed. For simplicity and given time and resource constraints, values have been adopted from the UK NEA (2011) or other studies where the studied scenario fits exactly with the context of this analysis (e.g. Christie & Rayment, 2012).

Values have been derived to give order of magnitude estimates (in £10's millions). The values are highly dependent on targets and other data and assumptions used. They are indicative in order to provide comparisons of the value of natural capital changes to society and hence inform priorities for managing natural capital. Figures are preliminary pending more detailed scrutiny of valuation evidence for key elements of natural capital. Monetary values should not be interpreted in isolation, but taken into account alongside other evidence on status and trends of natural capital.

2.12. What is the cost of improving status and trend?

The intention of this final step was to ask 'can we do anything about natural capital degradation?' and 'how much will it cost?' in order to determine how concerned we should be about degradation of MLCs. Given time and resource constraints, we have considered costs only for those relationships rated 'B' or 'C'.

Different types of cost information were identified:

Restoring the MLC and the underlying natural capital assets

The possibility that natural capital assets/ MLCs can be restored may offset concerns regarding their use. However, as degradation increases, the possibility of irreversible change is likely to increase. In theory, threshold levels of quality could be identified beyond which such restoration becomes increasingly difficult.

Recreating the MLC and the underlying natural capital assets

The possibility that an MLC can be recreated suggests that its degradation may be of less concern. This is because future benefit provision does not rely upon management of the current MLC stock. However, the productivity of recreated MLC in terms of benefit provision is unclear.

Replacing the function of the MLCs and/or benefits with substitute goods/services provided by man-made capital

The risk associated with degradation of natural capital assets/ MLC may be considered of less concern if there is a possibility of replacing the natural functioning of MLCs and the benefits they provide through man-made capital such as SuDS (hazard protection; wildlife) or wastewater treatment (clean water). The extent to which such substitution is considered suitable is a political decision. Rejecting such substitutability will lead to greater concerns over the sustainability of natural capital use than if it is embraced.

For our purposes we have assumed that society demands domestic production of benefits and therefore we do not consider costs of substituting domestic benefits with imported goods and services.

3. Results

This Section sets out the results for the metrics and risk assessment work outlined in Section 2.

3.1. White-Grey-Black Ratings

Annex 1 sets out a matrix with all 240 relationships (between MLC and specific goods/benefits) rated in White-Grey-Black categorisation depending on their current benefit provision and society's ability to influence the relationship, positively and/or negatively (see method Section 2.6).

As Table 3.1 shows, of the 240 relationships, 73 were identified as being 'Black' (i.e. where current provision is high and society could influence future provision significantly). It was considered that society cannot influence the amount of the benefit produced from 87 relationships considered.

Table 3.1 Proportion of relationships falling under White-Grey-Black ratings for major land-use categories

		Major land-use category								
		MMH	**EF**	**SNG**	**W**	**F**	**U**	**CM**	**M**	**TOTAL**
Rating	Black	8	9	5	16	11	13	9	2	**73**
	Grey	12	16	11	9	12	10	7	3	**80**
	White	10	5	14	5	7	7	14	25	**87**
										240

Table 3.1 shows that:

- Out of all MLCs, Woodland, Urban and Freshwater are of greatest interest given the range of benefit they provide (or natural capital assets they degrade, in the case of Urban) and society's ability to influence this provision (although the relative value of these is yet to be considered);

- Out of all MLCs, Marine, Coastal Margins and Semi-natural Grassland are of least interest given the range of benefits they provide and society's ability to influence this provision (although the relative value of these is yet to be considered);

Annex 1 illustrates the ratings for each 'MLC to benefit' relationship, it shows:

- All MLCs could contribute to food provision in the future if we influenced them in such a way, but only Marine and Enclosed Farmland are of interest given current provision and

the assumption that societal preferences will remain constant (i.e. continue to demand food from EF and M);

- Only fibre provision from woodland (timber) is sufficiently large to merit concern from human influence, given the need for human and built capital to manage and harvest commercial timber production;

- No MLCs contribute to current total Energy provision in a significant enough way for human influence to be of concern because we source most Energy provision from sources we are unable to influence in terms of its quality, quantity or spatial configuration (i.e. fossil fuels, wind, wave, solar);

- All MLCs contribute to the provision of wildlife benefit in England and human influence on MLCS is of great concern given the complexity and fragility of habitats and human demand for other land uses (e.g. provision of food, shelter, energy, infrastructure);

- Out of all MLCs, society could significantly impact the provision of the widest number of benefits from woodlands (8) (although the relative value of these is yet to be considered);

- Changes in quantity of Urban and Woodland MLCs are deemed to be most concerning for future benefits from MLCs, this is because increases in Urban area has a large degrading impact on many benefits (e.g. clean air; recreation; aesthetics; wildlife) and underlying natural capital assets (e.g. atmosphere; species);

- Changes in quality of Freshwater MLC are deemed to be most concerning for future benefits from MLC s, because this includes, rivers wetland areas as well as standing water bodies, which have significant range of benefits;

- Society is unable to influence the quantity or spatial configuration of the marine environment at all because of its vast volume. Any changes to intertidal areas other than rock, sand and mud are accounted for under Coastal Margins (e.g. estuaries, coastal lagoons, saltmarsh). Society can influence marine quality in a way that may be significant for provision of benefits in future, such as overharvesting fish species of food and wildlife benefits or improving recreation benefit via artificial reefs.

The relationships to be taken forward to the next prioritisation phase (the 'short-list') are those 73 relationships identified as having 'Black' ratings. This prioritisation brings risks that some relationships that have significant influence on human welfare (e.g. those rated amber but with very high economic value) are omitted from subsequent analysis.

3.2. Risk Ratings

We sought out relevant metrics (ways of measuring) for the status (relative to target) and trend for the 73 'Black' rated relationships and populated these with evidence (see method Section 2.7 and Annex 4: Risk Rating Supporting Evidence on Status and Trend). We then took this information and assessed the risk of changes in their status on an A to E categorisation given current status and trend information (see method Section 2.10 including 'risk scoring

matrix'). A-C ratings were later combined and Annex 2 was developed, which rates each of the prioritised 73 relationships according to this A-C categorisation.

We then analysed what this status, target and trend information might mean in terms of societal welfare/benefit provision (see method in 2.10). We also estimated some indicative costs of restoration or replacement should natural capital degrade. Throughout the process we accounted for uncertainty in evidence gathered using the UKNEA uncertainty approach (see method in 2.9).

Figure 3.1 is a summary illustration of the 73 prioritised relationships for which we were able to identify marginal values for a change in the relationship from current status to a target, on an annual basis assuming the target was met immediately. The values are grouped based on the risk associated with status and trend (A to C).

Figure 3.2 is a summary illustration of the 73 prioritised relationships that it we were able to identify marginal values for changes in the relationship between current status given trend. This assumes an extrapolation of the current trend* on an annual basis. These columns therefore represent the annual movement towards or away from the target (and so will be a proportion of the target column when moving towards it). The values are grouped based on the risk associated with status and trend (A to C).

Figure 3.3 sets out the remaining relationships (of the 73) where no valuation evidence has been identified. Therefore only the risk based on status and trend (A-C) rating is presented.

It is noted that 3.1., 3.2 and 3.3 will be further developed under separate work by the NCC Secretariat.

White-Grey-Black ratings indicate which relationships are at risk, even if we don't know what value we stand to lose. The White-Grey-Black ratings are also important as benefits evidence is only an order of magnitude indication of values.

Figure 3.1 Risk Rating of Prioritised Relationships and Valuation from Current Status to Target

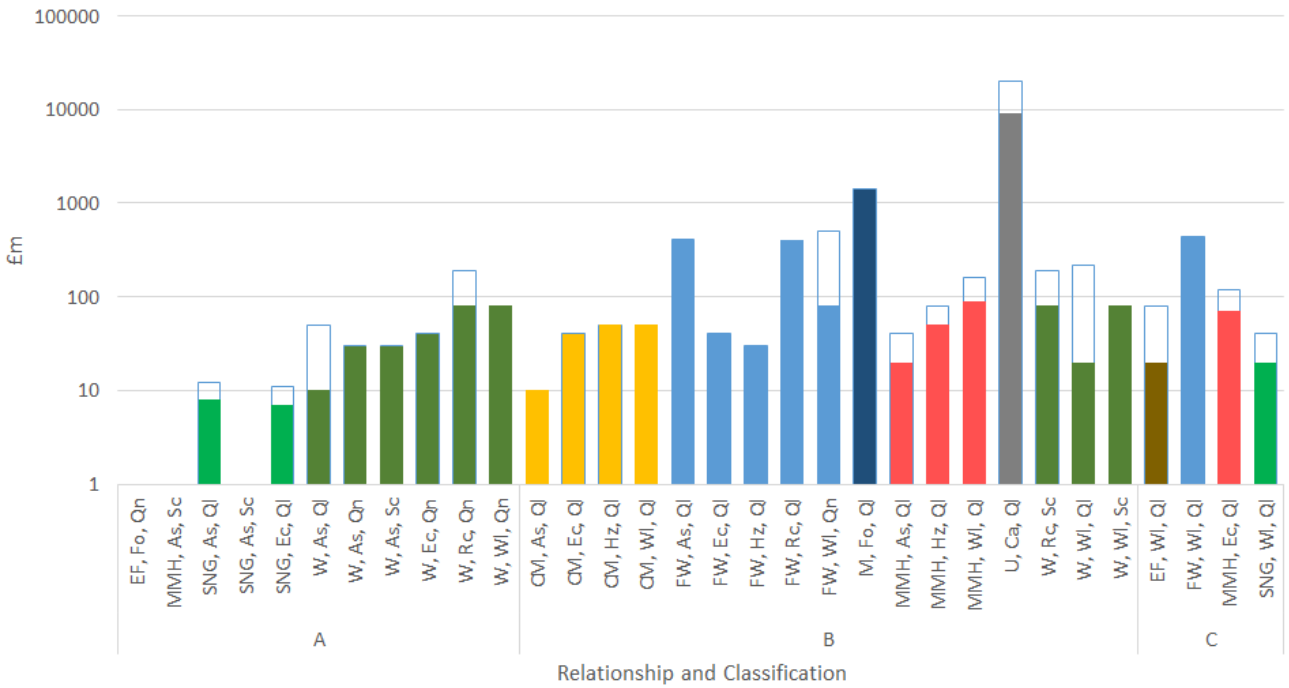


Figure 3.2 Risk Rating of Prioritised Relationships and Valuation from Current Status given Trend

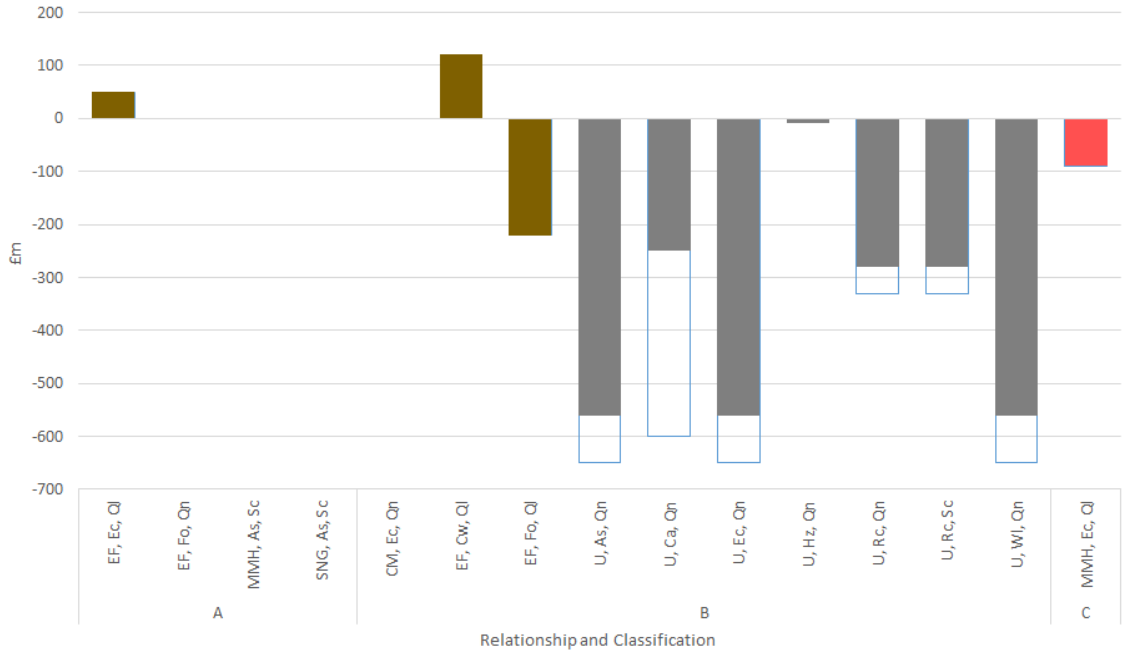


Figure 3.3 Risk Rating of Unvalued Prioritised Relationships

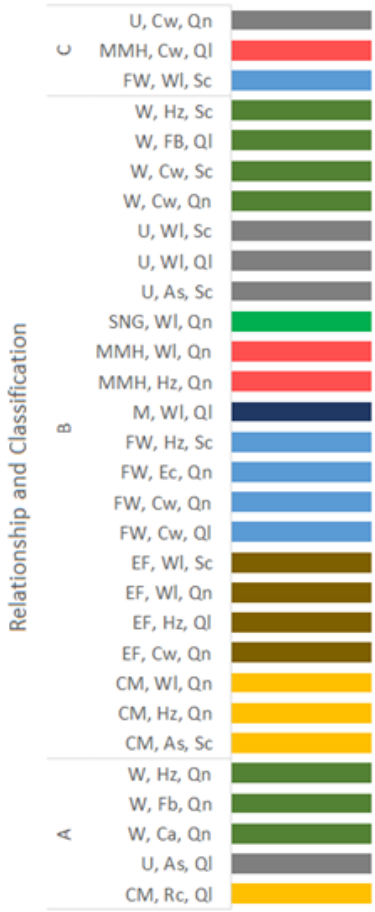


Table 3.2 provides a brief explanation of how to interpret Figures 3.1 and 3.2. An expanded explanation is provided in Annex 3, Table A3.1.

Table 3.2 Accompanying Explanation of Figures 3.1 & 3.2

Question	Answer
What do the columns represent?	Each of the columns represents one of the 73 prioritised relationships that we have been able to monetise. Some of the marginal values are £0m (hence the 'spaces' on the x-axis).
What do the horizontal boxes represent?	The boxes under each of the ratings (A-C) represent one of the 73 prioritised relationships that we have **not** been able to monetise.
Why are the columns different colours?	Each of the colours represents a different MLC: **MMH** **EF** **SNG** **W** **FW** **U** **CM** **M**
Why is there a more transparent section at the top of some columns?	This represents the range in values for the marginal change considered.
Why are there three graphics?	Figure 3.1 sets out the value where the marginal change is from current status to target, on an annual basis assuming the target was met immediately. The values are grouped based on the risk associated with status and trend (A to C). Figure 3.2 is the value of the relationship where the marginal change is from current status assuming an extrapolation of the current trend* on an annual basis. These columns therefore represent the annual movement towards or away from the target (and so will be a proportion of the target column when moving towards it). The values are grouped based on the risk associated with status and trend (A to C). Figure 3.3. is the relationships where no valuation evidence has been identified. Therefore only the risk based on status and trend (A-C) rating is presented. * Note: trends are worked out for different time periods for different MLCs, for details see Annex 4.

Table 3.3 shows the proportion of the 73 prioritised relationships falling under each risk rating band.

Table 3.3 Number of Relationships by Risk Rating

Risk Rating	Number
A	17
B	49
C	7

The high number of relationships under 'B' rating is primarily an outcome of the fact that where no evidence is available, we have classified the status and/or trend as a 'B' rating. We have done this as a precaution because the status and/or trend may be severely degraded with a negative trend and in the absence of information to the contrary we have rated these 'unknowns' as 'B'. (Note the overall rating of the relationship will be outcome of both status and trend, according to the risk matrix in methodology in 2.10).

Annex 4 sets out a summary of the identified evidence base which underpins each relationship rating 'A' to 'C' (i.e. it sets out the populated metrics for status, trend and valuation). We provide a summary for each of the ratings below.

'A' Rated Relationships

Aesthetic benefit associated with spatial configuration of MMH and SNG was considered to have a marginal value of £0m based on assumption that aesthetic benefits are at 'target' level because government acts on behalf of society to satisfy demand for vast uninterrupted landscapes through designating national parks and AONB.

Food benefit is not at risk from quantity of EF as information on quantity of agricultural land now and in the past (as well as the extent of food imports), suggests that the provision of food for consumption in England is not limited by this, suggesting 'target' for quantity of EF is met.

6 out of 17 'A' rated relationships refer to woodland quantity, the status of which is based on a target of 12% with current status at 9% (i.e. a 30% deficit). Trend in woodland quantity is increasing according to ONS. Most valuation evidence based on UKNEA.

Aesthetic value from spatial configuration of woodland is valued by splitting the estimated value of woodland expansion equally between quantity and spatial configuration.

The equable climate benefit associated with the quality of enclosed farmland is focused on methane emissions which have no target (i.e. 'D' rating for status) but the trend is strongly declining (i.e. positive, 'A' rating) based on UKNEA evidence of approximately 20% fall from 1990.

'B' Rated Relationships

49 of the relationships are categorised under 'B'. The urban environment is particularly damaging to natural capital assets. Therefore, an increase in the extent of urban areas is expected to result in declines in the value of all benefits that rely upon these assets for their provision, specifically recreation, aesthetics, clean air, wildlife and equable climate. Estimated valuation is based upon *Go With The Flow* scenario in UKNEA, which suggests a trend of 3% growth in urban areas between 2011 and 2060, and split equally between these benefits.

The quality of the Urban MLC impacts natural capital assets and the benefits they contribute to producing profoundly. This is especially true for the impact of the Urban MLC on the atmosphere as a natural capital asset, and the provision of clean air that it contributes to. An assumed target to remove the negative health impacts associated with $PM_{2.5}$, has an estimated value of between £9bn/yr to £20bn/yr.

The quality of the Marine MLC for the provision of food benefit includes the integrity of species which is impacted by built capital (as explained through the production functions). Assuming a target to restore fish stock levels to enable average annual catches equal to that over the period 1938 – 1970 (assuming that this reflects a sustainable harvest level), has a value based on today's market value for demersal and pelagic fish is £1.4bn.

The quality of Enclosed Farmland for food benefit is not limited by degradation in the soil itself as evidence suggests that this has in part, been replaced by the increased use of fertiliser. However, pollination is identified as a key natural capital asset input to the production function of this MLC, the status of which is unknown (i.e. 'B') and evidence suggest that the trend is negative. A worst case scenario for the lost value of pollination given trends in abundance and diversity is a cost of £215m/yr, based on UKNEA figures.

Recreation and aesthetic benefits from freshwater are linked closely with its quality and the estimated valuation is relatively high, for explanation of this, see 'C' rated relationships below on freshwater quality. The quantity of Freshwater MLC is important for wildlife, based on targets for marginal increases in wetland quantity of 1.1% of current extent and UKNEA values, the value of increasing quantity of wetland area is £80m/yr to £500m/yr.

The clean water benefit from an improvement in enclosed farmland quality to an assumed target where the nitrate loading is reduced by 50%, results in a benefit of £120m/yr.

Lack of information on the cost to wastewater treatment works associated with declines in the quality of Freshwater and Woodland major land use categories, mean we have used a lower bound figure of £0m marginal cost for clean water provision. This is based on Morris and Camino (2012) suggesting that direct market benefits of improved water quality to GES are unlikely to be significant (as drinking water standards are so high so water still needs to be treated).

Much of the relationships under 'B' that have not been explained in points above relate to the quality of MLC s. In these cases, the Christie and Rayment (2012) paper has been used to

estimate the marginal value associated with improving the quality of the MLC to favourable condition from its current status.

'C' Rated Relationships

7 of the relationships are categorised under 'C'. These are relationships were we can be sure that the status is poor and that the trend is strongly negative.

Equable climate benefit from the quality of Mountains, Moors and Heaths is at greatest risk due to high rates of soil erosion and carbon release. Evidence suggests that status is <40% away from target, based on SSSI condition and trend is strongly negative based on soil erosion rates (UKNEA; Evans and Warburton, 2007). Marginal value associated with improved 'equable climate' if Mountains, Moors and Heaths were to meet favourable condition is estimated at between £70m/yr to £120m/yr (Christie & Rayment, 2012). The value of 'equable climate' impacts associated with trends in peatland erosion is a cost of £90m/yr. Total deficiency in value to society of approximately £160m/yr to £210m/yr.

The wildlife benefit associated with the quality of freshwater is also a significant risk. This is based on Environment Agency evidence that only 27% of freshwater bodies are in WFD 'good ecological status'. UKNEA evidence suggests the trend in freshwater wildlife is declining. Valuation of £1.2bn for marginal improvement in recreation, biodiversity and aesthetics associated with meeting GES (Morris and Camino, 2011), in absence of information we split this figure equally across these benefits (recreation and aesthetics fall under 'B' based on trend information).

Lack of information on the cost to wastewater treatment works associated with declines in the quality of Mountains, Moors and Heaths and Urban major land-use categories, mean we have used a lower bound figure suggesting £0m marginal cost for clean water provision. This is based on Morris and Camino (2012) suggesting that direct market benefits of improved water quality to GES are unlikely to be significant (as drinking water standards are so high so water still needs to be treated).

Despite the status in the quality of Semi-natural Grassland for wildlife benefit being <20% away from target (i.e. 'A), evidence from Countryside Survey on the trend suggests this is strongly negative (i.e. 'C'). Marginal value associated with improved 'charismatic and non-charismatic species' if Semi-natural Grassland were to meet favourable status is estimated at between £20m/yr to £40m/yr (Christie & Rayment, 2012).

Evidence on the status in the quality of Enclosed Farmland for wildlife benefit from the UKNEA (2011) is that it is at least 50% away from target for SSSI favourable condition (i.e. 'C'). There is mixed evidence on the trend in the condition of the MLC and wildlife benefit. Valuation evidence is based on agri-environment scheme payments assuming that the wildlife benefits from AES are at least as valuable as the payments made, estimated at £20m/yr to £80m/yr.

Table 3.4 shows each of the 73 prioritised relationships in terms of the MLC characteristic, according to risk rating.

Table 3.4 Risk by MLC Characteristic

Risk Rating	Quality	Quantity	Spatial Configuration
A	6	8	3
B	21	18	10
C	5	1	1

Table 3.4 shows that:

- changes in the quality of MLCs is of highest concern as 26 of 73 relationships that are 'B' or 'C' rated are for risks associated with this;
- changes in the quantity of MLCs is also of concern as 19 of 73 relationships that are 'B' or 'C' rated are for risks associated with this; and
- spatial configuration is of concern as 11 of 73 that are 'B' or 'C' rated are for risks associated with this. However, this relates mainly to the fact that the status and trend of this are unknown, which relates in part to the fact that there is no target for spatial configuration.

Table 3.5 shows each of the 73 prioritised relationships in terms of the benefits that are at risk, according to risk rating.

Table 3.5 Risk by Benefit

Risk Rating	Food	Fibre	Energy	Clean Water	Clean Air	Recr-eation	Aesthetics	Wildlife	Hazard Protection	Equable Climate
A	1	1	0	0	1	2	7	1	1	3
B	2	1	0	6	2	4	6	14	9	5
C	0	0	0	2	0	0	0	4	0	1

Table 3.6 'B' and 'C' relationships by Benefit & Characteristic

Charact-erstic	Food	Fibre	Energy	Clean Water	Clean Air	Recr-eation	Aesthetics	Wildlife	Hazard Protection	Equable Climate
Quality	2	1	0	3	1	1	3	8	4	3
Quantity	0	0	0	4	1	1	1	6	3	3
Sp. Config	0	0	0	1	0	2	2	4	2	0

Table 3.5 shows that:

- wildlife is at greatest risk, as 18 of the 73 relationships are 'B' or 'C' rated for wildlife provision;
- hazard protection benefits are also at risk as 9 of the 73 relationships are 'B' or 'C' rated for this;
- clean water is at risk as 8 of the 73 relationships are 'B' or 'C' rated for this benefit;
- aesthetics and equable climate is at risk as 6 of the 73 relationships are 'B' or 'C' rated for this benefit; and
- energy provision is not at risk from changes in MLC .

It should be noted that the relative value of these at risk relationships has not been set out here. Further Tables summarising the results with such valuation evidence are set out in Annex 5.

Table 3.6 below shows the 56 'B' or 'C' rated relationships in terms of characteristic and benefit they relate to.

Table 3.6 shows that:

- changes in the quality of MLC pose a risk to all benefits apart from energy;
- changes in the quality of MLC are especially important for wildlife and hazard protection benefits;
- changes in the quantity of MLC are especially important for wildlife and clean water provision; and
- changes in the spatial configuration of MLC are especially important for wildlife provision.

3.3. Uncertainty

Table 3.7 provides a breakdown of the identified evidence that was used to rate the relationships on A-C risk categorisation for the 73 prioritised relationships.

Table 3.7 Evidence Supporting Risk Ratings

Evidence Identified?	A	B	C	Total
Identified status, trend and valuation evidence	10	17	6	33
Identified either status or trend, and valuation evidence	2	12	0	14
Status and trend not relevant, valuation £0m	2	0	0	2
Identified both status and trend but not valuation	3	1	0	5
Identified either status or trend but not valuation	0	8	1	9
No evidence on status, trend or valuation found	0	9	0	9
No evidence on status or trend, but valuation estimate using assumptions	0	2	0	2
				73

Table 3.7 shows:

- we identified evidence on status, trend and valuation for 33 out of a total of 73 relationships;
- we were able to estimate economic value of a marginal change (associated with trend or to meeting a target) for 51 relationships (The 22 unvalued relationships are the horizontal boxes in Figures 3.1 and 3.2); *and*
- we were not able to identify any evidence at all for 9 relationships out of 73.

Table 3.7 summarises where there are gaps in our knowledge regarding the status of natural capital and what this might mean for societal welfare in terms of economic value. However, it should be noted that our literature review was limited by time and resource constraints and was by no means exhaustive, so information may exist that has not been identified. Moreover, these constraints mean that although information has been identified, it may not be the best information and it is suggested that further research is conducted to corroborate and refine the evidence used.

We also identified the uncertainty associated with the evidence underpinning each relationship (see methodology in 2.9). Uncertainty ratings are scored on a scale from 3 to 12. Table 3.8 sets out the average uncertainty rating for the A-C categories.

Table 3.8 Uncertainty of Evidence by Risk Rating

Risk Rating	Average Uncertainty
A	9
B	10
C	9

Table 3.8 shows that the average uncertainty of evidence on which the risk ratings are decided, as well as the valuation evidence used is between 9 and 10 across all risk ratings. This suggests that although we were able to identify status, trend and valuation information for many of the relationships, there is a great deal of uncertainty across all evidence.

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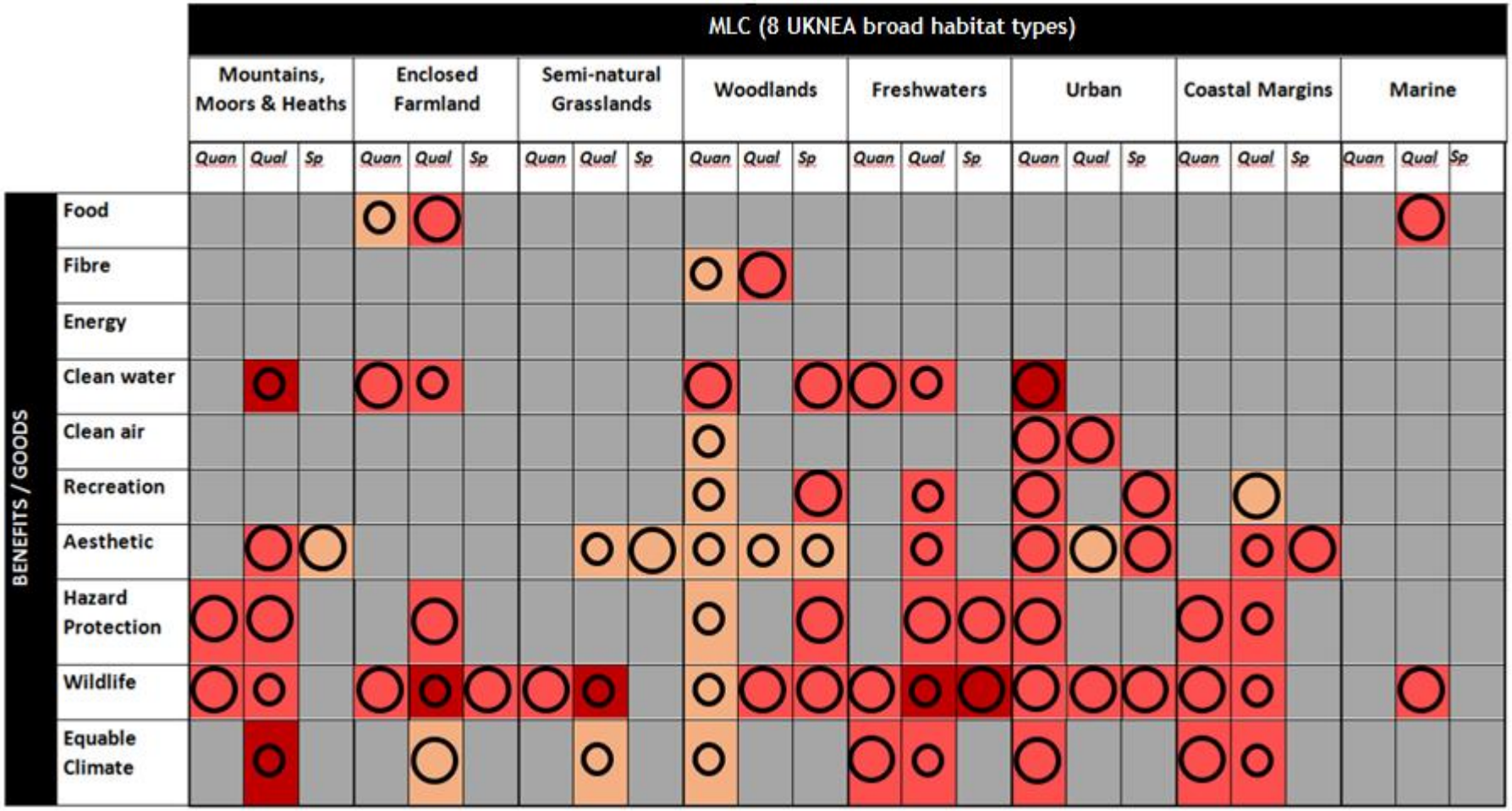
ANNEX 1 – STAGE 1 WHITE-GREY-BLACK PRIORITISATION

BENEFITS / GOODS	MAJOR LAND-USE CATEGORIES (8 UKNEA broad habitat types)																							
	Mountains, Moors & Heaths			Enclosed Farmland			Semi-natural Grasslands			Woodlands			Freshwaters			Urban			Coastal Margins			Marine		
	Quan	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*	*Quan*	*Qual*	*Sp*
Food																								
Fibre																								
Energy																								
Clean water										(?)														
Clean air																								
Recreation																								
Aesthetic																								
Hazard Protection	(?)	(?)																						
Wildlife	(?)																							
Equable Climate								(?)											(?)	(?)				

Key

Society cannot influence benefit from MLC	
Minor/moderate impact on benefit from MLC	
Major impact on benefit from MLC	
Landscape continuity impacted by development/mining	
Uncertainty over relationship	?
Significant interactions	X

ANNEX 2 – STAGE 2 RISK ABC RATINGS



Key

Rating	Status & Trend
	-30% from target & either positive/uncertain trend
	-40% from target/ uncertain & either weakly negative/unknown trend
	>40% from target & strongly negative trend
Rating	**Level of Uncertainty**
	2 to 3
	4 to 5
	6 to 8

ANNEX 3 – EXPLANATION OF RISK GRAPHICS

Table 12. Expanded Explanation of Figure 1 & 2

Question	Answer
What is being measured on the x-axis?	The risk ratings (A to C) for each of the prioritised relationships, based on status and trend information, using the risk matrix (see method Step 9).
What is being measured on the y-axis?	The marginal value of change, which may relate to change in benefit provision either: i) from current status to target; *or* ii) from current status given trend
What do the columns represent?	Each of the columns represents one of the 73 prioritised relationships that we have been able to monetise. Some of the marginal values are £0m (hence the 'spaces' on the x-axis).
What do the horizontal boxes represent?	The boxes under each of the ratings (A-C) represent one of the 73 prioritised relationships that we have **not** been able to monetise.
Why are the columns different colours?	Each of the colours represents a different MLC: **MMH**, **EF**, **SNG**, **W** **FW**, **U**, **CM**, **M**
Why is there a more transparent section at the top of some columns?	This represents the range in values for the marginal change considered.
Why are there three graphics?	Figure 3.1 sets out the value where the marginal change is from current status to target, on an annual basis assuming the target was met immediately. The values are grouped based on the risk associated with status and trend (A to C). Figure 3.2 is the value of the relationship where the marginal change is from current status assuming an extrapolation of the current trend* on an annual basis. These columns therefore represent the annual movement towards or away from the target (and so will be a proportion of the target column when moving towards it). The values are grouped based on the risk associated with status and trend (A to C). Figure 3.3. is the relationships where no valuation evidence has been identified. Therefore only the risk based on status and trend (A-C) rating is presented. * Note: trends are worked out for different time periods for different MLCs, for details see Annex 4.
Should we always expect +ve columns in A ratings?	Not necessarily, the ratings are a combination of status and trend. All relationships rated A have moderately good status (within 30% of target) but are either moving towards the target (in which case have +ve column) or have an uncertain trend (see risk matrix Step 9).

Should we always expect –ve columns in B and C ratings?	Yes, the ratings are a combination of status and trend. For all B and C rated relationships the status is poor (at least 40% away from target) and with a declining trend (see risk matric Step 9). [N.B. It may be that a B rated relationship has an unknown value in which case there is no column.]

ANNEX 4 – RISK RATING SUPPORTING EVIDENCE ON STATUS & TREND ABC

We set out here all 73 relationships identified in the first Stage of the analysis as being of most interest (i.e. 'Black' rating) according to their risk rating. We provide an explanation as to how a decision on risk rating was made and the valuation evidence that was used through a range of illustrative examples. We start with those relationships rated as 'A' and move through to 'C'.

The Table below explains out how the Annex 2 Table's should be interpreted.

<table>
<tr><th>MLC</th><th>Benefit</th><th>Characteristic</th><th>Value
(mil/yr)</th><th colspan="2">Current Status</th><th>Target</th><th>Trend</th><th>RAG
(A-E)</th></tr>
<tr><td rowspan="3">What is the accounting unit?</td><td rowspan="3">What benefit are we concerned with from the MLC?</td><td rowspan="3">What characteristic of the A-U are we concerned with? [Quantity, Quantity or Spatial Configuration]

Quality sets out production functions, with underlying natural capital assets. Those in red can be influenced and are important to provision of ES benefit from MLC.</td><td>What is the evidence for the marginal value of ES provision (i.e. welfare) given the change in condition of the MLC:

– Based on trend in status of the MLC?; or

– Associated with meeting a policy target?</td><td colspan="2">What is the status of the relationship relative to a defined target?</td><td>What is the trend in the relationship?</td><td rowspan="3">RAG
(Overall RAG based on risk matrix, Step 9)

Total Uncertainty

(Summation of Uncertainty)</td></tr>
<tr><td></td><td colspan="2">RAG rating for Trend</td><td>RAG rating for Status</td></tr>
<tr><td>Uncertainty of Valuation</td><td colspan="2">Uncertainty of Trend</td><td>Uncertainty of Status</td></tr>
</table>

Figure 2 illustrates the relationships that were rated as being 'Black' (of concern) based on Stage 1 (ES provision and potential influence), and 'A' based on stage 2 (status and trend) as well as the value of marginal change (from current status, given trend or to target).

Figure 2. 'A' Rated Relationships

2a. 'A' Risk Rating and Valuation from Current Status to Target

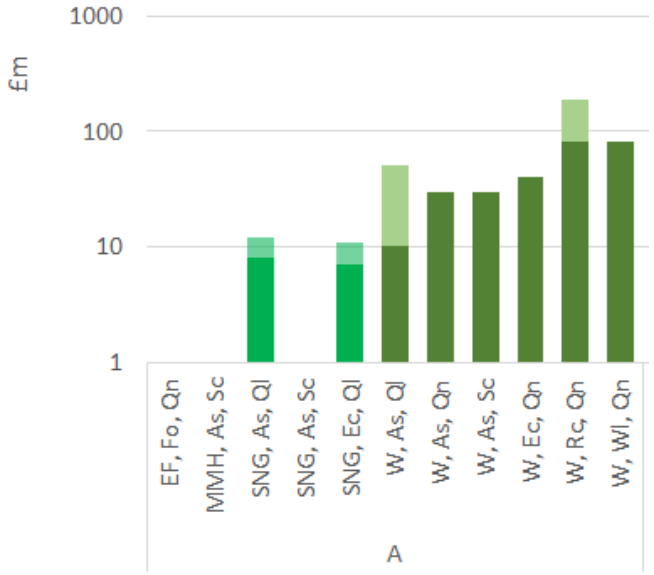
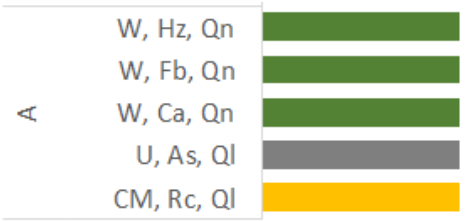


Figure 2b. ‘A’ Risk Rating and Valuation from Current Status given Trend

2c. ‘A’ Risk Rating no Valuation



MMH, As, Sc: Aesthetic Benefit from the Spatial Configuration of Mountains Moors and Heaths A-U

EF, Fo, Qn: Food Benefit from the Quantity of Enclosed Farmland A-U

SNG, As, Sc: Aesthetic Benefit from the Spatial Configuration of Semi-natural Grassland A-U

W, As, Ql Aesthetic Benefit from the Quality of Woodland A-U

CM, As, SC: Aesthetic Benefit from the Spatial Configuration of Coastal Margin A-U

SNG, As, Ql: Aesthetic Benefit from Quality of Semi-natural Grassland A-U

SNG, Ec, Ql: Equable Climate Benefit from Quality of Semi-natural Grassland A-U

W, Fb, Qn: Fibre from Quantity of Woodland

W, Ca, Qn: Clean Air from Quantity of Woodland

W, As, Qn: Aesthetic Benefit from Quantity of Woodland

W, As, Sc: Aesthetic Benefit from Spatial Configuration of Woodland

W, Ec, Qn: Equable Climate Benefit from Quantity of Woodland

EF, Ec, Ql: Equable Climate Benefit from Quality of Enclosed Farmland

W, Wl, Qn: Wildlife Benefit from Quantity of Woodland

W, Rc, Qn: Recreation Benefit from Quantity of Woodland

W, Hz, Qn: Hazard Protection Benefit from Quantity of Woodland

CM, Rc, Ql: Recreation Benefit from Quality of Coastal Margins

U, As, Ql: Aesthetic Benefit from Quality of Urban

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
MMH	Aesthetics	Spatial Configuration	-	Assumed target met based on Government ability to designate areas to meet societal preferences.		N/A	**A**
			(4)	(4)		(4)	(12)
EF	Food	Quantity	£0 Evidence suggests able to respond to increased demand by increasing total quantity of land or UAA. Therefore marginal cost to society due to trend in quantity of EF is £0m.	52.1% of land area in England is EF (Defra, 2013) The utilised agricultural area (UAA) in England is 9.0 million hectares (Defra, 2013) Assume meeting necessary societal demands (no specific target) - quantity not limiting factor		UAA in England increased by 1% between 2012 and 2013 from 8.9 to 9.0 million hectares (Defra, 2013) Production increased since 1945 driven by technology and policy (UK NEA, 2011)	**A** (8)
				A		**A** +ve	
			(2)	(4)		(2)	
			(4)	(2)		(3)	
SNG	Aesthetics	Spatial Configuration	£0 It is assumed that society is satisfied with the aesthetic value from SNG, suggesting a marginal value of trend is £0m.	Assumed target met based on Government ability to designate areas to meet societal preferences.		N/A	**A** (12)
			(4)	(4)		(4)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
W	Aesthetics	Quality	+£10 to +£50 (TGT) Based on consumer surplus to meet favourable SSSI status (£0.27/hh/yr) (Christie and Rayment, 2012) = £10mil/yr if applied to SSSIs, £50mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 86% of SSSI woodland and wood-pasture is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	No significant change in species richness in broadleaved or coniferous woodland between 1998 and 2007 (Countryside Survey 2007)	
				A (-30% from target)		**A** (stable)	
			(4)	(2)		(2)	
SNG	Aesthetics	Quality	+£10 (TGT) Based on consumer surplus to meet favourable SSSI status (£0.39/hh/yr) (Christie and Rayment, 2012) = £8mil/yr if applied to SSSIs, £12mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 83% of SSSI grassland (all types) is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Neutral grassland stable condition and significant increase in area, calcareous grassland stable and under management to conserve, mixed improvements and declines in acid grassland (Countryside Survey 2007)	**A** (9)
				A (-30% from target)		**A** (stable)	
			(4)	(2)		(3)	
SNG	Equable climate	Quality	+£10 (TGT) Based on consumer surplus to meet favourable SSSI status (£0.34/hh/yr) (Christie and Rayment, 2012) = £7mil/yr if applied to SSSIs, £11mil/yr if also	By area, 83% of SSSI grassland (all types) is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Neutral grassland stable condition and significant increase in area, calcareous grassland stable and under management to conserve, mixed improvements and declines in acid grassland (Countryside Survey 2007)	**A** (9)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			applied to non-SSSIs and assume same proportion improve	**A** (-30% from target)		**A** (stable)	
			(4)	(2)		(3)	
EF	Equable climate	Quality	+£50 (TRND) Social cost of carbon values: £57/tCO2e for sectors not covered by the EU ETS (DECC, 2009). Assuming continued decline in emissions, at similar proportion, marginal value of reduction in CH_4 will be £50m/yr (over 20 years)	Greenhouse gas emissions from agriculture = ~7.0% of the UK total (UK NEA, 2011) Agriculture was responsible for 43% of total UK methane emissions; 84% of total nitrous oxide emissions; and 86% of total ammonia emissions in 2012 (UK NEA, 2011)	No target	From 1990 emissions declined - nitrous oxide (-23%), methane (-18%) and carbon dioxide (-19%) (UK NEA, 2011) 2000- 2011 soil nutrient balances for nitrogen and phosphorus are estimated to have fallen (19% and 33% respectively) indicating a reduction in the nutrient surpluses which could be lost to the environment (Defra, 2012 - AUK)	**A** (7)
				B (unknown)		**A** (+ve +ve)	
			(1)	(4)		(2)	
W	Fibre	Quantity	£0 85% of domestic demand for wood is met from imports (Forestry Commission, 2004). Quantity not limiting factor, marginal increase =	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			£0mil/yr	**A** (-30% from target)		**A** (+ve)	
			(4)	(2)		**(2)**	
W	Clean air	Quantity	£0 Air pollution absorption by GB Forests per year £0.5m (UKNEA, 2011). £0.9m/yr (Powe &Willis, 2004) £0.4 million per year (Willis et al., 2003) Assume increase in area of woodland gives proportionate increase in air pollutant absorption, range between 9% and 12% is £0.13 and 0.3mil/yr respectively	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)
				A (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	
W	Recreation	Quantity	+£80 to +£190 (TGT) Recreation visits value from GB Forests per year £484mill/yr (UKNEA, 2011; Willis *et al*. 2003). With value of forest-reliant game	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			shooting = £1,124mill/yr. Increase in recreational visit value following trend, range between 9% and 12% gives £80 and £190mil/yr respectively (divided with spatial configuration)	**A** (-30% from target) (2)		**A** (+ve) (2)	
			(4)	(2)		(2)	
W	Aesthetics	Quantity	+£30 (TGT) Aesthetic (landscape) value from GB Forests per year £185m (UKNEA, 2011). £150 million per year (Willis *et al*., 2003) Increase in aesthetic value following trend, range between 9% and 12% gives £25 and £30mil/yr respectively (divided with spatial configuration)	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)
				A (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	
W	Aesthetics	Spatial Configuration	+£30 (TGT) Increase in aesthetic value following trend, range between 9% and 12% gives £25 and £30mil/yr respectively (divided with	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			quantity)	**A** (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	
W	Hazard protection	Quantity	-	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)
				A (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	
W	Wildlife	Quantity	+£80 (TGT) Biodiversity from GB Forests per year £476m. Increase in wildlife value to target gives £157m/yr. Cannot separate value between quantity and spatial configuration = £80mil/yr	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)
				A (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
W	Equable climate	Quantity	+£40 (TGT) Carbon sequestration by GB Forests: £115 mill/yr (UK NEA 2011, Willis 2003). Increase in climate regulation value to target (12% woodland cover) gives £40m/yr.	9% of England is wooded (UK NEA, 2011)	12% woodland cover by 2060 (Defra Forestry and Woodlands Policy Statement, 2013)	Since 1945, the area of woodland has doubled to cover 12% of the UK (UK NEA, 2011) Total area of the UK covered by woodland increased by 0.3% 2010-2011 (ONS, 2012)	**A** (8)
				A (-30% from target)		**A** (+ve)	
			(4)	(2)		(2)	
U	Aesthetics	Quality	-	Taking residents' satisfaction with local parks and green spaces as an indicator of condition, on average 73% of urban residents in England are 'satisfied' or 'highly satisfied' (NAO, 2006) (eftec, asset check)	No formal or statutory target for the 'performance' of urban green space Assume that everyone (100%) should be satisfied with greenspace.	Decline in quality of urban green space in England has been halted in most areas and there are signs of recovery in many places (NAO, 2006). In 2005, 16% of green space managers perceived the condition of urban green space in their local authority to be declining, 41% stable, and 43% improving (NAO, 2006) (eftec, asset check)	**A** (12)
				A (-30%)		**A** (+ve)	
			(4)	(4)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
CM	Recreation	Quality	-	England's coastline is estimated to be over 7,000 km in length (SoNE 2008) In 2008, 17 bathing waters failed to meet the mandatory standard. 16 of these were in England . (EA, Our Corporate Strategy 2010-2015 Evidence: water).	Right of access to all the coast of England has been created by the Marine and Coastal Access Act 2009 (UK NEA, 2011) Bathing Water Directive	2013 - 55 beaches received the Blue Flag, this is down on the 79 for 2012 (Daily Mail, 2013) Bathing water quality has improved over time. In 2008, 97% of bathing waters in England and Wales met water quality standards, compared to 78% in 1990 (EA, Our Corporate Strategy 2010-2015 Evidence: water)	**A** (11)
				A (+ve -ve)		**A** (+ve -ve)	
			(4)	(4)		(3)	

Figure 5 illustrates the relationships that were rated as being 'Black' (of concern) based on Stage 1 (ES provision and potential influence), and 'B' (high concern) based on stage 2 (status and trend) as well as the value of marginal change (from current status, given trend or to target).

Figure 5. 'B' Rated Relationships

2a. 'B' Risk Rating and Valuation from Current Status to Target

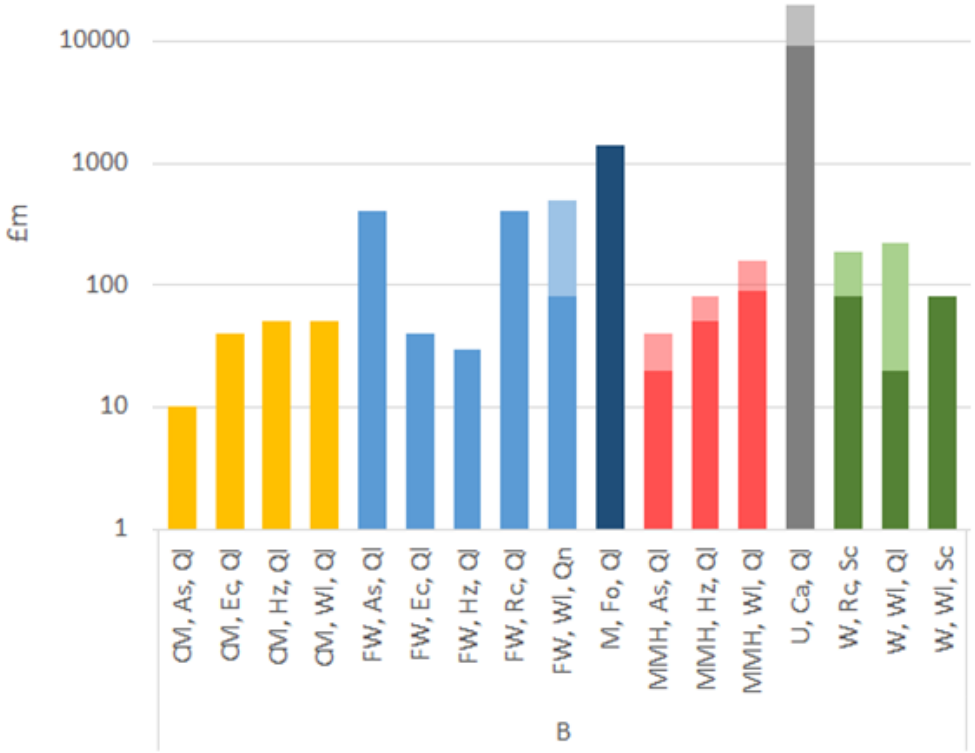
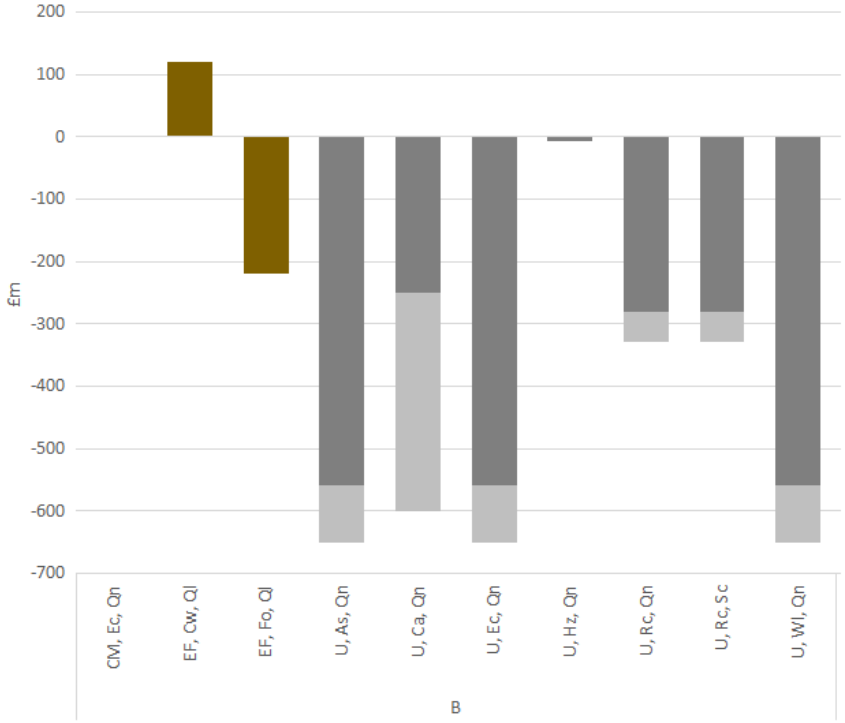
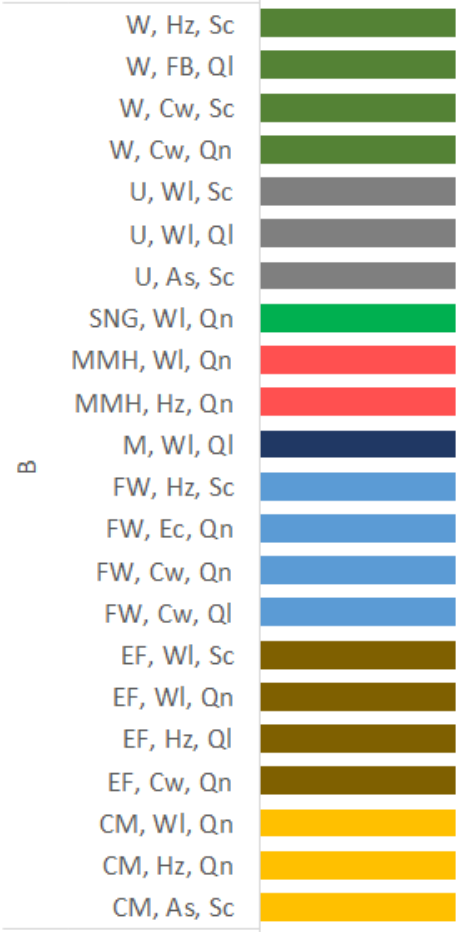


Figure 2b. 'B' Risk Rating and Valuation from Current Status given Trend



2c. ‘B’ Risk Rating no Valuation



FW, Cw, Ql: Clean Water from the Quality of Freshwaters A-U
FW, Cw, Qn: Clean Water from the Quantity of Freshwaters A-U
CM, Ec, Qn: Equable Climate Benefit from the Quantity of Coastal Margins A-U
U, Hz, Qn: Protection from Hazards from the Quantity of Urban A-U
CM, As, Ql: Aesthetic Benefits from the Quality of Coastal Margins A-U
FW, Hz, Ql: Protection from Hazards from the Quality of Freshwaters A-U
FW, Ec, Ql: Equable Climate Benefits from the Quality of Freshwaters A-U
MMH, As, Ql: Aesthetic Benefits from the Quality of Mountains, Moorlands and Heaths A-U
CM, Ec, Ql: Equable Climate Benefits from the Quality of Coastal Margins A-U
CM, Hz, Ql: Protection from Hazards from the Quality of Coastal Margins A-U
CM, Wl, Ql: Wildlife Benefit from the Quality of Coastal Margins A-U
MMH, Hz, Ql: Protection from Hazards from the Quality of Mountains, Moorlands and Heaths A-U
EF, Wl, Ql: Wildlife Benefit from the Quality of Enclosed Farmland A-U
W, Wl, Sc: Wildlife Benefit from Spatial Configuration of Woodlands A-U
MMH, Wl, Ql: Wildlife Benefits from the Quality of Mountains, Moorlands and Heaths A-U
EF, Cw, Ql: Clean Water from the Quality of Enclosed Farmland A-U
W, Rc, Sc: Recreational Benefits from Spatial Configuration of Woodlands A-U
W, Wl, Ql: Wildlife Benefits from the Quality of Woodlands A-U
EF, Fo, Ql: Food from the Quality of Enclosed Farmland A-U
FW, Rc, Ql: Recreational Benefits from the Quality of Freshwaters A-U
FW, As, Ql: Aesthetic Benefits from the Quality of Freshwaters A-U
FW, Wl, Qn: Wildlife Benefits from the Quantity of Freshwaters A-U
U, Ca, Qn: Clean Air from the Quantity of Urban A-U
U, Rc, Qn: Recreational Benefits from the Quantity of Urban A-U
U, As, Qn: Aesthetic Benefits from the Quantity of Urban A-U
U, Wl, Qn: Wildlife Benefits from the Quantity of Urban A-U
U, Ec, Qn: Equable Climate Benefits form the Quantity of Urban A-U
MMH, Ec, Ql: Equable Climate Benefits from the Quality of Mountains, Moorlands and Heaths A-U
M, Fo, Ql: Food from the Quality of Marine A-U
U, Ca, Ql: Clean Air from the Quality of Urban A-U
U, Hz, Qn: Protection from Hazards from the Quantity of Urban A-U
CM, As, Ql: Aesthetic Benefits from the Quality of Coastal Margins A-U
FW, Hz, Ql: Protection from Hazards from the Quality of Freshwaters A-U

FW, Ec, Ql: Equable Climate Benefits from the Quality of Freshwaters A-U
MMH, As, Ql: Aesthetic Benefits from the Quality of Mountains, Moorlands and Heaths A-U
CM, Ec, Ql: Equable Climate Benefits from the Quality of Coastal Margins A-U
CM, Hz, Ql: Protection from Hazards from the Quality of Coastal Margins A-U
CM, Wl, Ql: Wildlife Benefit from the Quality of Coastal Margins A-U
MMH, Hz, Ql: Protection from Hazards from the Quality of Mountains, Moorlands and Heaths A-U
EF, Wl, Ql: Wildlife Benefit from the Quality of Enclosed Farmland A-U
W, Wl, Sc: Wildlife Benefit from Spatial Configuration of Woodlands A-U
MMH, Wl, Ql: Wildlife Benefits from the Quality of Mountains, Moorlands and Heaths A-U
EF, Cw, Ql: Clean Water from the Quality of Enclosed Farmland A-U
W, Rc, Sc: Recreational Benefits from Spatial Configuration of Woodlands A-U
W, Wl, Ql: Wildlife Benefits from the Quality of Woodlands A-U
EF, Fo, Ql: Food from the Quality of Enclosed Farmland A-U
FW, Rc, Ql: Recreational Benefits from the Quality of Freshwaters A-U
FW, As, Ql: Aesthetic Benefits from the Quality of Freshwaters A-U
FW, Wl, Qn: Wildlife Benefits from the Quantity of Freshwaters A-U
U, Ca, Qn: Clean Air from the Quantity of Urban A-U
U, Rc, Qn: Recreational Benefits from the Quantity of Urban A-U
U, As, Qn: Aesthetic Benefits from the Quantity of Urban A-U
U, Wl, Qn: Wildlife Benefits from the Quantity of Urban A-U
U, Ec, Qn: Equable Climate Benefits form the Quantity of Urban A-U
MMH, Ec, Ql: Equable Climate Benefits from the Quality of Mountains, Moorlands and Heaths A-U
M, Fo, Ql: Food from the Quality of Marine A-U
U, Ca, Ql: Clean Air from the Quality of Urban A-U

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
MMH	Aesthetics	Quality	+£20 to +£40 (TGT) Based on consumer surplus to meet favourable SSSI status (£1.33/hh/yr) (Christie and Rayment, 2012 = £20mil/yr if applied to SSSIs, £40mil/yr if also applied to non-SSSIs and assume same proportion improve	SSSI in favourable status: blanket bog =58%, upland fen&marsh = 46% upland heath = 71% lowland heath = 81% (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Peatland bog areas decreased significantly last 60yrs, area of active peat bog declining by <1% per annum, 1990 to 1998 (UK NEA, 2011)	**B** (12)
				B (-40% from target)		**B** -ve	
			(4)	(4)		(4)	
MMH	Hazard protection	Quantity	-	Coverage of upland areas = ~0.7million ha in England (UK NEA, 2011)	No target	No trend	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
MMH	Hazard protection	Quality *Soil erosion = f [**ecological communities; soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table) **land** (gradient), **atmosphere** (temperature, rainfall and wind);**pressures***	+£50 to +£80 (TGT) Based on consumer surplus to meet favourable SSSI status (£2.11/hh/yr) (Christie and Rayment, 2012) = £50mil/yr if applied to SSSIs, £80mil/yr if also applied to non-SSSIs	SSSI in favourable status: blanket bog =58%, upland fen&marsh = 46% upland heath = 71% lowland heath = 81% (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Peatland bog areas decreased significantly last 60yrs, area of active peat bog declining by <1% per annum, 1990 to 1998 (UK NEA, 2011) 10-30% of UK peatland upland was subject to serious erosion (eftec, asset check)	**B** (12)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
		(management practices e.g. low grazing, low drainage gripping, limit burning)] *Flooding risk = ƒ [**ecological communities; soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table) **land** (gradient), **atmosphere** (rainfall);**pressures** (management practices e.g. low drainage gripping, limit burning)]* *Wildlife risk = ƒ [**ecological communities** (heath biomass, blanket bog); **soils** (eroding); **freshwater** (low water table); **atmosphere** (temperature, rainfall); **pressures** (management practices e.g. burning regime)]*	and assume same proportion improve (4)	**B** (-40% from target) (4)		**B** (-ve) (4)	
			(4)	(4)		(4)	
MMH	Wildlife	Quantity	-	Coverage of upland areas = ~0.7million ha in England (UK NEA, 2011) UK has 75% of Europe's upland heath, and 10-15% of the world's blanket bog (eftec, asset check)	No target	No trend.	**B** (12)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
MMH	Wildlife	Quality *= f [**species**; **ecological communities** (pollination), **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table); **land** (altitude, gradient, topography), **atmosphere** (temperature, rainfall, CO_2, N); **pressures** (management practices e.g. grazing, drainage gripping, burning)]*	+£90 to +£160 (TGT) Based on consumer surplus to meet favourable SSSI status (£3.80/hh/yr) (Christie and Rayment, 2012) = £90mil/yr if applied to SSSIs, £160mil/yr if also applied to non-SSSIs and assume same proportion improve	SSSI in favourable status: blanket bog =58%, upland fen&marsh = 46% upland heath = 71% lowland heath = 81% (SoNE, 2008) 11% upland subject to drainage gripping (eftec, asset check)	≥95% SSSI favourable/ recovering by 2020	Peatland bog areas decreased significantly last 60yrs, area of active peat bog declining by <1% per annum, 1990 to 1998 (UK NEA, 2011) Vegetation richness stable 1998-2007 (Countryside Survey 2007) Lowland heath birds recovering, upland wetland birds declining (SoNE, 2008)	**B** (8)
				B (-40% from target)		**B** (-ve)	
			(3)	(2)		(3)	
EF	Food	Quality *Crop yield = f [**species** (crop type); **soils** (agricultural Grade I – V, erosion); **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall), **freshwater** (groundwater); **minerals** (potassium, magnesium); **ecological***	-£220 (TRND) Marginal cost of declines in pollinators in the future based on extrapolating forward trend figures is a 50% decline = -£220 Marginal cost reductions in UK food	***SOILS:*** Grades 1 & 2 = 21% England; Subgrade 3a =21% (Natural England, 2012) ***ECOLOGICAL COMMUNITIES (POLLINATORS)*** Honeybees colonies in the UK = 274,000 (eftec, asset check)	***SOILS:*** CAP (GAEC) maintain organic matter, reduce soil erosion risk & damage to soil structure. By 2030, all England's soils will be managed sustainably and degradation threats tackled successfully (Defra, 2009	***SOILS*** Unknown ***ECOLOGICAL COMMUNITIES (POLLINATORS)*** 1985-2005, honey bee colonies declined by 54% in England (UK NEA, 2011) 1990-2010, the honeybee species richness decline less dramatic than 1950-1989.	**B** (11)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
		communities *(pollination, invasive species/disease);* ***material capital*** *(management practices e.g. irrigation, pest/disease control, nutrient enrichment, aeration of soil, crop rotation, GM crops)]*	production due to trend in quality of agricultural soils in UK is considered to be £0m. Reductions in soil quality are compensated for by fertiliser use.		- Soil Strategy) ***ECOLOGICAL COMMUNITIES (POLLINATORS)*** Unknown	Solitary bee species have recovered, rates of wild flower species decline have slowed (eftec, asset check)	
				B (unknown)		**B** (-ve)	
			(4)	(4)		(3)	
EF	Clean water	Quantity	?	52.1% of land area in England is EF (Defra, 2013) The utilised agricultural area (UAA) in England is 9.0 million hectares (Defra, 2013)	Unknown	Unknown	**B** (12)
			(4)	(4)		(4)	
EF	Clean water	Quality *Water quality = f [****species****;* ***ecological communities*** *(pollination, pollutant uptake);* ***soils*** *(exposure);* ***freshwater*** *(temperature, suspended*	+£0 to +£120 (TRND) Direct market benefits unlikely to be significant and difficult to estimate =£0m.	27% of England's freshwater bodies are currently classified as being of 'good status' or 'potential' or better (Environment Agency)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD)	Nitrate levels in English rivers have fallen overall since 2000 reflecting a decrease in fertiliser use (UK NEA, 2011) 2000- 2011 soil nutrient balances for nitrogen and phosphorus are	**B** (6)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
		*sediment); **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall, wind); **material capital** (management practices e.g. use of buffer strips, reduced application of fertilisers, ploughing direction to reduce soil erosion, crop rotation to maximise uptake of nutrients for different plant species)]*	Lovett et al.(2006) estimate costs of around £8/person/yr to treat nitrate problems in affected areas (UKNEA, 2011). If nitrates from enclosed farmland were reduced by 50%, then this would lead to an estimated reduction in cost of £120m/yr.	Agriculture was responsible for 28% of the damage to rivers due to phosphorous and 61% due to nitrogen in 2012 (Defra, 2013)		estimated to have fallen (19% and 33% respectively) indicating a reduction in the nutrient surpluses which could be lost to the environment (Defra, 2012 - AUK)	
				C (-50% from target)		**A** (+ve)	
			(2)	(2)		(2)	
EF	Hazard protection	Quality *Soil erosion = f [**species**; **ecological communities** (pollination); **soils** ; **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall, wind); **material capital** (management practices e.g. use of buffer strips, ploughing direction to reduce soil erosion, field drainage)]*	- (4)	Agriculture contributes to approximately 75% of sediment in watercourses 1/3 waterbodies are at risk from eroded soil (EA, Corporate Strategy 2010-2015) ***SOILS:*** Grades 1 & 2 = 21% England; Subgrade 3a =21% (Natural England, 2012) 2.2 million tonnes of topsoil are eroded each year (EA, Corporate Strategy 2010-	***SOILS:*** CAP (GAEC) maintain organic matter, reduce soil erosion risk & damage to soil structure. By 2030, all England's soils will be managed sustainably and degradation threats tackled successfully (Defra, 2009 - Soil Strategy)	No trend information	**B** (12)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
				2015).			
				B (unknown) (4)		**B** (unknown) (4)	
			(4)	(4)		(4)	
EF	Wildlife	Quantity	-	60,000 ha of permanent grassland margins, 7,000 ha of cultivated margins, 9,000 ha of wild bird mix and 3,600 ha of flower margins for bumblebees and other insects (via AES) (SoNE, 2008)	No target	Landscape diversity improved through AES and set aside schemes - area of enclosed grassland increased by 5.4% between 1998 and 2007 (UK NEA, 2011) Hedgerows in GB declined - ~624,000 km in 1984 to ~506,000km by 1990 (UK NEA, 2011)	**B** (11)
				B (unknown)		**A** (+ve -ve)	
			(4)	(4)		(3)	
EF	Wildlife	Spatial Configuration	-	60,000 ha of permanent grassland margins, 7,000 ha of cultivated margins, 9,000 ha of wild bird mix and 3,600 ha of flower margins for bumblebees and other insects (via AES) (SoNE, 2008)	No target	Landscape diversity improved through AES and set aside schemes - area of enclosed grassland increased by 5.4% between 1998 and 2007 (UK NEA, 2011) Hedgerows in GB declined - ~624,000 km in 1984 to	**B** (11)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
						~506,000km by 1990 (UK NEA, 2011)	
				B (unknown)		**A** (+ve -ve)	
			(4)	(4)		(3)	
SNG	Wildlife	Quantity	-	Semi-natural grassland equates to approximately 109,576 ha covering 1% of the total area of England (SoNE, 2008)	No target	Countryside Survey 2007 - no change in area of acid and calcareous grasslands in each of the UK countries . There was a significant increase in the area of neutral grassland (UK NEA, 2011)	**B** (10)
				B (unknown)		**A** (stable/+ve)	
			(4)	(4)		(2)	
W	Fibre	Quality *Fibre = ƒ [**species** (hardwood and softwood), **ecological communities** (invasive, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient*	-	Total of 8.4 million green tonnes of softwood was produced in the UK in 2008, hardwood production of 0.4 million green tonnes (UK NEA, 2011) ***ECOLOGICAL***	No target	***ECOLOGICAL COMMUNITIES:*** Statutory Plant Health Notices served 2012-2013 - 89% increase from 2011-12 (Forestry Commission, 2013)	**B** (12)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
		cycling); ***freshwaters*** *(groundwater);* ***land*** *(altitude, gradient);* ***atmosphere*** *(rain, temperature, nitrogen, carbon dioxide, wind);* ***minerals*** *(potassium, magnesium);* ***material capital*** *(management - coppicing, felling, crop rotation, irrigation, processing timber, machinery transport, pest control, nutrient enrichment, pollution - SO_2)]*		***COMMUNITIES:*** Statutory Plant Health Notices (prevent spread of pests and diseases) -418 notices were served in England between 2010 and 2013 (= ~2.1 thousand hectares) (Forestry Commission, 2013)			
				B (unknown)		**B** (-ve)	
			(4)	(4)		(4)	
W	Clean water	Quantity	£0m to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m.	9% of England is wooded (UK NEA, 2011)	Unclear relationship	Unknown trend	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
W	Clean water	Spatial Configuration	£0m to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m.	A study demonstrated that 99% of nitrate draining from arable fields in southern England during winter was retained within the first 5m of a buffer planted with poplar (The Woodland Trust, 2008).	No target	Unknown trend	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
W	Recreation	Spatial Configuration	+£80 to +£190 (TGT) Recreation visits value from GB Forests per year £484mill/yr (UKNEA, 2011; Willis *et al*. 2003). With value of forest-reliant game shooting = £1,124mill/yr. Increase in recreational visit value following trend, range between 9% and 12% gives £80 and £190mil/yr respectively (divided with quantity)	55% of the population have access to woods greater than 20 ha within 4 km, and 10% have access to woods greater than 2 ha within 500 m of their home (Woodland Trust 2004)	Woodland Access Standard: • no person live >500m from at least one area of accessible woodland (2ha) • at least one area of accessible woodland 20ha within 4km (8km roundtrip) (Woodland Trust)	Overall, the percentage of people in the UK with access to woodland has increased over the five-year period from 2004 to 2009 (The Woodland Trust, 2010).	**B** (10)
				B (-40% from target)		**A** (+ve)	
			(4)	(4)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
W	Hazard protection	Spatial Configuration	-	9% of England is wooded (UK NEA, 2011)	No target for spatial configuration and flooding	Unknown trend	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
W	Wildlife	Quality *Wildlife = ƒ [**species**; **ecological communities** (invasives, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient cycling); **freshwaters** (groundwater); **land** (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); **minerals** (potassium, magnesium); **material capital** (management - coppicing, felling, restocking with native species, dead log piles, pest control, pollution - SO_2)]*	+£20 to +£220 (TGT) Based on consumer surplus to meet favourable SSSI status (£1.07/hh/yr) (Christie and Rayment, 2012) = £20mil/yr if applied to SSSIs, £220mil/yr if also applied to non-SSSIs and assume same proportion improve	86% SSSI favourable/ Recovering (SoNE, 2008) ~10% vascular woodland plants threatened (SoNE, 2008). No recovery from bird declines in 1990's, ~20% (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	<1980s much conversion to plantations (UK NEA, 2011) No significant change in species richness in broadleaved or coniferous woodland between 1998 and 2007 (Countryside Survey 2007) Increase in UK BAP habitats (SoNE, 2008). Woodland Bird Survey – mixed (1980s-2003/4) and major decline in butterflies (SoNE, 2008)	**B** (11)
				A (-30%)		**B** (-ve)	
			(4)	(4)		(3)	
W	Wildlife	Spatial Configuration	+£80 (TGT) Biodiversity from GB Forests per year £476m. Increase in wildlife value to target	Low connectivity across landscape (UK NEA, 2011). Our woodland resource is highly fragmented (Biodiversity Strategy 2020)	No target for connectivity	Little or no overall change in the degree of connectivity for broad-leaved, mixed and yew woodland between 1990 and 2007. Over the same period there has been an increase in the area of broad-	**B** (10)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			(12% woodland cover) gives £157mil/yr. Cannot separate value between quantity and spatial configuration = £80mil/yr			leaved woodland, which would tend to increase connectivity (JNCC Biodiversity Indicators, 2013) Increase in UK BAP habitats (SoNE, 2008).	
				B (unknown)		**A** (stable/+ve)	
			(4)	(4)		(2)	
FW	Clean water	Quantity	£0 to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m. Unclear the extent to which increases in area of wetlands will improve the provision of clean water.	The UK has at least 392,000 ha of fens, reedbed, lowland raised bog and grazing marsh (UK NEA, 2011)	No target	~90% of the national resource of wetlands has been lost since Roman times, 13% of the floodplain resource degraded or completely disconnected from river channels and area of lowland raised bog retaining a largely undisturbed surface has declined by 94% (UK NEA, 2011)	**B** (10)
				B (unknown)		**B** -ve	
			(4)	(4)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
FW	Clean water	Quality *Potable water = f [**freshwater** (water - volume, nutrient concentrations e.g. phosphorous, nitrate, dissolved organic carbon, bacteria levels (E.coli and streptococci), levels of cyanobacteria, phytoplankton, macro-algae), suspended sediment); **atmosphere** (temperature, rainfall); **material capital** (abstraction infrastructure, water treatment plants); **pressures** (pollution, abstraction rates)]*	£0 to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m. Unclear the extent to which improvements in the quality of wetlands will improve the provision of clean water.	27% of England's freshwater bodies are currently classified as being of 'good status' or 'potential' or better (Environment Agency) 99.96% of all tests in 2012 met drinking water standards (UK DWI, 2012) South east and eastern England - 'under stress' due to water abstraction (EEA, 2003)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD) Drinking Water Directive 1998 standards	Biological and chemical classification of 7,000 km of English rivers improved significantly from 1990 to 2008 (UK NEA, 2011) Nitrate levels in English rivers have fallen overall since 2000 reflecting a decrease in fertiliser use in EF (UK NEA, 2011) 1.6% of drinking water standard failures in 1991 compared to 0.04% in 2012 (UK DWI, 2012)	**D** (8)
				C (-50% from target)		**A** (+ve)	
			(4)	(2)		(2)	
FW	Recreation	Quality *Recreation = f [**freshwater** (water - volume, flow velocity, nutrients, bacteria, aquatic vegetation), **land** (gradient, altitude), **species** (fish), **material capital** (access, signage/waymarks), **pressures** (enclosed farmland outputs)]*	+£400 (TGT) Value of Meeting GES = £1.2bn EF = £220mil/yr Urban = £980mil/yr contribution to failure Split between recreation, biodiversity, aesthetics in absence of	27% of England's freshwater bodies are currently classified as being of 'good status' or 'good ecological potential' or better (Environment Agency)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD)	Biological and chemical classification of 7,000 km of English rivers improved significantly from 1990 to 2008 (UK NEA, 2011) Nitrate levels in English rivers have fallen overall since 2000 reflecting a decrease in fertiliser use in EF (UK NEA, 2011) Bathing water quality has improved over time - 97% met	**B** (8)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			information (on extent of greater weight towards biodiversity)			standards in 2008 compared to 78% in 1990 (EA, Our Corporate Strategy 2010-2015 Evidence: water)	
				C (-50% from target)		**A** (stable/+ve)	
			(4)	(2)		(2)	
FW	Aesthetic	Quality *Aesthetics = f [**freshwater** (water - volume, flow, nutrients, floodplain connectivity), **land** (gradient, altitude); **atmosphere** (temperature, rainfall); **species**, **material capital** (pollution e.g. oil, litter, absence of significant modifications)]*	+£410 (TGT) Value of Meeting GES = £1.2bn EF = £220mil/yr Urban = £980mil/yr contribution to failure Split between recreation, biodiversity, aesthetics in absence of information (on extent of greater weight towards biodiversity)	27% of England's freshwater bodies are currently classified as being of 'good status' or 'good ecological potential' or better (Environment Agency) 55% open water, 69% wetland, 81% lowland raised bog, 87% fen, marsh and swamp SSSIs favourable/ recovering (SoNE, 2008)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD) ≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Biological and chemical classification of 7,000 km of English rivers improved significantly from 1990 to 2008 (UK NEA, 2011) Nitrate levels in English rivers have fallen overall since 2000 reflecting a decrease in fertiliser use in EF (UK NEA, 2011)	**B** (8)
				C (-50% from target)		**A** (stable/+ve)	
			(4)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
FW	Hazard protection	Quality *Flood protection = ƒ [**freshwater** (floodplain connectivity, extent and permeability, water - volume, flow velocity, suspended sediment), **land** (gradient), **atmosphere** (rainfall), **species** (woody debris), **material capital** (flow regulation, storage reservoirs, channel modification), **pressures** (enclosed farmland outputs)]*	+£30 (TGT) Based on consumer surplus to meet favourable SSSI status (£2.457/hh/yr) (Christie and Rayment, 2012) = £27mil/yr if applied to SSSIs, £31mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 69% of wetland, 81% of lowland raised bogs, 87% of fen, marsh and swamp and 89% of lowland neutral grasslands SSSIs are in favourable or recovering condition (UK NEA, 2011) More than 50% of English and Welsh rivers have been modified physically	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	No trend information	**B** (10)
				A (-30% from target)		**B** (unknown)	
			(4)	(2)		(4)	
FW	Hazard protection	Spatial Configuration	-	Over 2/5 (42% by area) of all floodplains in England and Wales (defined by the 100-year flood envelope) have been separated from their rivers by flood embankments and channel modifications (UK NEA, 2011).	No target	Unknown trend	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
FW	Wildlife	Quantity	+£80 to +£500 (TGT) Biodiversity non-use value; Inland wetlands: £273 million p.a. (m.v. = £304/ha p.a.); Coastal wetlands: £1,275 million p.a. (m.v. = £1,866/ha p.a.) (UKNEA, 2011). UK = 243,610 km² = 24,361,000ha. 1.1% of this is target = 267,971ha. Provides a range between £81.5m/yr and £500m/yr	There are more than 389,000 km of rivers in the UK, almost 6,000 permanent large lakes covering around 200,000 ha and nearly half a million ponds (covering less than 2 ha) (UK NEA, 2011)	No target ~ 1.1% (UK wide) of land for wetlands (lowland) is needed to deliver sustainable populations of all birds considered within a calculation by the RSPB (Pers. comm. Jo Gilbert 2007) (Hume, 2008 - Wetland Vision Technical Document)	~90% of the national resource of wetlands has been lost since Roman times, 13% of the floodplain resource degraded or completely disconnected from river channels and area of lowland raised bog retaining a largely undisturbed surface has declined by 94% (UK NEA, 2011)	**B** (10)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
FW	Equable climate	Quantity	-	~ 392,000 ha of fens, reedbed, lowland raised bog and grazing marsh (UK NEA, 2011) Remaining lowland fen in English peatlands stored 1,004–2,576 tonnes of carbon/ha, and raised bog peats stored 1,575–1,629 tonnes of carbon/ha (UK NEA, 2011)	No target	~90% of the national resource of wetlands has been lost since Roman times and area of lowland raised bog retaining a largely undisturbed surface has declined by 94% (UK NEA, 2011) Lowland meadows have declined from 6,600,000 ha to 200,000 ha, fens 310,000 ha to 26,000 ha, reedbeds 10,000 ha to 6–8,000 ha (UK NEA, 2011)	**B** (10)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
FW	Equable climate	Quality *Carbon sequestration = f [**species** (plankton biomass); **freshwater** (water - volume, flow, nutrients, floodplain connectivity, suspended sediment, nutrient levels, acidity, groundwater); **land** (gradient, altitude); **atmosphere** (temperature); **pressures** (pollution e.g. oil, flow regulation, channel modification)]*	+£40 (TGT) Based on consumer surplus to meet favourable SSSI status (£3.42/hh/yr) (Christie and Rayment, 2012) = £37mil/yr if applied to SSSIs, £43mil/yr if also applied to non-SSSIs and assume same proportion improve	69% wetland, 81% lowland raised bog, 87% fen, marsh and swamp SSSIs favourable/ recovering (UK NEA, 2011)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	~90% of the national resource of wetlands has been lost since Roman times and area of lowland raised bog retaining a largely undisturbed surface has declined by 94% (UK NEA, 2011) Lowland meadows have declined from 6,600,000 ha to 200,000 ha, fens 310,000 ha to 26,000 ha, reedbeds 10,000 ha to 6–8,000 ha (UK NEA, 2011)	**B** (8)
				A (-30% from target)		**B** (-ve)	
			(4)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
U	Clean air	Quantity	-£250 to -£600 (TRND) Air Quality Strategy 2007 estimates health impact of particulate matter = £8.5 billion and £20.2 billion a year (Defra 2007). Assume the target is for removal of particulate matter. Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011) Assume clean air costs rise at proportional rate to urban expansion = increase in cost of between £250m/yr and £600m/yr (4)	~10% of England's land area is classified as urban (UK NEA, 2011) 90 % of city dwellers in the EU are exposed to damaging air pollutants (EEA AQ Report, 2013)	Air Quality Strategy 2007	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (10)
				B (-40% from target - approximate)		**B** (-ve)	
			(4)	(4)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
U	Clean air	Quality *Clean air = ƒ [**species** (London plane trees); **atmosphere**; **material capital** (policies to cap emissions - PM_{10}, NO_2, SO_2, reduction in car useage, proportion of green space to built urban)]*	+£9BN to +£20BN (TGT) In 2005, the estimated cost of the overall health impact from levels of anthropogenic $PM_{2.5}$ (particulate matter of 2.5µm or less) was between £9 billion and £20.2 billion (UK NEA, 2011)	Current 7% tree cover in the West Midlands reduces air concentrations of PM10 (particulates < 10 micro-metres) by 4% (McDonald *et al*. 2007)	No target	Decline in condition of greenspace has been halted (NAO, 2004) 2004/2005 - 70% of urban street trees in good condition. Decline since 1992/3 data (UK NEA, 2011)	**B** (10)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
U	Recreation	Quantity	-£280 to -£330 (TRND) Lost value associated with a *Go With The Flow* scenario for urban green space is -£129/hh/yr. 22.1million households in England (DCLG), suggests a cost of £2.85bn/yr. With trend in urban growth (3% 2011 to 2060), loss of between -£560 and -£650mil/yr	Total extent of urban green space in GB is ~290,000 ha (eftec, asset check)	No target	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (12)
				B (unknown)		**B** (-ve)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			(cannot split between recreation, aesthetics, wildlife or equable climate) (split between quantity and spatial configuration)				
			(4)	(4)		(4)	
U	Recreation	Spatial Configuration	-£280 to -£330 (TRND) Lost value associated with a *Go With The Flow* scenario for urban green space is -£129/hh/yr. 22.1million households in England (DCLG), suggests a cost of £2.85bn/yr. With trend in urban growth (3% 2011 to 2060), loss of between -£560 and -£650mil/yr (cannot split between recreation, aesthetics, wildlife or equable climate) (split between quantity and spatial configuration)	Mean accessible greenspace is 2 hectares (ha) per 1,000 people in England (UK NEA, 2011) Wards with fewer than 20 dwellings per hectare have three times as much greenspace as wards in high density areas (eftec, asset check)	Accessible Natural Greenspace Standards (ANGSt) - 1ha of LNR per 1000 pop, 20ha site within 2km from home (eftec, asset check)	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (12)
				B (-40% from target - approximate)		B (-ve)	
			(4)	(4)		(4)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
U	Aesthetics	Quantity	-£560 to -£650 (TRND) Lost value associated with a *Go With The Flow* scenario for urban green space is -£129/hh/yr. 22.1million households in England (DCLG), suggests a cost of £2.85bn/yr. With trend in urban growth (3% 2011 to 2060), loss of between -£560 and -£650mil/yr (cannot split between recreation, aesthetics, wildlife or equable climate)	Total extent of urban green space in GB is ~290,000 ha (eftec, asset check) Mean accessible greenspace is 2 hectares (ha) per 1,000 people in England (UK NEA, 2011) Wards with fewer than 20 dwellings per hectare have three times as much greenspace as wards in high density areas (eftec, asset check)	No target	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (12)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(4)	
U	Aesthetics	Spatial Configuration	-	Use of Natural England's Accessible Natural Greenspace Standards (ANGSt) (?)	No formal or statutory target for the 'performance' of urban green space in the UK	No trend information	**B** (12)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
U	Hazard protection	Quantity	-£8 (TRND) Urban flooding costs ~£270million a year in England and Wales Assume costs associated with increased risk of flooding rise at a rate that is proportional to the expansion of urban areas (3% 2011- 2060), then an increase in cost of £8.1m/yr	80,000 homes in England and Wales at risk of urban flooding	No target	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (10)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
U	Wildlife	Quantity	-£560 to -£650 (TRND) Lost value associated with a *Go With The Flow* scenario for urban green space is -£129/hh/yr.	The total extent of urban green space in GB is just under 290,000 ha (eftec, asset check)	No target	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2011) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (10)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			22.1million households in England (DCLG), suggests a cost of £2.85bn/yr. With trend in urban growth (3% 2011 to 2060), loss of between -£560 and -£650mil/yr (cannot split between recreation, aesthetics, wildlife or equable climate)	**B** (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
U	Wildlife	Quality	-	Common frog, song thrush and hedgehog, are found in significant numbers in urban areas and particularly domestic gardens (SoNE 2008) 'Wider countryside' butterfly species more likely to be found in suburban areas than in rural areas (SoNE 2008).	No target	Increase in urban generalist bird species between 1994 and 2006 e.g. woodpecker, wood pigeon, goldfinch. Urban specialists e.g. swift, house martin, collared dove and house sparrow have declined by 15% over this period (SoNE 2008).	**B** (12)
				B (unknown)		**A** (+ve -ve)	
			(4)	(4)		(4)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
U	Wildlife	Spatial configuration	-	Green corridors are generally poorly quantified by local authorities making their extent and condition difficult to assess	No target	Green corridors included in planning and conservation policy in 2010 through their inclusion in the UK BAP as Open Mosaic Habitats.(UK NEA) No trend information.	**B** (12)
				B (unknown)		**B** (unknown)	
			(4)	(4)		(4)	
U	Equable climate	Quantity	-£560 to -£650 (TRND) Lost value associated with a *Go With The Flow* scenario for urban green space is -£129/hh/yr. 22.1million households in England (DCLG), suggests a cost of £2.85bn/yr. With trend in urban growth (3% 2011 to 2060), loss of between -£560 and -£650mil/yr (cannot split between recreation, aesthetics, wildlife or equable climate)	The total extent of urban green space in GB is just under 290,000 ha (eftec, asset check)	No target	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2011) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011)	**B** (10)
				B (unknown)		**B** (-ve)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			(4)	(4)		(2)	
CM	Aesthetics	Quality *Aesthetics = ƒ [**coasts** (abundance of habitats); **oceans** (view, sense of being at seaside); **ecological communities** (wildlife associated with habitats); **material capital** (hard engineering, cultural memories, archaeology and heritage)]*	+£10 (TGT) Based on consumer surplus to meet favourable SSSI status (£0.6/hh/yr) (Christie and Rayment, 2012) = £13mil/yr if applied to SSSIs, £14mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 91% of SSSI coastal habitat is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Proportion of early successional habitats has decreased -by up to 90% in some dune systems—while scrub and grassland have increased (UK NEA, 2011) Quality of coastal margin habitats has declined since 1945 due to changes in soft sediment supply (UK NEA, 2011)	**B** (8)
				A (-30% from target)		**B** (-ve)	
			(4)	(2)		(2)	
CM	Aesthetics	Spatial Configuration	-	Unknown		Unknown	**B** (12)
			(4)	(4)		(4)	
CM	Hazard protection	Quantity	-	Approximately 44% of the English coastline is defended, with 30% of the coastline eroding (Defra)	No target	Coastal margin habitats have declined by an estimated 16% since 1945 due to development and coastal squeeze (UK NEA, 2011) Sand dunes - 30% loss since 1900. Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK	**B** (10)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
						NEA, 2011).	
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
CM	Hazard protection	Quality *Hazard protection = f [**species**; **coasts** (sediment, feature is wide and elevated, low creek density (saltmarsh)); **ecological communities** (colonisers such as Salicornia, sand dune stabilisers e.g. marram grass, tall and dense vegetation); **freshwater** (sediment); **land** (coastal morphology, aspect); **ocean** (tidal submergence, tidal current velocity, salinity, temperature)]+ [**pressures** (hard engineering structures - interrupt sediment flows, change wave action)]*	+£50 (TGT) Based on consumer surplus to meet favourable SSSI status for benefit (£2.15/hh/yr) (Christie and Rayment, 2012) = £48mil/yr if applied to SSSIs, £50mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 91% of SSSI coastal habitat is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy, 2020)	Proportion of early successional habitats has decreased -by up to 90% in some dune systems—while scrub and grassland have increased (UK NEA, 2011) Quality of coastal margin habitats has declined since 1945 due to changes in soft sediment supply (UK NEA, 2011)	**B** (8)
				A (-30% from target)		**B** (-ve)	
			(4)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
CM	Wildlife	Quantity	-	Sand dunes, machair, saltmarsh, shingle, sea cliffs and coastal lagoons) make up only 0.6% of the UK's land area. Sand dunes and saltmarsh have areas of approximately 70,000 hectare (ha) and 45,000 ha respectively (UK NEA, 2011)	No target	Coastal margin habitats have declined by an estimated 16% since 19452 due to development and coastal squeeze (UK NEA, 2011) Sand dunes - 30% loss since 1900. Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK NEA, 2011)	**B** (10)
				B (unknown)		**B** (-ve)	
			(4)	(4)		(2)	
CM	Wildlife	Quality *Wildlife = ƒ [**species** (specialised, native, range of successional species); **ecological communities** (mosaic of habitats, range of successional stages, maintenance of stable systems); **freshwater** (sediment); **land** (coastal morphology incl. aspect and gradient); **atmosphere** (wind); **oceans** (tidal submergence, water velocity, turbulence, salinity levels, nutrient levels); **coasts** (stable systems, sediment, soil pH); **material***	+£50 (TGT) Based on consumer surplus to meet favourable SSSI status for benefit (£2.30/hh/yr) (Christie and Rayment, 2012) = £51mil/yr if applied to SSSIs, £54mil/yr if also applied to non-SSSIs and assume same proportion improve (4)	By area, 91% of SSSI coastal habitat is in favourable or recovering condition (SoNE, 2008) ***SPECIES:*** England's mudflats support some 4.3-4.7 million such birds in winter (~70% to 80% of GB total) (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Proportion of early successional habitats decreased -by up to 90% in some dune systems—scrub and grassland have increased (UK NEA, 2011) Sand dunes - 30% loss since 1900. Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK NEA, 2011). ***SPECIES:*** Average numbers of waterbirds wintering in, or migrating through, marine areas in the UK doubled mid-1970s - mid-1990s. However, some species of diving	**B** (8)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
		capital *(management regimes e.g. light grazing, scrub clearance, lack of disturbance on shingle);* ***pressures*** *(air pollution -acidification from sulphur and nitrogen deposition)]*				duck and estuarine wader have recently declined (SoNE, 2008) ***COASTS:*** Quality of coastal margin habitats has declined since 1945 due to changes in soft sediment supply (SoNE, 2008)	
				A (-30% from target)		**B** (-ve)	
			(4)	(2)		(2)	
CM	Equable climate	Quantity	-£0.06 (TRND) Sand dune marginal carbon sequestration value = £32 to £241/ha p.a. Saltmarsh marginal sequestration value = £61 to £622/ha p.a.). Following trend, carbon emissions from sand dunes = £0.02m/yr, saltmarsh = £0.04m/yr.	Sand dunes, machair, saltmarsh, shingle, sea cliffs and coastal lagoons) make up only 0.6% of the UK's land area. Sand dunes and saltmarsh have areas of approximately 70,000 hectare (ha) and 45,000 ha respectively (UK NEA, 2011) Sand dunes on the west coast of the UK store 0.58 to 0.73t C/ha/yr, while saltmarsh stores 0.64 to 2.19 t C/ha/yr (UK NEA, 2011)	No target	Coastal margin habitats have declined by an estimated 16% since 19452 due to development and coastal squeeze (UK NEA, 2011) Sand dunes - 30% loss since 1900. Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK NEA, 2011).	**B** (10)
				B (unknown) (4)		**B** (-ve) (2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
			(4)	(4)		(2)	
CM	Equable climate	Quality *Carbon sequestration=ƒ [**coasts** (sediment); **atmosphere** (wetter conditions); **ecological communities** (successional species, vegetation fixes CO_2)]*	+£40 (TGT) Based on consumer surplus to meet favourable SSSI status for benefit (£1.82/hh/yr) (Christie and Rayment, 2012) = £40mil/yr if applied to SSSIs, £42mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 91% of SSSI coastal habitat is in favourable or recovering condition (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Proportion of early successional habitats has decreased -by up to 90% in some dune systems—while scrub and grassland have increased (UK NEA, 2011) Sand dunes - 30% loss since 1900. Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK NEA, 2011).	**B** (8)
				A (-30% from target)		**B** (-ve)	
			(4)	(2)		(2)	
M	Food	Quality *Food = ƒ [**species** (fish, shellfish); **coasts** (saltmarsh - nursery ground for fish species;, **atmosphere** (wind); **oceans** (salinity, currents, tides, waves, temperature, pH); **ecological communities** (population regulation, food web dynamics); **land** (morphology); **pressures** (harvesting effort, harvesting preferences - policy driven, equipment, pollution)]*	+£1.4BN (TGT) Value of stocking levels equivalent to average annual catches 1938 to 1970 at today's market value (£m/kt) for: Demersal fish = £1.93m/kt Pelagic fish = £0.93m/kt	***SPECIES:*** 50% of 18 indicator finfish stocks in UK waters = full reproductive capacity &harvested sustainably, 2008 (UK NEA, 2011) The majority of stocks continue to be fished at rates well above the values expected to provide the highest long-term yield (UK NEA, 2011) ***COASTS:*** Intertidal mudflats and	***SPECIES:*** Fish stocks c. 1938-1970 ***COASTS:*** ≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	***SPECIES:*** 10% of 18 indicator finfish stocks in UK waters = full reproductive capacity &harvested sustainably, 1998 (UK NEA, 2011) ***COASTS:*** Major saltmarsh loss pre-1980s, current losses are estimated at 100ha per year (UK NEA, 2011).	**B** (10)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
				saltmarsh - 90% of SSSI area in favourable or recovering condition (SoNE, 2008)			
				B (-ve)		**B** (-ve)	
			(4)	(4)		(2)	
M	Wildlife	Quality *Wildlife = f [**species**; **ecological communities**; **land** (topography, elevation); **atmosphere** (wind), **oceans** (salinity, tides, currents, waves, temperature, pH); **material capital** (pollution (e.g. oil spills, sewage effluent), invasive species (e.g. ballast water), fish by-catch)]*	- (4)	Two of the four Annex I marine habitats for which SACs have been designated are in unfavourable condition (SoNE, 2008). 22% of UK large shallow inlets and bays identified as being 'at risk' of failing to meet the standard of GES (SoNE, 2008)	Marine Strategy Framework Directive (2008) - achieve Good Environmental Status (GES) in all UK marine waters by 2020	Most estuarine and marine fish communities have improved in recent years, however certain vulnerable fish have continued to deteriorate e.g. many deep-water fish species, and species that move between fresh- and saltwater, such as the European eel and sturgeon (UK NEA, 2011) Between 2000 and 2008, the total number of breeding seabirds decreased by around 9% (UK NEA, 2011)	**B** (11)
				B (-ve) (4)		**A** (+ve -ve) (3)	
			(4)	(4)		(3)	

Figure 6 illustrates the relationships that were rated as being ‘Black’ (of concern) based on Stage 1 (ES provision and potential influence), and ‘C’ (very high concern) based on stage 2 (status and trend) as well as the value of marginal change (from current status, given trend or to target).

Figure 6. ‘C’ Rated Relationships

2a. ‘C’ Risk Rating and Valuation from Current Status to Target

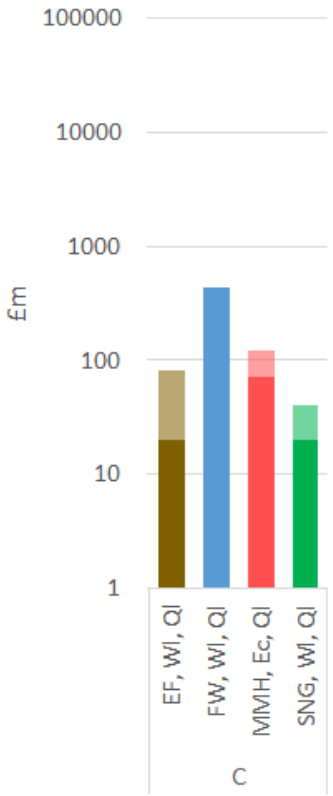
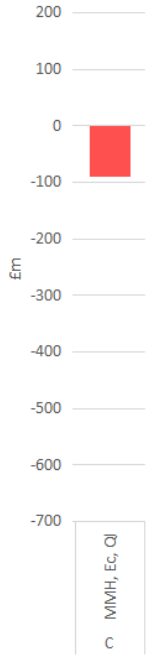
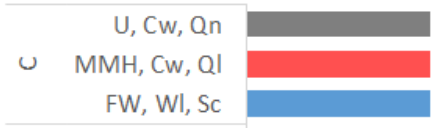


Figure 2b. ‘C’ Risk Rating and Valuation from Current Status given Trend



2c. ‘B’ Risk Rating no Valuation



MMH, Cw, Ql: Clean Water from the Quality of Mountains, Moorlands and Heaths A-U
U, Cw, Qn: Clean Water from the Quantity of Urban A-U
SNG, Wl, Ql: Wildlife Benefits from the Quality of Semi-Natural Grasslands A-U
EF, Wl, Ql: Wildlife Benefits from the Quality of Enclosed Farmland A-U
FW, Wl, Ql: Wildlife Benefits from the Quality of Freshwaters A-U
MMH, Ec, Ql: Equable Climate Benefits from the Quality of Mountains, Moorlands and Heaths A-U
FW, Wl, Sc: Wildlife Benefits from the Spatial Configuration of Freshwaters A-U

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
MMH	Clean water	Quality *Clean water = ƒ [**species** (sphagnum moss), **ecological communities** (vegetation - nutrient cycling, pollutant absorption), **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (high water table) **land** (altitude, gradient), **atmosphere** (temperature and rainfall); pressures (management practices e.g. low intensity grazing, low drainage gripping, limit burning)]*	~£0 to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m. However, this is contradicted by the observed behaviour of water companies in upland areas.	SSSI in favourable status: blanket bog =58%, upland fen&marsh = 46% upland heath = 71% lowland heath = 81% (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Peatland bog areas decreased significantly last 60yrs, area of active peat bog declining by <1% per annum, 1990 to 1998 (UK NEA, 2011) 10-30% of UK peatland upland was subject to serious erosion (eftec, asset check)	**C** (8)
				B (-40% from target)		**C** -ve -ve	
			(4)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
MMH	Equable climate	Quality *Carbon sequestration = ƒ [**species** (sphagnum moss); **ecological communities** (photosynthesis and carbon locking); **soils** (high acidity, organic matter and water holding capacity, nutrient availability); **atmosphere** (temperatures, rainfall, CO_2, N); **freshwater** (high water table); **land** (low gradient); **pressures** (extraction methods, land management - burning and grazing regimes)]*	+£70 to +£120 (TGT) Based on consumer surplus to meet favourable SSSI status (£3.02/hh/yr) (Christie and Rayment, 2012) = £70mil/yr if applied to SSSIs, £120mil/yr if also applied to non-SSSIs and assume same proportion improve -£90 (TRND) Social cost of carbon values indicate the cost of replacing carbon stored in peatland: £57/tCO2e for sectors not covered by the EU ETS. Marginal value of carbon emissions given current trends in degradation of upland peatland bog = -£90mil/yr	40% of UK's soil carbon is stored in upland peatland ~300MtCO_2 (eftec, asset check) SSSI in favourable status: blanket bog =58%, upland fen&marsh = 46% upland heath = 71% lowland heath = 81% (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020) Restore 10,000km^2 peatland by 2020 (UK Committee Peatlands Programme, 2012)	Peatland bog areas decreased significantly last 60yrs, area of active peat bog declining by <1% per annum, 1990 to 1998 (UK NEA, 2011) 10-30% of UK peatland upland was subject to serious erosion (eftec, asset check) Peatlands are net-emitters of carbon due to degradation (eftec, asset check).	**C** (6)
				B (-40% from target)		**C** -ve -ve	
			(2)	(2)		(2)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
EF	Wildlife	Quality *Wildlife = ƒ [**species**; **ecological communities** (pollination); **soils**; **land**; **atmosphere**; **material capital** (management practices e.g. use of buffer strips, set aside schemes, creation of waterbodies, reduction in pesticide application, reduction in monoculture)]*	+£20 to +£80 (TGT) Deficit in agri-environment schemes is 4% - 16% (70% of land to be in AES is target), if improve = £20-£80mil/yr.	Only 26 out of 710 Areas/Sites of Special Scientific Interest on Enclosed Farmland are in favourable condition (UK NEA, 2011)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Increase in agri-environment scheme and payments under CAP. Numbers of specialist farmland birds had fallen to 40% of their 1970 levels in 2000, and they have fallen a further 4% since then (UK NEA, 2011) Specialist species (those restricted to semi-natural habitats) showing recovery, generalists stable trend (SoNE, 2008)	**C** (6)
				C (>40% from target)		**A** (+ve -ve)	
			(1)	(2)		(3)	
SNG	Wildlife	Quality *Wildlife = ƒ [**species** (high diversity); **ecological communities** (pollination); **soils**; **land** (topography); **atmosphere** (rain, temperature); **material capital** (conservation management - grazing, cutting, scrub management)]*	+£20 to £40 (TGT) Based on consumer surplus to meet favourable SSSI status (£1.11/hh/yr) (Christie and Rayment, 2012) = £20mil/yr if applied to SSSIs, £40mil/yr if also applied to non-SSSIs and assume same proportion improve	By area, 83% of SSSI grassland (all types) is in favourable or recovering condition (SoNE, 2008) Calcareous grasslands provide breeding habitat for 85% of British butterfly species (SoNE, 2008)	≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	Neutral grassland stable condition and significant increase in area, calcareous grassland stable and under management to conserve, mixed improvements and declines in acid grassland (Countryside Survey 2007) Significant decline in plant species richness 1998-2007 (Countryside Survey 2007)	**C** (9)

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
						Major declines in breeding and wintering birds associated with SNG, and butterflies (UK NEA, 2011)	
				A (-30% from target)		**C** (-ve -ve)	
			(4)	(2)		(3)	
FW	Wildlife	Quality *Wildlife = ƒ [**species**; **freshwater** (water - volume, flow, nutrients, floodplain connectivity, suspended sediment, nutrient levels, acidity, groundwater), **land** (gradient, altitude), **pressures** (pollution e.g. oil, litter, flow regulation, channel modification)]*	+£440 (TGT) Value of Meeting GES = £1.2bn EF = £220mil/yr Urban = £980mil/yr contribution to failure Split between recreation, biodiversity, aesthetics in absence of information (on extent of greater weight towards biodiversity)	27% of England's freshwater bodies are currently classified as being of 'good status' or 'good ecological potential' or better (Environment Agency) 55% open water, 69% wetland, 81% lowland raised bog, 87% fen, marsh and swamp SSSIs favourable/ recovering (UK NEA, 2011)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD) ≥95% SSSI favourable/ recovering by 2020 (Biodiversity Strategy 2020)	1996-2007 plant species richness in ponds decreased by 20% and proportion of poor or very poor quality ponds increased by 17% (UK NEA, 2011). Bird data is mixed - wet meadows declined, reed beds increased, slow/standing water increased, wetland birds declined with increasing severity in recent years (UK NEA, 2011)	**C** (9)
				C (>40% from target)		**B** (-ve)	
			(4)	(2)		(3)	

MLC	Benefit	Characteristic	Value (mil/yr)	Current Status	Target	Trend	RAG (A-E)
FW	Wildlife	Spatial configuration	-	27% of England's freshwater bodies are currently classified as being of 'good status' or 'good ecological potential' or better (Environment Agency)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD)	No trend information.	C (12)
				C (>40% from target)		**B** (unknown)	
			(4)	(4)		(4)	
U	Clean water	Quantity	£0 to ? Direct market benefits unlikely to be significant and difficult to estimate =£0m.	27% of England's freshwater bodies are currently classified as being of 'good status' or 'good ecological potential' or better (Environment Agency) ~10% of England's land area is classified as urban (UK NEA, 2011)	All inland and coastal waters within defined river basin districts must reach at least good status by 2015 (WFD)	Urban land cover projected to rise from 10.6% in 1991 to 11.9% in 2016 (SoNE, 2008) Average projection for urban growth between 2011 and 2060 across UK is 3% (UKNEA. 2011) Within London, the proportion of rivers and canals of 'good' chemical or biological status has more than doubled between 1990 and 2005 (ONS, 2007)	C (11)
				C (>40% from target)		**A** (+ve -ve)	
			(4)	(4)		(3)	

Annex 5. Overview of 'B' and 'C' Ratings

Table A sets out the valuation evidence associated with those benefits that are deemed to be at risk from changes in quality of MLC ('B' or 'C' rated).

Table A. Valuation Evidence for Changes in Quality of MLC

A-U	Benefit	Quality Risk	*Benefit(£m/yr)*	*Uncertainty Rating*	*Cost of Restoration*
Mountains, Moors and Heaths	Clean W *(Blanket Bog)*	C	*~£0 to ?*	8	£430 - £910/ha *(total)*
	Aesthetics	B	*+£20 to + £40 (TGT)*	12	
	Hazard Protection	B	*+£50 to +£80 (TGT)*	12	
	Wildlife	B	*+£90 to +£160 (TGT)*	8	
	Equable Climate	C	*+£70 to +£120 (TGT) -£90 (TRND)*	6	
Enclosed Farmland	Food	B	*-£220 (TRND)*	11	£328 - £400/ha/yr *(ongoing)*
	Clean W	B	*~£0 to £120 (TGT)*	6	
	Hazard Protection	B	*?*	12	
	Wildlife	C	*+£20 to +£80 (TGT)*	6	
Semi-Nat Grassland	Wildlife	C	*+£20 to +£40 (TGT)*	9	£522/ha *(total)*
Woodland	Fibre	B	*?*	12	£3,000/ha *(total)*
	Wildlife	B	*+£20 to +£210 (TGT)*	11	
Freshwater	Clean Water	B	*£0 to ?*	8	£63 - £4,178/ha *(total)* £8.4bn *(to meet WFD GES targets)*
	Aesthetics	B	*+£410 (TGT)*	8	
	Recreation	B	*+£400 (TGT)*	8	
	Wildlife	C	*+£440 (TGT)*	9	
	Hazard Protection	B	*+£50 (TGT)*	10	
	Equable Climate	C	*+£40 (TGT)*	8	
Urban	Clean A	B	*+£8,500 to £20,200 (TGT)*	10	£1.7bn - £2.4bn/yr *(reduce $PM_{2.5}$ by 40%)*
	Wildlife	B	*?*	12	
Coastal M	Aesthetics	B	*+£10 (TGT)*	8	£110/ha - £840/ha *(total)*
	Hazard Protection	B	*+£50 (TGT)*	8	
	Wildlife	B	*?*	8	

	Equable Climate	B	*+£40 (TGT)*	8	
Marine	Food	B	*+£1,350 (TGT)*	10	*£1.5bn - £11.5bn* (to protect 15-20% global ocean)
	Wildlife	B	?	11	

Table B sets out the valuation evidence associated with those benefits that are deemed to be at risk from changes in quantity of MLC ('B' or 'C' rated).

Table B

A-U	Benefit	Quantity Risk	*Benefit(£m/yr)*	*Uncertainty Rating*	*Cost (£m/yr)*
Mountains, Moors and Heaths	Hazard Protection	B	*?*	12	£210 - £472/ha *(total)*
	Wildlife	B	*?*	12	
Enclosed Farmland	Clean Water	B	*?*	12	£0/ha *(agri. land is opportunity cost)*
	Wildlife	B	*?*	11	
Semi-natural Grassland	Wildlife	B	*?*	10	£1,680 - £5,040/ha *(total)*
Woodland	Clean Water	B	*?*	12	£2,914 - £10,182/ha *(total)*
Freshwater	Clean Water *(Wetland)*	B	*~£0 to £480 (TGT)*	10	£1,260/ha *(total)*
	Wildlife *(Wetland)*	B	*+£80 to +£500 (TGT)*	10	
	Equable Climate	B	*+£40 (TGT)*	10	
Urban	Clean Water	C	*~£0 to ?*	11	n/a *[Replacement costs:* SuDS: £500-£1000/unit Green roofs: £98 - £600/m^2 Carbon: £57/tCO2e]
	Clean Air	B	*-£260 to -£610 (TRND)*	10	
	Aesthetics *(Green Space)*	B	*-£560 to -£650 (TRND)*	12	
	Recreation *(Green Space)*	B	*-£280 to -£330 (TRND)*	12	
	Wildlife *(Green Space)*	B	*-£560 to -£650 (TRND)*	10	
	Hazard Protection	B	*-£10(TRND)*	10	
	Equable	B	*-£560 to -£650 (TRND)*	10	

	Climate *(Green Space)*				
Coastal Margins	Hazard Protection	B	*?*	10	£4,400 - £115,500/ha *(total)*
	Wildlife	B	*?*	10	
	Equable Climate	B	*?*	10	

Table C sets out the valuation evidence associated with those benefits that are deemed to be at risk from changes in spatial configuration of MLC ('B' or 'C' rated).

Table C

A-U	Benefit	Spatial Configuration Risk	*Benefit(£m/yr)*	*Uncertainty Rating*	*Cost (£m/yr)*
Enclosed Farmland	Wildlife	B	*?*	11	See Quantity costs above - not possible to identify variation in costs of recreating MLCs on a geographic basis in this project.
Freshwater	Hazard Protection *(Wetlands)*	B	*?*	12	
	Wildlife	C	*?*	12	
Woodland	Clean Water	B	*?*	12	
	Recreation	B	*?*	10	
	Hazard Protection	B	*?*	12	
	Wildlife	B	*+£80 (TGT)*	10	
Urban	Recreation	B	*-£280 to -£330 (TRND)*	12	
	Aesthetics	B	*?*	12	
	Wildlife	B	*?*	12	
Coastal Margins	Aesthetics	B	*?*	12	

Table D sets out the estimated 'deficiency' in value of wildlife benefit associated with the current quality status of A-Us relative to targets.

Table D

A-U	Benefit	Qty	*Benefit(£m/yr)*	Qlty	*Benefit(£m/yr)*	Spatial Config	*Benefit(£m/yr)*
MMH	**Wildlife**	B	*?*	B	*+£90 to +£160 (TGT)*		
EF		B	*?*	C	*+£20 to +£80 (TGT)*	B	?
SNG		B	?	C	*+£20 to +£40 (TGT)*		
W				B	*+£20 to +£210 (TGT)*	B	*+£80 (TGT)*
FW		B	*?*	B	*+£440 (TGT)*	C	?
U		B	*-£560 to -£650 (TRND)*	B	*?*	B	?
CM		B	?	B	*+£50 (TGT)*		
M				B	?		

Annex 6. Costs of Restoring or Recreating MLC's or Replacing ES

MLC	*Evidence*	*Cost*
MMH	**Restoring Quality of MMH** Up to a threshold, MMH quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination of land for wildlife benefit. Combined restoration payments for Heathland & Tundra range from £430/ha to £910/ha in the UK, with an average of £617/ha (IEEP, 2013)[1] incurred every year for a decade. These figures are indicative only, it is unclear what the baseline quality or target quality for restoration was in this case. The expectation is that the unit costs were based on an average of cases with differing levels of degradation. The area of 'uplands' in England is 693,000ha, the % favourable status across upland blanket bog (58%) and heathland (19%) habitat types, using these to estimate an average area in unfavourable condition, suggests around 39% or 270,270ha of MMH. This gives an estimated lower bound cost for restoring MMH MLC of between £118m and £244m a year for a decade.	**£430 - £910/ha**
MMH	**Recreating MMH to Increase Quantity/Alter Spatial Configuration** Estimated from 2012 agri-environment compensation rates. The costs of all combined measures necessary for recreating **heathland** in England being £210/ha following forestry and £472/ha following conversion to arable or improved grassland (IEEP, 2013)[ii]. We found no target for quantity of heathland, to enable aggregate cost or benefit estimations to be made.	**£210 - £472/ha** (heathland only)

[1] Figures have been converted from 2010 values to 2013 values assuming that £100 (2010) = £108.57 (2013). Source: http://www.thisismoney.co.uk/money/bills/article-1633409/Historic-inflation-calculator-value-money-changed-1900.html

MMH

Replacing ES/Benefits from MMH with Material Capital

Benefit	Is the ES/Benefit replaceable?
Clean W *(Blanket Bog)*	Yes wastewater treatment plants; desalinisation plants.
Aesthetics	No (although substitutes of some degree exist)
Hazard Protection	Yes man-made flood defence.
Wildlife	No (although substitutes of some degree exist)
Equable Climate	Yes carbon can be offset elsewhere.

Aesthetics and Wildlife benefits - cannot be replaced if MMH ability to provide ES benefits is destroyed

EF

Restoring Quality of EF

Up to a threshold, enclosed farmland quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination of land for wildlife benefit.

CAP cross-compliance requirements and agri-environment schemes exist to improve the quality of farmland for ES benefits, such as hedgerows for wildlife which is funded at £400/ha/yr (£5/metre; NE, 2013)

Maintenance of buffer zones is funded under agri-environment at £328-£351/ha/yr in the UK, these contribute to provision of clean water/wildlife/hazard protection (IEEP, 2013) [ii]

£328-£351/ha/yr

EF

Recreating EF to Increase Quantity/Alter Spatial Configuration

It is possible to increase the extent of agricultural lands which is a relevant concern for food provision. However, other ES are likely to decline if EF increases. This will depend on the previous land-use.

Land purchase or agricultural opportunity cost is estimated £4,700 - £14,100/ha (IEEP, 2013) [ii]. However, these are assumed to be relevant costs when recreating all MLC's. Therefore in addition to this baseline, the marginal cost of agricultural land is £0/ha.

£0/ha

EF

Replacing ES/Benefits from EF with Material Capital

Benefit	Is the ES/Benefit replaceable?
Food	No, although natural capital assets of concern can be replaced (e.g. artificial pollination; synthetic fertilisers) and GM crops exist.
Clean W	Yes, wastewater treatment plants; desalinisation plants.
Hazard Protection	Yes, man-made flood defence.
Wildlife	No (although substitutes of some degree exist)

Food and Wildlife benefit

-

cannot be replaced if EF ability to provide this ES benefit is destroyed

SNG

Restoring Quality of SNG

Up to a threshold, semi-natural grassland quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination of land for wildlife benefit.

Combined restoration payments for SNG is £522/ha (IEEP, 2013) [ii].

These figures are indicative only, it is unclear what the baseline quality or target quality for restoration was in this case. The expectation is that the unit costs were based on an average of cases with differing levels of degradation.

The area of 'SNG' in England is 109,576ha. The % favourable status is 36%, or 39,487ha, across SSSI and non-SSSI. These figures allow us to estimate that around 64%, or 70,090ha, of SNG is either recovering or in unfavourable condition. This gives an estimated cost for restoring SNG MLC of £37m.

£522/ha

SNG

Recreating SNG to Increase Quantity/Alter Spatial Configuration

Estimated from 2012 agri-environment compensation rates. The costs of all combined measures necessary for recreating grassland in England being £5,040/ha following forestry and £1,680/ha following conversion from arable land (IEEP, 2013) [ii]. We found no target for quantity of SNG, to enable aggregate cost or benefit estimations to be made.

£1,680 - £5,040/ha

SNG

Replacing ES/Benefits from SNG with Material Capital

Benefit	Is the ES/Benefit replaceable?
Wildlife	No (although substitutes of some degree exist)

Wildlife benefit

-

cannot be replaced if SNG ability to provide this ES benefit is destroyed

W

Restoring Quality of W

Up to a threshold, woodland quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination of land for wildlife benefit.

The cost of maintaining the extent of existing woodlands, restoring native woodlands sites, and improving the ecological condition of woodlands to achieve *favourable condition* under Habitats Action Plan is estimated to be £3,000/ha capital expenditure over 10 years and an annual management cost should be considered of £75/ha/y for native woodlands restoration (IEEP, 2013) [ii].

£3,000/ha

W

Recreating W to Increase Quantity/Alter Spatial Configuration

The Forestry Commission estimates that establishing a standard woodland mixture of 90% broadleaves and 10% conifers in England is £10,182/ha and £5,230/ha in Wales. The cost for a 10% broadleaves and 90% conifer mixture in Wales is £2,914 (UKNEA, 2010).

£2,914 - £10,182/ha

W

Replacing ES/Benefits from W with Material Capital

Benefit	Is the ES/Benefit replaceable?
Fibre	No
Clean Water	Yes wastewater treatment plants; desalinisation plants.

Fibre (timber), Recreation, Wildlife benefits

-

cannot be replaced if W ability to provide this ES benefit is

		destroyed

Recreation	No (although substitutes of some degree exist)	
Hazard Protection	Yes man-made flood defence.	
Wildlife	No (although substitutes of some degree exist)	

FW	**Restoring Quality of FW** Up to a threshold, freshwater quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination of waterbodies/wetlands for wildlife benefit. Measures contemplated to meet WFD good ecological status in the English & Welsh RBMP to 2060 (i.e. NPV over 43 years) is £8.40bn (ACTeon, 2012). Estimated average cost of £21,000/ha to £84,000/ha for re-naturalisation of modified river courses. Estimated costs for restoration of reed bed £63 - £857/ha; inland marsh £670/ha (IEEP, 2013) [ii]; lowland bog £4,178/ha (IEEP, 2013) [ii].	**£8.40bn (to meet WFD GES targets)** **£63 - £4,178/ha**
FW	**Recreating FW to Increase Quantity/Alter Spatial Configuration** Estimated average cost of £1,260/ha for reconnection of floodplain habitats, assuming that 15% of river lengths are on floodplains (IEEP, 2013) [ii]. Creation of floodplain scrapes in wetland cost an average of £1,050/ha; a wetland habitat mosaic through re-profiling > £78,000/ha; a new reed bed in the UK costs £2,500/ha (IEEP, 2013) [ii]	**£1,260/ha**
FW	**Replacing ES/Benefits from FW with Material Capital**	**Recreation, Aesthetic and Wildlife benefits - cannot be**

Benefit	Is the ES/Benefit replaceable?
Clean Water	Yes wastewater treatment plants; desalinisation plants.

Aesthetics	No (although substitutes of some degree exist)	
Recreation	No (although substitutes of some degree exist)	
Hazard Protection	Yes man-made flood defence.	
Wildlife	No (although substitutes of some degree exist)	
Equable Climate	Yes carbon can be offset elsewhere.	

replaced if FW ability to provide this ES benefit is destroyed

U	**Restoring Quality of U** The U MLC is unique in that it is not a naturally functioning ecosystem. When we refer to restoration the understanding is that the natural capital assets are degraded by the U MLC and that we can act to restore these assets towards a pristine state. It is possible to partially restore the atmosphere as a natural capital asset to a level where provision of ES is improved. This may involve reducing pressures (to facilitate the natural assimilation and dispersion of pollutants e.g. less fossil fuelled cars) as well as positive abatement technologies being adopted (e.g. urban trees; particle traps on vehicles). Cost of reducing emissions of $PM_{2.5}$ by 40% (from 48kt to 29kt) in 2015 is £1.7bn - £2.4bn/yr (AEA, 2001). Creating urban green space constitutes a 'restoration' of natural capital assets within the U MLC. Creating urban green space for example is viewed as an increase in species (e.g. urban plane trees; grasses), which provides an environment (in urban areas) for other species (i.e. wildlife benefit) and for recreation, aesthetics and equable climate benefits. It is not possible to 'restore' capital assets in the urban environment to provide hazard protection or clean water benefits.	**£1.7bn - £2.4bn/yr** (reduce $PM_{2.5}$ by 40%)
U	**Recreating U to Increase Quantity/Alter Spatial Configuration** *Increasing quantity and spatial configuration will have negative consequences for natural capital assets.*	**n/a**
U	**Replacing ES/Benefits from U with Material Capital** As for all MLC, the 'replacement' costs refer to the adoption of material capital technologies which replace and/or mimic natural processes (e.g. SuDS).	**Clean Air, Recreation, Aesthetic benefits** -

		cannot be replaced if FW ability to provide this ES benefit is destroyed

Benefit	Is the ES/Benefit replaceable?
Clean Water	Yes wastewater treatment plants; desalinisation plants.
Clean Air	No
Aesthetics	No (although substitutes of some degree exist)
Recreation	No (although substitutes of some degree exist)
Hazard Protection	Yes SuDS, costs of systems typically high - £500 to £1000/unit (DCLG, 2011)
Wildlife	Yes, green roofs, SuDS. Typical cost of green roof is £98 - £600/m^2 (English Nature, 2003)
Equable Climate	Yes carbon can be offset elsewhere.

CM	**Restoring Quality of CM** Overall restoration cost of dunes is £840/ha; of saltmarsh of £110/ha/yr (IEEP, 2013) [ii].	**£110/ha - £840/ha**
CM	**Recreating CM to Increase Quantity/Alter Spatial Configuration** The cost of replacing the same area of saltmarsh that is being lost in the UK through saltmarsh re-creation is estimated to be around £33m/yr (IEEP, 2013) [ii]. Costs of re-creating intertidal habitat is £115,500/ha; shingle beach expansion £10,500/ha; coastal lagoons through managed re-alignment from £4,400/ha to £59,800/ha (IEEP, 2013) [ii].	**£4,400 - £115,500/ha**

CM

Replacing ES/Benefits from CM with Material Capital

Benefit	Is the ES/Benefit replaceable?
Aesthetics	No (although substitutes of some degree exist)
Hazard Protection	Yes man-made flood defence.
Wildlife	No (although substitutes of some degree exist)
Equable Climate	Yes carbon can be offset elsewhere.

Aesthetic and Wildlife benefits - cannot be replaced if CM ability to provide this ES benefit is destroyed

M

Restoring Quality of M

Up to a threshold, marine quality can be restored to a level where ES are provided. Beyond this the damage may be irreversible, such as toxic contamination.

Assume that protection of the marine environment will allow natural regeneration in (appreciation of) natural capital assets. Estimated cost to protect 20-30% of the global oceans by Cullis-Suzuki and Pauly (2010) of $25-37bn/yr (US) and Balmford et al (2004) of $5-19bn (US). Suggests a range of $5 to $37bn/yr (US).

Assumption that UK fisheries utilise 15-20% of global oceans, halves this value to $2.5bn – $18.5bn. Converting $:£ ($1 = £0.63), suggests a value of between £1.5bn/yr - £11.5bn/yr

£1.5bn/yr - £11.5bn/yr (to protect 15-20% global ocean)

M

Recreating M to Increase Quantity/Alter Spatial Configuration

Quantity and spatial configuration of Marine MLC cannot be influenced.

n/a

M

Replacing ES/Benefits from M with Material Capital

Benefit	Is the ES/Benefit replaceable?
Food	Yes through aquaculture

Wildlife benefits - cannot be replaced if M ability to provide

Wildlife	No (although substitutes of some degree exist)	this ES benefit is destroyed

ANNEX 7: FUNCTIONAL RELATIONSHIPS & WGB JUSTIFICATION

Key

Society cannot influence benefit from MLC	
Minor/moderate impact on benefit from MLC	
Major impact on benefit from MLC	
Landscape continuity impacted by development/mining	
Uncertainty over relationship	?
Significant interactions	X

RAGG - GREY

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Food	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Fibre	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	
MMH	Energy	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	
MMH	Clean water	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	
MMH	Clean air	Quantity	MMH MLC has no significant relationship in production of clean air benefit.	-	
		Quality		-	
		Spatial configuration		-	
MMH	Recreation	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	
MMH	Hazard protection	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Equable climate	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of benefit realised. Location of MLC is defined by altitude - over 300m.	-	
EF	Clean air	Quality	No relationship - the quality of the MLC cannot be influenced by society to change the amount of the benefit produced. (Note that effects of methane/nitrogen oxide are considered in equable climate)	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of the benefit produced.	-	
EF	Recreation	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of the benefit produced i.e. the location of EF will not be changed for recreational benefits - other over riding factors regarding location (e.g. best soils for arable crops etc).	-	
EF	Hazard protection	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to significantly change the amount of the benefit produced.	-	
EF	Equable climate	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society to change the amount of the benefit produced.	-	
SNG	Energy	Quantity	No relationship. Biofuel production has been included in the Enclosed Farmland MLC.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Quality	SNG covers 1% of the total area of England (SoNE, 2008) and characterised by grassland that has not been managed for anything other than conservation.	-	
		Spatial configuration		-	
SNG	Clean water	Quantity	No relationship. SNG does not contribute to the production of clean water. The UK NEA discusses semi-natural grassland as being a better land use that the Enclosed Farmland MLC in terms of water quality.	-	
		Quality		-	
		Spatial configuration		-	
SNG	Clean air	Quantity	No relationship. Semi-natural grassland does not contribute to the clean air benefit.	-	
		Quality		-	
		Spatial configuration		-	
SNG	Recreation	Spatial configuration	No relationship. Semi-natural grassland is geographically constrained by underlying geology and restricted to 1% of total area of England (SoNE, 2008).	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
SNG	Hazard protection	Quantity	No relationship. Semi-natural grassland does not contribute to the protection from hazards and restricted to 1% of total area of England (SoNE, 2008).	-	
		Quality		-	
		Spatial configuration		-	
SNG	Equable climate	Spatial configuration	No relationship - semi-natural grassland is geographically constrained by underlying geology.	-	
W	Fibre	Spatial configuration	No relationship - it does not matter where the woodland is, assuming infrastructure is in place to transport timber to beneficiaries. Currently 80% of the UKs wood and wood product needs are met by imports (UK NEA 2011,pg 262).	-	
W	Energy	Spatial configuration	No relationship - it does not matter where the woodland is, assuming infrastructure is in place to transport timber, for biofuel, to beneficiaries. Currently 80% of the UKs wood and wood product needs are met by imports (UK NEA 2011,pg 262).	-	
W	Clean water	Quality	No relationship- it is not the quality of the MLC that determines the benefit, but quantity and spatial configuration of woodland, and therefore uptake of water and potential to intercept pollutants.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
W	Hazard protection	Quality	It is not the quality of the MLC that determines the benefit, but quantity and spatial configuration of woodland, and therefore uptake of water and binding of soils.	-	
W	Equable climate	Spatial configuration	No relationship - storage of carbon can occur anywhere.	-	
FW	Food	Spatial configuration	No relationship - it does not matter where fish production occurs assuming infrastructure is in place to transport to beneficiaries.	-	
FW	Fibre	Spatial configuration	No relationship - it does not matter where reeds are grown, assuming infrastructure is in place to transport reeds to beneficiaries. Currently a large proportion of UK's reed product needs are met by imports.	-	
FW	Energy	Quantity	No relationship - it is not considered realistic to increase the extent of the MLC unit e.g. rivers to provide more hydro power due to complexity of conditions that determine where these habitats occur.	-	
		Quality	No relationship - to get energy from freshwater MLC need to put the material capital in the right place to harness energy.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Clean air	Quantity	No relationship - cannot influence the MLC for clear air benefit.	-	
		Quality		-	
		Spatial configuration		-	
U	Food	Spatial configuration	No relationship- tend to be community farms/domestic gardeners and allotment holders. Limited extent of cultivation and high proportion of impermeable areas restricting ability to change spatial configuration.	-	
U	Fibre	Quantity	No relationship - cannot influence the MLC for fibre benefit.	-	
		Quality		-	
		Spatial configuration		-	
U	Energy	Quantity	No relationship - cannot influence the MLC for energy benefit.	-	
		Quality		-	
		Spatial		-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		configuration			
CM	Food	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society-restricted to interface between land and sea.	-	
CM	Fibre	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be influenced by society-restricted to interface between land and sea.	-	
CM	Energy	Quantity	No relationship - the MLC cannot be influenced by society to provide an energy benefit. i.e. we harness what is already in place (tidal).	-	
		Quality		-	
		Spatial configuration		-	
CM	Clean water	Quantity	No relationship - Although sand dunes and shingle with a reasonable depth form shallow aquifers of clean water (used for small-scale local abstractions such as golf) (UK NEA), the quantity of the MLC cannot be influenced by society to increase the value of the benefit produced. i.e. we utilise what is there.	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
CM	Clean air	Quantity	No relationship - the MLC cannot be changed or influenced by human management to provide a clean air benefit.	-	
		Quality		-	
		Spatial configuration		-	
CM	Recreation	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced - restricted to interface between land and sea.	-	
CM	Hazard protection	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
CM	Wildlife	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced	-	
CM	Equable climate	Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
M	Food	Quantity	No relationship - the quantity of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
M	Fibre	Quantity	No relationship - none of the characteristics of the MLC can be changed or influenced by human management to increase the value of the benefit produced.	-	
		Quality		-	
		Spatial configuration		-	
M	Energy	Quantity	No relationship - none of the characteristics of the MLC can be changed or influenced by human management to increase the value of the benefit produced.	-	
		Quality		-	
		Spatial configuration		-	
M	Clean water	Quantity	No relationship - none of the characteristics of the MLC can be changed or influenced by human management to increase the value of the benefit produced.	-	
		Quality		-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Spatial configuration		-	
M	Clean air	Quantity	No relationship - none of the characteristics of the MLC can be changed or influenced by human management to increase the value of the benefit produced.	-	
		Quality		-	
		Spatial configuration		-	
M	Recreation	Quantity	No relationship - the quantity of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
M	Aesthetic	Quantity	No relationship - the quantity of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
M	Hazard protection	Quantity	No relationship - none of the characteristics of the MLC can be changed or influenced by human management to increase the value of the benefit produced.	-	
		Quality		-	
		Spatial configuration		-	
M	Wildlife	Quantity	No relationship - the quantity of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
M	Equable climate	Quantity	No relationship - the quantity of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	
		Spatial configuration	No relationship - the spatial configuration of the MLC cannot be changed or influenced by human management to increase the value of the benefit produced.	-	

RAGG - GREEN

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Food	Quantity	MMH is of low/medium low importance in providing food. MMH naturally have low agricultural productivity due to soil properties, water logging and topography (sheep predominant use) therefore classed as poor quality agricultural land. Although we could influence the quantity and quality characteristics, this would be limited to the margins (e.g. change in lowland heath) and there would be negligible change in total benefit produced from the MLC over the next 25 yrs.	-	
		Quality		-	
MMH	Fibre	Quantity	MMH is of low/medium low importance in providing fibre, sheep wool by product of sheep meat-little market value. Although we could influence the quantity and quality characteristics, there would be negligible change in total benefit produced from the MLC over the next 25 yrs.	-	
		Quality		-	
MMH	Clean water	Quantity	The relationship is considered to be +L (none/negligible). The quantity of the MLC could decrease through change in land use (e.g. to woodland, to enclosed farmland) or development, however the potential to increase the extent of the habitats is limited to the margins e.g. heath areas, majority of other subcomponents require specific topographic conditions to exist. As any changes in extent will be minimal, the impact to benefit produced over the next 25yrs will be none/negligible. Although MMH significant source of water (70% UK drinking water) -coincidental in location - quantity of the MLC does not significantly affect amount of water.		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Recreation	Quantity	The relationship is considered to be +L (none/negligible). The quantity of the MLC could decrease through change in land use (e.g. to woodland, to enclosed farmland) or development, however the potential to increase the extent of the habitats is limited to the margins e.g. heath areas, majority of other subcomponents require specific conditions to exist. As any changes in extent will be minimal, the impact to benefit produced over the next 25yrs will be none/negligible.	-	
		Quality	The relationship is considered to be +NL (none/negligible). The use of MMH for recreation e.g. mountain biking, walking etc will largely be determined by access, and material capital investments e.g. trails, footpaths etc, and the maintenance of these. The impact to the benefit produced over 25yrs, resulting from a change in quality, is considered to be none/negligible. Recreation = f [land (topography, altitude); material capital (management practices - trails, footpaths, access to rock faces for climbing)]	-	
MMH	Aesthetics	Quantity	The relationship is considered to be +L (none/negligible). It is considered that most of the aesthetic value of MMH is the scenery and sense of wilderness, and what is available will be highly valued. The quantity of the MLC could decrease through change in land use (e.g. to woodland, to enclosed farmland) or development, however the potential to increase the extent of the habitats is limited to the margins e.g. heath areas, majority of other subcomponents require specific conditions to exist	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			and therefore unlikely to be adversely affected by land use changes. As any changes in extent will be minimal, the impact to benefit produced over 25yrs will be none/negligible.		
EF	Food	Spatial configuration	The relationship is considered to be +NL (none/negligible). Although we can influence the spatial configuration of enclosed farmland, this does not influence the total benefit produced or its value i.e. it does not matter where produce food. It is also acknowledged that some geology/soils are more fertile than others, however again, society cannot influence where these occur, can just utilise for best output.	-	
EF	Fibre	Quantity	Enclosed farmland is of low/medium low importance in providing fibre (considered to be a secondary crop to food production). Although we could influence the quantity, quality and spatial configuration characteristics, there would be negligible change in total value of benefit produced because of low ES provision from the MLC over the next 25 yrs.	-	
		Quality		-	
		Spatial configuration		-	
EF	Energy	Spatial configuration	The relationship is considered to be +NL (none/negligible). Although we can influence the spatial configuration of EF, this does not influence the value of the benefit produced i.e. it does not matter where produce biofuel. It is also acknowledged that some geology/soils are more fertile than others, however again, society cannot influence where these occur, can just utilise for best output.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
EF	Clean water	Spatial configuration	The relationship is considered to be +NL (none/negligible). Although we can influence the spatial configuration of EF, this is not considered to significantly change the amount of the benefit produced - other over-riding factors would affect location of farms.	-	
EF	Clean air	Quantity	The relationship is considered to be -NL (none/negligible). Although we can influence the quantity of EF, and therefore potential for air quality issues (vehicle emissions), this is not considered to significantly change the amount of the benefit produced. (urban MLC greater contributor).	-	
EF	Recreation	Quantity	The relationship is considered to be +NL (none/negligible). Although we can change the quantity of EF, this is not considered to significantly change the benefit produced - this is primarily determined by the quality characteristic .i.e. access.	-	
EF	Aesthetics	Quality	The relationship is considered to be +NL (none/negligible). Although we can influence the quality of EF to improve aesthetics e.g. greater heterogeneity of farming types in the landscape is likely to be more aesthetically pleasing than a homogenous farming landscape, this is not considered to significantly change the amount of the benefit produced.	-	
		Spatial configuration	The relationship is considered to be +NL (none/negligible). Although we can influence the spatial configuration of EF to bring closer to people, this is not considered to significantly change the amount of the	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			benefit produced and over riding factor of locality.		
EF	Hazard protection	Quantity	The relationship is considered to be -NL (none/negligible). Although we can influence the quantity of EF, this is not considered to significantly change the amount of the benefit produced – quality more important. However it is assumed that there is a level of soil erosion under baseline quality conditions, and therefore an increase in area of EF would have some impact flooding (increased sediment in rivers potentially causing flooding problem)	-	
EF	Equable climate	Quantity	The relationship is considered to be -NL (none/negligible). Although the area of enclosed farmland can be increased, the stocking density of livestock that give rise to methane emissions is part of the quality characteristic at baseline it is assumed some increase.	-	
SNG	Food	Quantity	SNG is of low/medium low importance in providing food. Although we could influence the quantity, quality and spatial configuration characteristics for food, there would be negligible change in benefit produced from the MLC over the next 25 yrs. Livestock grazing on improved grasslands has been included in the Enclosed Farmland MLC.	-	
		Quality		-	
		Spatial configuration		-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
SNG	Fibre	Quantity	Semi-natural grasslands is of low/medium low importance in providing fibre. Although we could influence the quantity, quality and spatial configuration characteristics, there would be negligible change in benefit produced from the MLC over the next 25 yrs.	-	
		Quality		-	
		Spatial configuration		-	
SNG	Recreation	Quantity	The relationship is considered to be +NL (none/negligible). It is assumed that all SNG could be replaced with another MLC. The first units of grassland will be highly valued, however, at a critical amount i.e. enough grassland to satisfy recreational demands, any increases over this will not be as valued. The overall increase in area of semi-natural grassland is considered to be limited, as it is dependent on underlying geological conditions. As only 1%, potential change in quantity is limited and also ability to extend (due to underling geological conditions required).	-	
		Quality	The relationship is considered to be +NL (none/negligible). The recreational benefits from SNG will be governed by low level management e.g. light grazing, management of footpaths. Overall it is considered that there is limited requirement to improve the quality of the MLC for recreational benefits assuming access in place. Recreation = f [**species**; **soils**; **land** (topography); **material capital** (light	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			grazing to minimise scrub, footpaths, bridlepaths)]		
SNG	Aesthetic	Quantity	The relationship is considered to be +NL (none/negligible). It is assumed that all SNG could be replaced with another MLC. The first units of grassland will be highly valued, however, at a critical amount i.e. enough grassland to satisfy recreational demands, any increases over this will not be as valued. The overall increase in area of semi-natural grassland is considered to be limited, as it is dependent on underlying geological conditions. As only 1%, potential change in quantity is limited and also ability to extend (due to underling geological conditions required).	-	
SNG	Equable climate	Quantity	The relationship is considered to be +NL (none/negligible). It is assumed that all semi-natural grassland could be replaced with another MLC therefore the value crosses the origin. The first units of grassland will be highly valued, however, at a critical amount i.e. enough grassland to satisfy recreational demands, any increases over this will not be as valued. The overall increase in area of semi-natural grassland is considered to be limited, as it is dependent on underlying geological conditions.	-	
W	Food	Quantity	Woodland MLC is of low importance in providing food. Although we could influence the quantity, quality and spatial configuration characteristics,	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Quality	there would be negligible change in total benefit produced from the MLC over the next 25 yrs.	-	
		Spatial configuration		-	
W	Energy	Quality	The relationship is considered to be +NL (none/negligible). It is the quantity that drives the change in benefit more than the quality i.e. amount of timber grown for biofuel. However, aspects of quality of the MLC can affect the yield. In a poor quality environment e.g. high levels of acidification, low nutrient cycling, tree growth will be poor and therefore limit yield. It may also be possible to select the species that are grown, to select those with quickest growth rates. Improvements in material capital to harvest the timber will also increase the amount of output. Biofuel yield = f [**species** (quick growing), **ecological communities** (invasives, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient cycling); **freshwaters** (groundwater); land (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); minerals (potassium, magnesium); **material capital** (management - coppicing, felling, crop rotation, irrigation, processing, machinery, transport, pest control, nutrient enrichment, pollution - SO2)] Overall, the value of woodland for biofuel will be lower than the value for timber, as biofuel is readily substitutable and therefore there is a lower	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			demand.		
W	Clean air	Quality	The relationship is considered to be +NL (none/negligible) It is the quantity that drive the change in benefit i.e. more woodland equals greater potential to absorb pollutants and increase O_2 production.		
		Spatial configuration	The relationship is considered to be +NL (none/negligible). UK NEA suggests that trees could be planted around livestock units to reduce pollution spreading, and it is considered that the same approach could be applied to roads to absorb pollutants. However, the overall change in benefit is considered to be minimal, with the greatest change driven by quantity of trees (0_2 production, pollutant absorption). Please note, the importance of greenspace and trees is considered in the urban MLC.	-	
FW	Food	Quantity	The relationship is considered to be +L (none/negligible). The overall value of food from freshwater (fish) is considered to be low when compared to EF (crops and livestock). As the number of waterbodies increases, the potential for use for aquaculture also increases. However, the overall change in extent is considered to be small i.e. cannot significantly increase number of rivers or lakes.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Fibre	Quantity (Wetland)	The relationship is considered to be +L (none/negligible). Although the UK NEA identifies that there is a strong demand for quality thatching reed, this is considered to be relatively low in value compared to other fibre products e.g. timber from woodland. It is also considered that the area of reedbed available for harvesting is unlikely to increase considerably if the area of 'freshwater' increases due to prevailing conditions limiting how much habitat can be created.	-	
		Quality (Wetland)	The relationship is considered to be +NL (none/negligible). The quality of the wetland subcomponent will affect reed growth and therefore amount that can be harvested and sold. However the future provision is considered to be low. In a degraded wetland, it is considered unlikely that there would be sufficient quantity of reeds to be commercially viable to harvest. However, as the quality of the wetland increases, the quantity and quality of reeds available for harvesting will increase significantly. At a critical point, further improvements will not significantly increase value from reed yield. Reed yield = f [**species** (common reed), **freshwater** (water, floodplain, low flows, submergence - 300mm water depth in spring, soils-clays and silts, nutrient enrichment), **land** (gradient), atmosphere (temperature), **material capital** (cutting and harvesting)]	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Clean water	Spatial configuration	The relationship is considered to be +NL (none/negligible). Storage reservoirs and water treatment works are typically located within close proximity to populations, or where rainfall or river flows are high. However, there is an historic context to this as water supply components will be developed where cities have developed i.e. close to populations. Distribution networks connect a range of water supply components which may be some miles from the beneficiary. The location of wetlands can alter the effectiveness of purification, with some being located in areas of between sources of pollutants and the main watercourse. However, this is considered to have a negligible effect to the overall cost of treating water for use.	-	
FW	Recreation	Quantity	The relationship is considered to be +L (none/negligible). It is assumed that freshwater is valued moderately high for aesthetics e.g. coastal margins and MMH more valued. Although you can change the area of some of the subcomponents e.g. wetlands, reservoirs, you cannot significantly change the area of the MLC for a recreational benefit. Wetlands and reservoirs are normally created for another purpose (e.g. wildlife, clean water) and recreation is a by-product.	-	
FW	Aesthetics	Quantity	The relationship is considered to be +L (none/negligible). It is assumed that freshwater is valued moderately high for aesthetics e.g. coastal margins and MMH more valued.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			It is considered that you cannot significantly change the area of the MLC, just around the margins such as the wetland subcomponent. These changes in area will not give rise to a significant change in value.		
		Spatial configuration	The relationship is considered to be +NL (none/negligible). The proximity of freshwater to populations will be valued, although there will be a certain distance which is acceptable, and any improvements on this will not be valued as greatly and ability to change limited.	-	
FW	Hazard protection	Quantity	The relationship is considered to be -NL (none/negligible). As the number of waterbodies increases, the potential for flooding also increases. With a low extent of waterbodies, the avoided cost of flood protection is high, as waterbodies increases, and therefore risk of flooding increases, this avoided cost decreases. However, it is considered that you cannot significantly change the area of the MLC, just around the margins such as the wetland subcomponent. These changes in area will not give rise to a significant change in benefit.	-	
U	Food	Quantity	The urban MLC is of low/medium low importance in providing food. Although we could influence the quantity and quality characteristics, there would be negligible change in total value of benefit produced from the MLC over the next 25 yrs.	-	
		Quality		-	

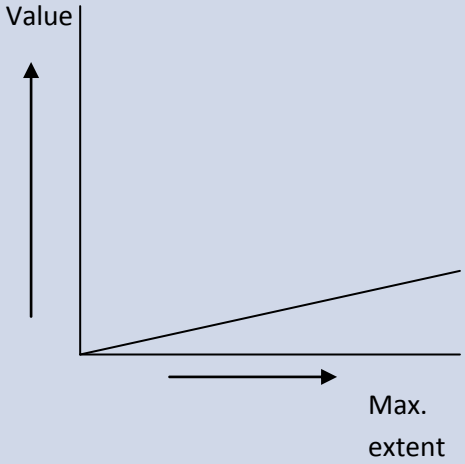
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
U	Clean water	Spatial configuration	The relationship is considered to be +NL (none/negligible). Urban greenspaces could be arranged to act as interceptors to pollution before it enters watercourses. However, the change in value to the clean water benefit is considered to be negligible with the greatest impact arising through replacement techniques e.g. SUDS, material capital investments such as Thames Tideway Tunnel (these not considered as part of the current scope of work to inform the risk register)	-	
U	Clean air	Spatial configuration	The relationship is considered to be +NL (none/negligible). It is considered that urban greenspaces could be configured to maximise potential to scavenge pollutants however the change of value to the clean air benefit is considered to be negligible given the overall impact of the built urban environment on air quality.	-	
U	Hazard protection	Quality	The relationship is considered to be +NL (none/negligible) The quality of the built urban environment could be improved by reducing the area of impermeable surfaces, and maximising potential of greenspaces to reduce surface water runoff.	-	
		Spatial configuration	The relationship is considered to be +L (none/negligible). It is considered that urban greenspaces could be configured to maximise potential to intercept rainfall and reduce surface water runoff however the change of value to the protection from hazards benefit is considered to be negligible given the overall impact of the built urban environment and reliance on replacement techniques to reduce the impact.	-	

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
CM	Food	Quantity Saltmarsh and sand dunes	The relationship is considered to be +NL (none/negligible) Older established saltmarsh and sand dune grasslands are used for grazing livestock (predominantly sheep) (UK NEA 2011). The current provision of food from this MLC is considered to be low when compared to EF and M. Although there is potential to reduce the quantity of these subcomponents through land use change, the ability to increase them is limited as they are the ultimate stage of succession for these habitats.		
		Quality Saltmarsh and sand dunes	The relationship is considered to be +NL (none/negligible) The saltmarsh and sand dunes which support livestock typically have a soil profile to support grass. Anything that affects the store of soil will affect the amount of benefit that can be produced. However, this is considered to be minimal as the grassland successional stage is well established and least vulnerable to erosion.		
CM	Fibre	Quantity	The relationships are considered to be +NL (none/negligible) Coastal margins are of low importance in providing fibre (wool). Although we could influence the quantity and quality characteristics (spatial configuration cannot be changed), there would be negligible change in total benefit produced from the MLC over the next 25 yrs.	-	
		Quality		-	
CM	Clean water	Quality	The relationship is considered to be +NL (none/negligible). It is assumed that as the quality of the habitat increases, its ability to purify also increases. It is considered that a limited number of aquifers benefit from this process, with the majority of aquifers in England being inland, and	-	

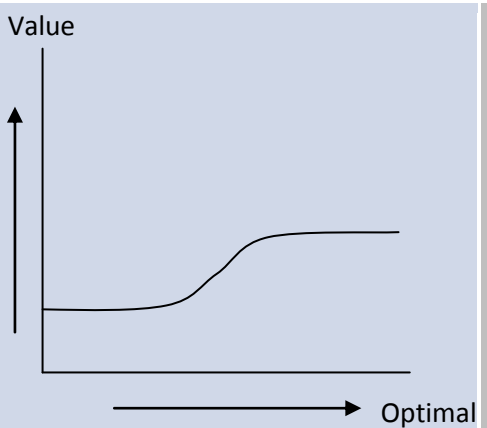
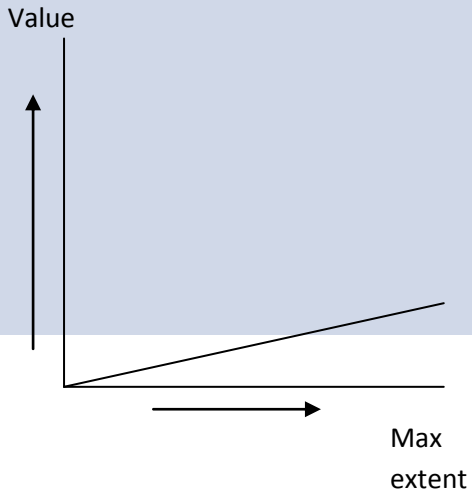
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			therefore the overall value of an increase in quality is minimal. As stated in the UK NEA, Dungeness is the only shingle site which provides a local source of drinking water. The benefit in purification is to the marine MLC. Clean water = f [**coasts** (substrate); **freshwater** (aquifer); **material capital** (abstraction wellfield)]		
CM	Recreation	Quantity	The relationship is considered to be +L (none/negligible). The ability to increase the quantity is limited e.g. some subcomponents only such as saltmarsh. Minor changes in the quantity of these habitats are not considered to be significantly valued for recreation.	-	
CM	Aesthetic	Quantity	The relationship is considered to be +L (none/negligible). The ability to increase the quantity is limited e.g. some subcomponents only such as saltmarsh. Changes in the quantity of these habitats are not considered to be significantly valued for aesthetics.	-	
M	Aesthetic	Quality	The relationship is considered to be +NL (none/negligible). The quality of the marine environment, and wider sea views, can be affected by offshore windfarms (perceived as both positive and negative impacts on landscape). The change in value of the benefit is considered to be none/negligible.	-	
M	Equable climate	Quality	The relationship is considered to be +NL (none/negligible). Marine organisms regulate the climate by acting as a sink for carbon dioxide and facilitating burial of carbon in seabed sediment. This is done by	-	

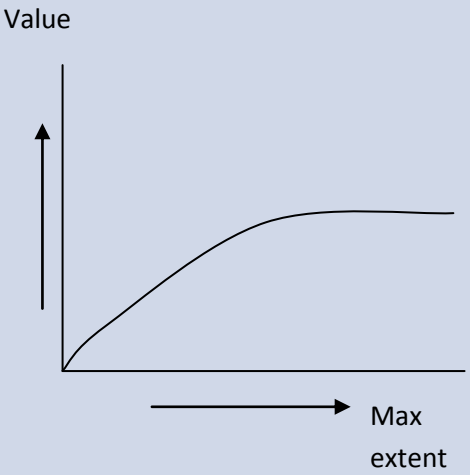
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			photosynthesis and also storage of carbon in shells (calcium carbonate). The abundance and diversity of marine flora and fauna will be primarily determined by the quality of the water. This will increase up to a critical point, after which any increase in quality, and therefore associated species abundance, will be less valued. However, our ability to change or influence the benefit by human management is considered to be limited. Equable climate = f [**species** (crustaceans, molluscs); **ecological communities** (phytoplankton, CaCO3 absorption); **ocean** (salinity, temperature, pH); **pressures** (pollution)]		

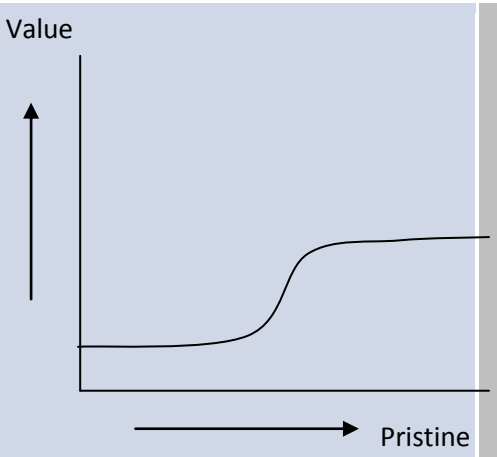
RAGG - AMBER

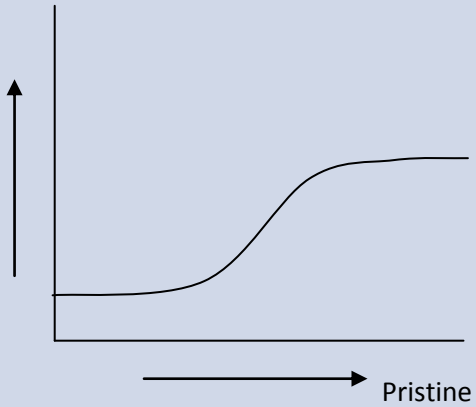
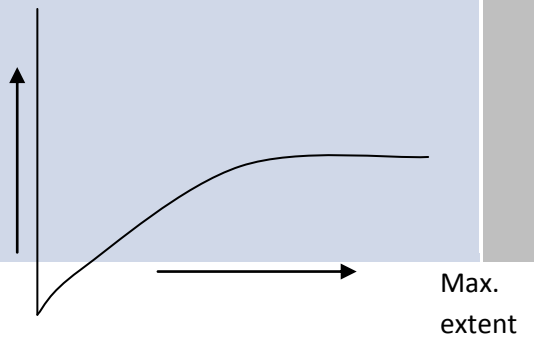
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Energy	Quantity Blanket bog and heath (habitats on peatland)	The relationship is considered to be +L (minor/moderate). Peat is a non-renewable energy source; only the rate of extraction/consumption can be managed. The quantity of the MLC could decrease through change in land use (e.g. heaths and bogs to grassland) or development, however the potential to increase the extent of the habitats is limited e.g. blanket bog requires certain conditions to exist. Therefore any changes in extent will be small. The timescales over which appropriate conditions need to be present to allow the formation of peat are considerable (decades). Peat has a slow rate of natural regeneration (mms per year), and therefore management would aim to maintain the 'stock' of peat that could be extracted for fuel, as this could be degraded. However, the change in quantity is often driven by a change in quality e.g. soil erosion (see below).		
		Quality	The relationship is considered to be +NL (minor/moderate). Peat will only form under certain conditions. If you	Value	

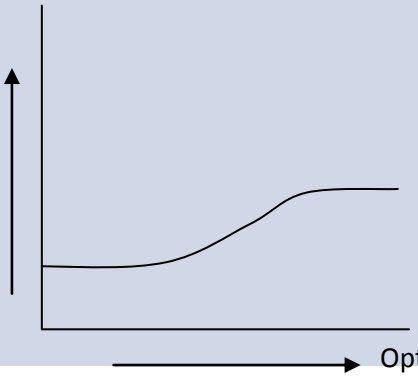
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			graze or burn blanket bog, the species required for peat formation e.g. sphagnum moss etc, will be lost by the resultant lowering of the water table and drying of the existing peat layer. The vegetation will be replaced by heath species typical of drier conditions. Suitable land management is therefore crucial in determining whether the stock of peat will be retained by ensuring continued conditions for it formation. The current provision of peat for energy is low and localised (UK NEA 2011, pg 126), and the UK Government is implementing measures to reduce peat use. Peat formation = f [**species** (sphagnum moss etc); **ecological communities** (photosynthesis and carbon locking); **soils** (high acidity, organic matter and water holding capacity, nutrient availability); **atmosphere** (temperatures, rainfall, CO2, N); freshwater (high water table); **land** (low gradient); **material capital** (extraction methods, land management - burning and grazing regimes)]		

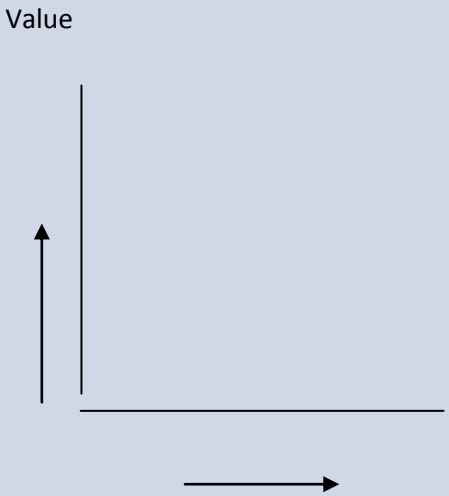
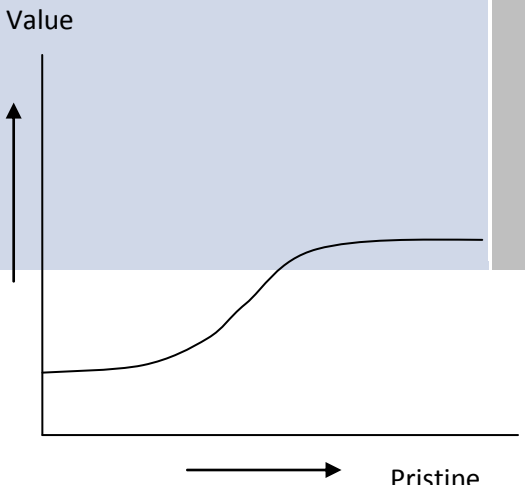
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Wildlife	Spatial configuration	The relationship is considered to be +NL (minor/moderate). The connectivity of habitats, e.g. blanket bogs and heaths, is important for maintaining wildlife. However, the ability to fragment with other land uses and/or provide better connectivity is considered to be limited by underlying conditions required for formation (e.g. geology, altitude, high precipitation etc.)		
MMH	Equable climate	Quantity Blanket bog	The relationship is considered to be +L (minor/moderate). The quantity of the MLC could decrease through change in land use (e.g. heaths and bogs to grassland) or development, however the potential to increase the extent of the habitats is limited e.g. blanket bog requires certain conditions to exist. Therefore any changes in extent will be small. However, given the		

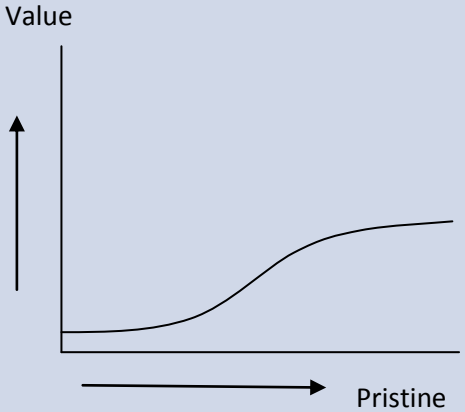
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			importance of blanket bog in carbon sequestration, the impact in benefit produced over 25yrs is considered to be minor/moderate.		
EF	Energy	Quantity	The relationship is considered to be +NL (minor/moderate). There is potential to both increase and decrease the area of the MLC, and the proportion of the MLC which is devoted to production of biofuels rather than food. As the quantity of the MLC increases so does the potential to produce biofuel and therefore resultant value. However, this will be limited by the market demand and therefore there will be a critical area required, after which increases in area will no longer be as highly valued. Given the current provision of benefit from MLC, considered to be minor/moderate.		

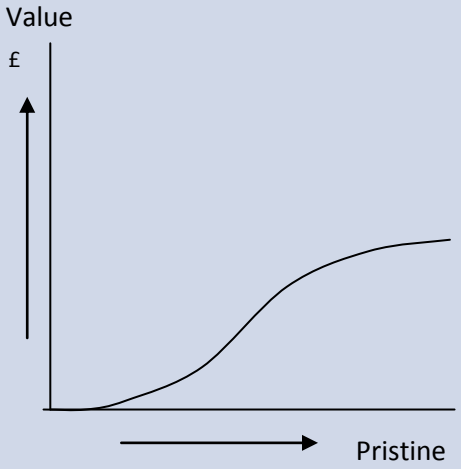
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Quality	The relationship is considered to be +NL (minor/moderate). The amount of biofuel that can be produced from EF will depend upon the quality of the habitat, but more importantly the material capital investment made to produce the crop. Poor quality habitats will not produce large amounts of biofuel and therefore the value will be low. As this increases, the value will significantly increase up to an optimal point, where after further improvements in quality will no longer give such substantial increases in benefit value. Biofuel crop yield = f [**species** (crop type); **soils** (agricultural Grade I – V); **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature and rainfall); **freshwater** (groundwater); **minerals** (potassium, magnesium); **ecological communities** (pollination, invasive species/disease); **material capital** (management practices e.g. irrigation, pest/disease control, nutrient enrichment, aeration of soil, crop rotation)] Given the current provision of benefit from MLC, considered to be minor/moderate.		

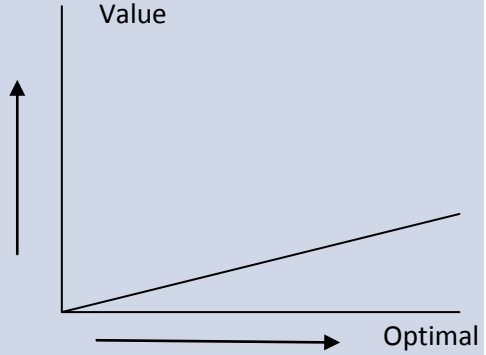
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
EF	Recreation	Quality	The relationship is considered to be +NL (minor/moderate). The quality of enclosed farmland can significantly affect the value of recreation e.g. through use of set aside to create game shooting areas, improve access arrangements. Recreation = f [**species**; **ecological communities** (pollination); **freshwater** (waterbodies present in enclosed farmland MLC); **land** (aspect, altitude, gradient); **material capital** (management practices e.g. buffer strips, set-aside, management of activities, signs/waymarks, well maintained footpaths/bridleways)]		Value
EF	Aesthetic	Quantity	The relationship is considered to be +NL (minor/moderate). There is potential to both increase and decrease the area of the MLC, which could result in a loss of the farming heritage from the wider landscape. The future provision to aesthetics is considered to be minor/moderate.		Value

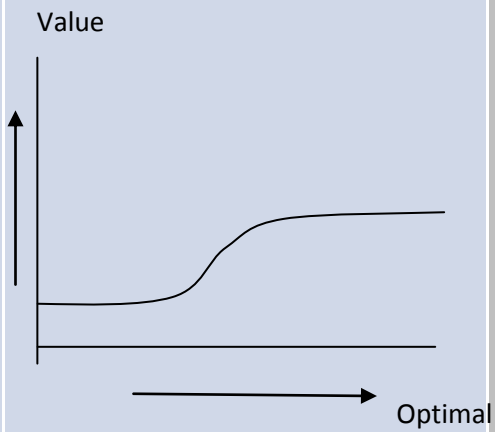
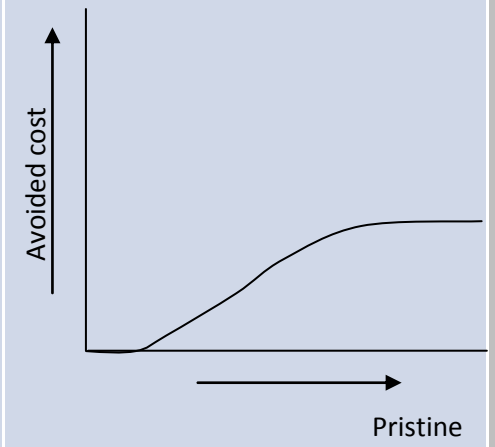
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
SNG	Wildlife	Spatial configuration	The relationship is considered to be +NL (minor/moderate) Semi-natural grassland is geographically constrained by underlying geology, but land use changes could interrupt the overall connectivity. However as SNG occupies only 1% of England land, and a large proportion is protected to some degree (68% of SNG is within SSSI, other designations also protect e.g. SAC, AONB), the ability to influence connectivity is considered to be limited, although could be significant in terms wildlife abundance and diversity.		Value

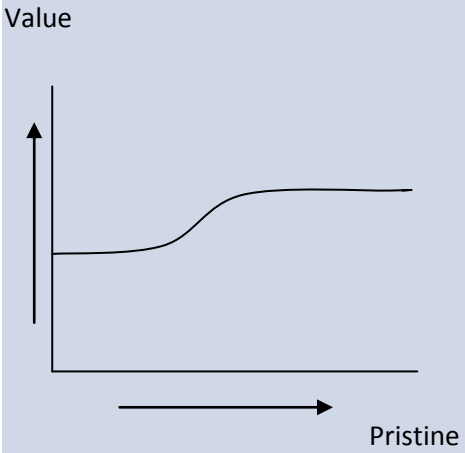
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
W	Energy	Quantity	The relationship is considered to be +NL (minor/moderate). The quantity of the MLC can be changed, with the potential for all areas of woodland to be converted to a different land use. Therefore the first unit of woodland will be highly valued. However, there will be a point where the area of woodland satisfies market demand, and any increase in quantity thereafter will not be as valued. Overall, the value of woodland for biofuel will be lower than the value for timber, as biofuel is readily substitutable and therefore there is a lower demand.		
W	Recreation	Quality	The relationship is +NL (minor/moderate). The quality of recreation will largely be governed by the management practices i.e. improving access, felling, coppicing, and creating recreational opportunities e.g. mountain biking trails, zip lines etc. The species composition of the woodland is not likely to be as important for recreational activities. As management improves the recreational facilities, the value will increase. At a certain point, further		

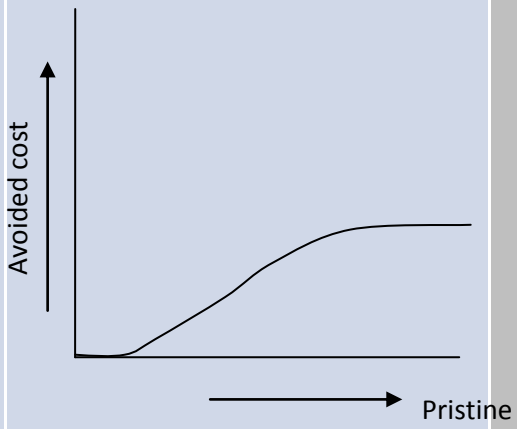
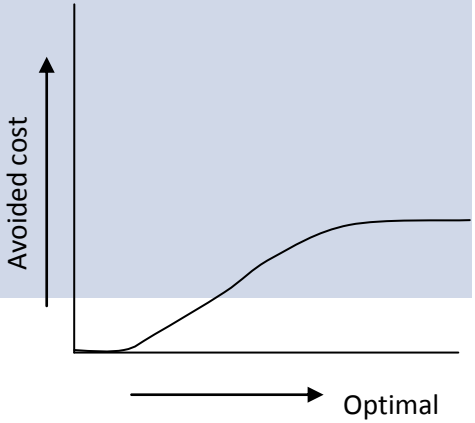
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			improvements will no longer be as valued. Recreation value = f [**species**, **ecological communities** (invasives, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient cycling); **freshwaters** (groundwater); **land** (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); **minerals** (potassium, magnesium); **material capital** (management - paths, bridleways, coppicing, felling, recreational equipment, pollution - SO_2)]		
W	Equable climate	Quality	The relationship is considered to be +NL (minor/moderate). Although different species may have different capacities and uptake rates of CO_2 it is predominantly the quantity of woodland that will give the greatest benefit. However the age of the woodland will also be important in CO_2 uptake in younger woodlands greater than mature woodlands. Species composition may also affect rates of uptake. Timber yield = f [**species** (fast growing e.g. eucalyptus), **ecological communities** (invasives, pests		

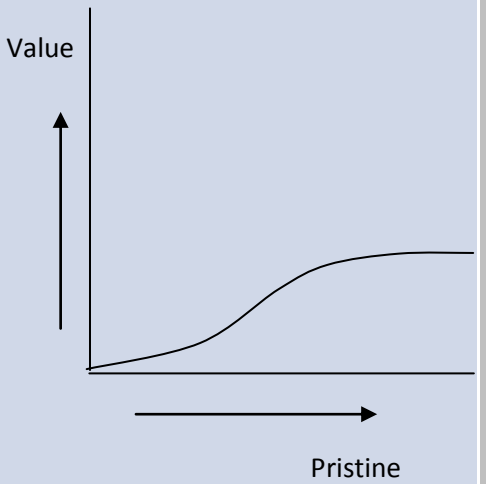
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient cycling); freshwaters (groundwater); **land** (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); **minerals** (potassium, magnesium); **material capital** (management - coppicing, felling, crop rotation, pest control, pollution - SO_2)]		
FW	Food	Quality	The relationship is considered to be +NL (minor/moderate). Overall value of food from freshwater (fish), and the contribution quality has to this, will be low. It is considered that the majority of fish production is undertaken in artificially created habitats, with high levels of human management, although noted that high value fish such as salmon can only be reared in high quality water courses. In a degraded/poor environment (either for water abstraction for artificial habitats or the natural system), the quantity and quality of water will limit fish production, with improvement in quality, fish production will increase. At a critical point, further improvements will not significantly increase value from fish production. Fish yield = f [**freshwater** (rivers, standing open water,		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			water - volume, quality (levels of O2, temperatures, nutrient levels), **land** (gradient, altitude), **ecological communities** (phytoplankton, zooplankton, aquatic vegetation), **species** (biomass, disease/pests), **manufactured capital** (controlled growing facilities (artificial waterbodies), fish passes on natural systems, water abstraction), **human management** (stocking densities, management of fish life cycle, disease/pest control, artificial feeding, nutrient enrichment)]		
FW	Energy	Spatial configuration	The relationship is considered to be +L (minor/moderate). The value of benefit realised is dependent on the positioning of material capital to harness the energy i.e. create dams in upland areas where there is sufficient flow, vertical distance (head) and volume of water, with low suspended sediment.		

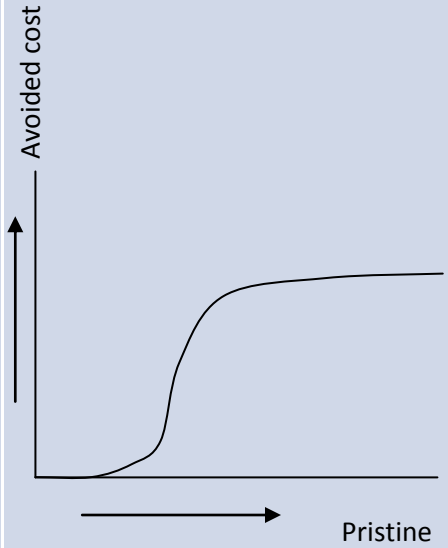
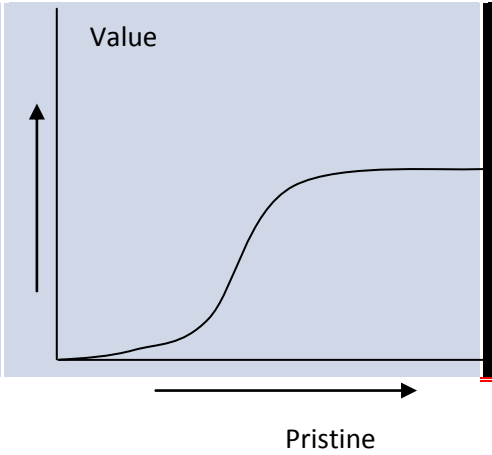
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Recreation	Spatial configuration	The relationship is considered to be +NL (minor/moderate). The proximity of freshwater to populations will be valued, although there will be a certain distance which is acceptable, and any improvements on this will not be valued as greatly. It also considered that there is a limit on the number of waterbodies that could be created near to populations to increase value from spatial configuration.		
U	Clean water	Quality Built urban	The relationship is considered to be +NL (minor/moderate). The impact from the built urban subcomponent on clean water is generally derived from combined sewer overflows during storm events and polluted surface water runoff that gets into the watercourses. Changes to use of cars, littering, reduced loading etc could reduce this. The main improvements would require the use of SUDS, oil interceptors etc and material capital investments e.g. Thames Tideway Tunnel are required. However these are all replacement techniques to reduce the impact of the urban MLC and not considered as part of the scope for the risk register work.		

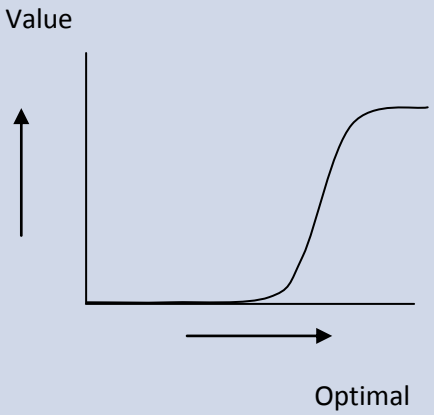
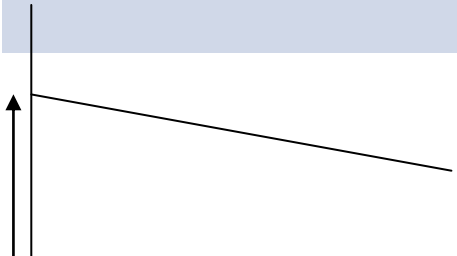
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
U	Recreation	Quality Greenspace	The relationship is considered to be +NL (minor/moderate). Poor quality greenspace is considered to be that which is unmanaged e.g. overgrown towpath, or possibly lacking in facilities e.g. greenspace with no play area in close proximity to residential housing i.e. active enjoyment of the greenspace is difficult. Pristine quality greenspace is that which is well managed and offers the facilities desired by the public. The initial unit of greenspace within the urban will be valued, but as the quality improves, this will increase. However, after a certain level of improvements, any additions are no longer as highly valued i.e. the marginal increase is less. = f [**ecological communities** (urban greenspace - parks, gardens, towpaths), **material capital** (management practices e.g. mowing, construction of playgrounds, football pitches, maintenance of these features)]		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
U	Equable climate	Quality Built urban	The relationship is considered to be +NL (minor/moderate). The built urban subcomponent of the MLC is considered to have a negative effect on flooding due to the extent of impermeable surfaces. A poor environment would be one of high impermeability, whereas a well designed environment would incorporate urban green spaces to intercept rainfall and reduce surface water runoff. Surface water flooding = f [**ecological communities** (vegetation); **soils** (permeability); **atmosphere** (rainfall)]		
		Spatial configuration	The relationship is considered to be +NL (minor/moderate) It is considered that urban greenspaces could be configured to maximise potential to intercept rainfall and reduce surface water runoff however the change of value to the protection from hazards benefit is considered to be negligible given the overall impact of the built urban environment and reliance on replacement techniques to reduce the impact.		

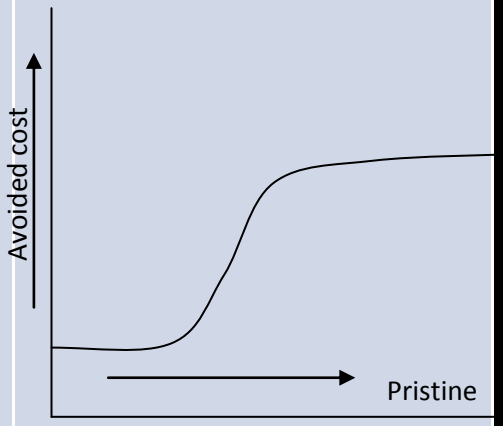
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
M	Recreation	Quality	The relationship is considered to be +NL (minor/moderate). The value of recreation can be improved with artificial reefs (e.g. surfing) and decreased through no-catch zones (angling).		

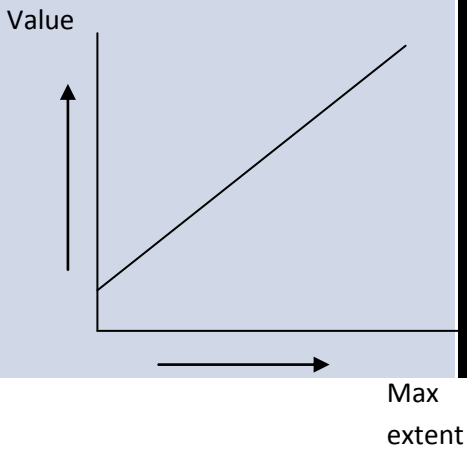
RAGG - RED

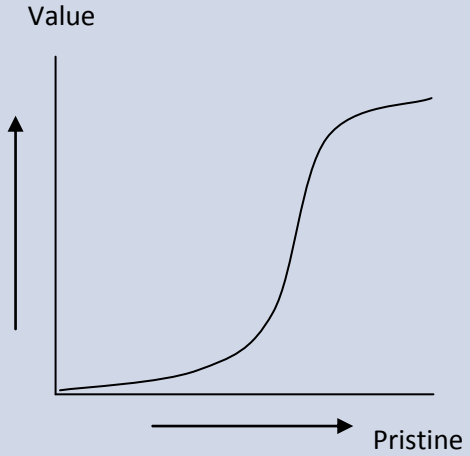
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
MMH	Clean water	Quality Blanket bog	The relationship is +NL (major). As the quality of blanket bog improves, the cost of treating water to drinking water standards will decrease - peat accumulation immobilises nutrients i.e. when not degraded, organic carbon, N etc held in place which would otherwise be released into water. The impact of degraded peatland on clean water is considered to be significant. Clean water = f [**ecological communities** (vegetation - nutrient cycling, pollutant absorption), **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (high water table) **land** (altitude, gradient), **atmosphere** (temperature and rainfall); **pressures** (management practices e.g. low intensity grazing, low drainage gripping, limit burning)]		
MMH	Aesthetics	Quality	The relationship is considered to be +NL (major). The quality of MMH can affect the 'sense of experience' gained from the MLC. Although the value of MMH for aesthetics will largely be determined by the land form which cannot be influenced by society. Appropriate management of the habitats e.g. heath could be considered to enhance views, with degraded habitats not offering the same 'scenery' as good or pristine habitats. (Note, the aesthetic appeal of special plant and animal		

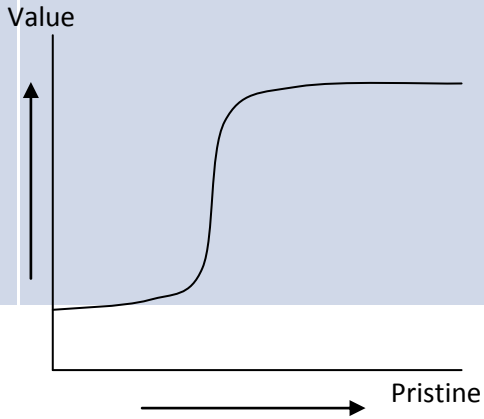
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			life is considered under the 'wildlife' benefit). Aesthetics = f [**land** (topography, altitude); **material capital** (management practices - burning, grazing, gripping)]		
		Spatial configuration	The relationship is considered to be +NL (major). Although the spatial configuration of the MLC cannot be influenced by society as it is defined by altitude (over 300m), the extent of it, and therefore aesthetic appeal, can be interrupted if the landscape is fragmented by urban area, tall structures or other land uses i.e. anything that interrupts the view, sense of wilderness. A continuous landscape is considered to be highly valued for aesthetics and therefore any impact on this are considered to be significant.		
MMH	Hazard protection	Quantity	The relationship is considered to be -NL (minor/moderate) for heaths and fire risk. The relationship between blanket bog and flooding is also		(?)

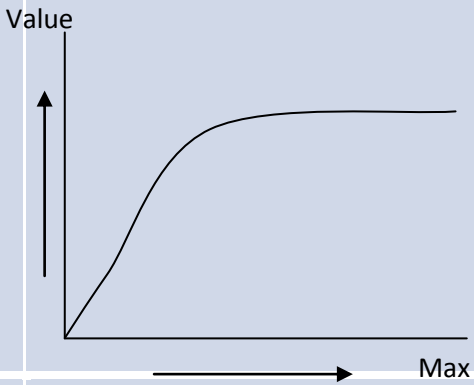
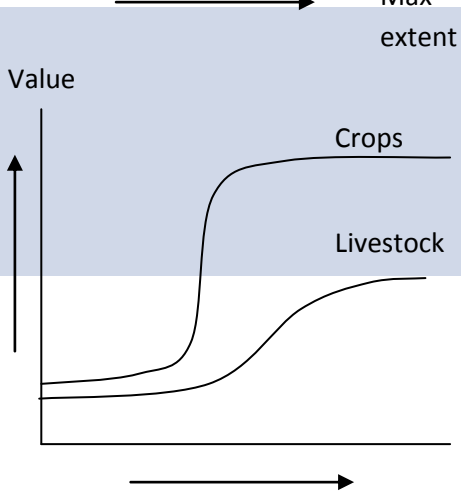
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			considered to be -NL but there is a high level of uncertainty on significance. There is the possibility of decreasing and to some extent increasing the quantity (although small) of some of the MMH subcomponents (blanket bogs and heaths) through land use changes e.g. afforestation, expansion of enclosed farmland. Wildfire is a risk, with heath being particularly susceptible and therefore if the quantity increased, the potential risk of fire would also increase. There is uncertainty around the role of blanket bog and flooding. As detailed in UK NEA 2011, historically have considered blanket bog as acting as a sponge and holding water, however good quality blanket bog would have a high water table, and therefore little capacity to hold additional water during a storm event. This could give rise to surface water runoff which would lead to increased flooding downstream. There is also some uncertainty over the role of quantity in soil erosion and slope instability. Assuming the current baseline quality (eroding blanket bog) it would be assumed that an increase in quantity would have a negative effect on soil stability. **Given the uncertainty of the relationships, this has been upgraded to major and will therefore be taken**		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			forward for further consideration in the risk register.		
		Quality	The relationship is considered to be +NL (minor/moderate) for both fire and soil stability. Wildfire risk can be decreased by managed burns to reduce the biomass present (UK NEA), with older heath having a higher fuel load (certain). Degraded blanket bog is also likely to increase the risk of fire, as the drier habitat will potentially assist in the spread of fire whilst a better quality habitat, which is wetter, is likely to reduce the spread (uncertain). It is unclear how blanket bog affects flooding (as stated above, the high water table could lead to runoff), however it is considered that a degraded blanket bog with grips and gullies would allow more efficient runoff of surface water during a storm event and therefore potentially increase flooding downstream (uncertain). A degraded blanket bog will experience soil erosion which could lead to slope instability (uncertain). Wildlife risk = f [**ecological communities** (heath biomass, blanket bog); **soils** (eroding); **freshwater** (low water table); **atmosphere** (temperature, rainfall); **pressures** (management practices e.g. burning regime)]		(?)

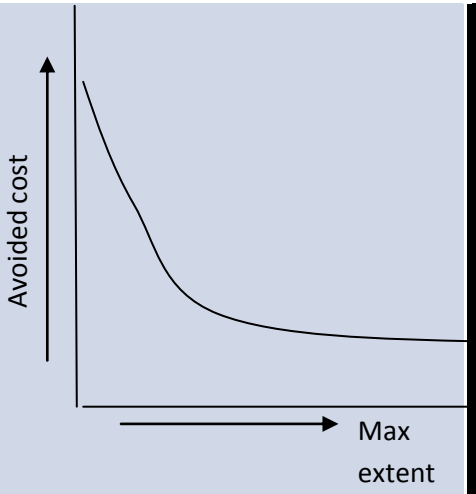
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			Flooding risk = f [**ecological communities**; **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table) **land** (gradient), **atmosphere** (rainfall); **pressures** (management practices e.g. drainage gripping, burning)] Soil erosion = f [**ecological communities**; **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table) **land** (gradient), **atmosphere** (temperature, rainfall and wind); **pressures** (management practices e.g. grazing, drainage gripping, burning)] **Given the uncertainty of the relationships, this has been upgraded to major and will therefore be taken forward for further consideration in the risk register.**		
MMH	Wildlife	Quantity	The relationship is considered to be +L (major). There is the possibility of decreasing and to some extent increasing the quantity (although small) of some of the MMH subcomponents (blanket bogs and heaths) through land use changes e.g. afforestation, expansion of enclosed farmland. The quantity will be important in determining the size of a population that can be supported i.e. carrying capacity. As the area increases, although only at the margins, there		(?)

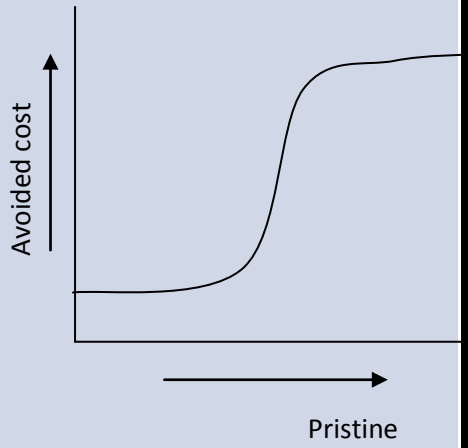
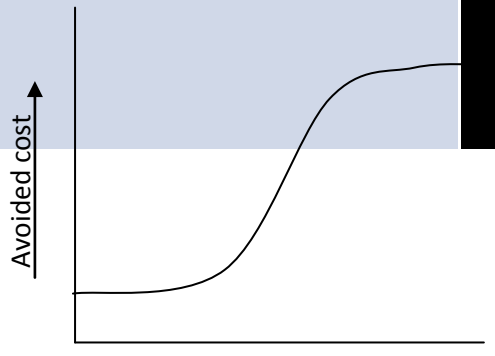
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			is potential to increase the abundance of species (note that quality is probably more important in determining the variety of species).		[redacted]
		Quality	The relationship is considered to be +NL (major). 'Pristine' MMHs are those which have a high level of heterogeneity, supporting a mosaic of habitats. These in turn support a range of highly specialised species. It is considered that people will highly value habitats nearing 'pristine' condition and although the contribution of additional species may only be of marginal value after this, the value will still increase. It is considered that land management practices can be both beneficial for wildlife, or adversely affect the wildlife. For example, a transition from heather to grass has been observed following an increase in pressure from sheep-grazing with consequences for plant diversity. Sheep preferentially graze grasses but utilise heather and other dwarf shrubs along the edge of grass patches and paths (Palmer *et al*. 2003). Consequently, the condition of heather can be severely impacted by grazers and ultimately leads to grass- dominance across hill slopes (UK NEA, pg 116). However, low intensity grazing could		[redacted]

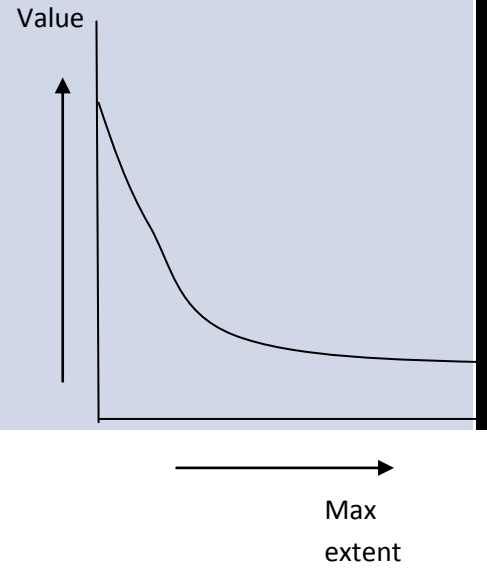
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			also be beneficial in reducing scrub succession. Wildlife = f [**species**; **ecological communities** (pollination), **soils** (pH, nutrient concentrations (TOC, nitrate, phosphate, ammonium), erosion, infiltration), **freshwater** (water table); **land** (altitude, gradient, topography), **atmosphere** (temperature, rainfall, CO_2, N);**material capital** (management practices e.g. grazing, drainage gripping, burning)]		[redacted]
MMH	Equable climate	Quality	The relationship is considered to be +NL (major). Blanket bog will only form under certain conditions. If you graze or burn blanket bog, the species required for peat formation, and those which store carbon, i.e. sphagnum moss, will be lost by the resultant lowering of the water table and drying of the existing peat layer. The vegetation will be replaced by heath species typical of drier conditions. Suitable land management is therefore crucial in determining whether peat will continue to form and sequester carbon, or whether the locked carbon could be released through poor management. Peat formation = f [**species** (sphagnum moss); **ecological communities** (photosynthesis and carbon locking); **soils** (high acidity, organic matter and water holding capacity,		[redacted]

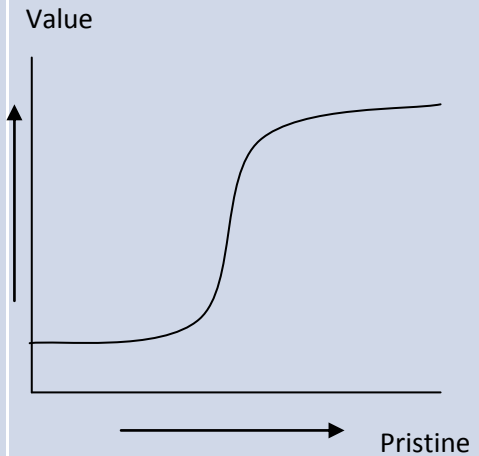
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			nutrient availability); **atmosphere** (temperatures, rainfall, CO_2, N); **freshwater** (high water table); **land** (low gradient); **pressures** (extraction methods, land management - burning and grazing regimes)]		
EF	Food	Quantity	The relationship is considered to be +NL (major). 52.1% of land area in England is EF, consisting of 30.4% arable and horticultural and 21.7% improved grassland (Carey et al. 2008) (UK NEA, pg 200). The EF MLC is therefore one of the main contributors to food production. The quantity of the MLC can be increased, and as this does, so does the potential to produce food. However, this will be limited by the market demand and therefore there will be critical area required, after which increases in area will no longer be as highly valued.		
		Quality	The relationship is considered to be +NL (major). The amount of food that can be produced from enclosed farmland will depend upon the quality of the habitat, but more importantly the material capital investment made to produce food. Poor quality habitats will not produce large amounts of food and therefore the value will be		

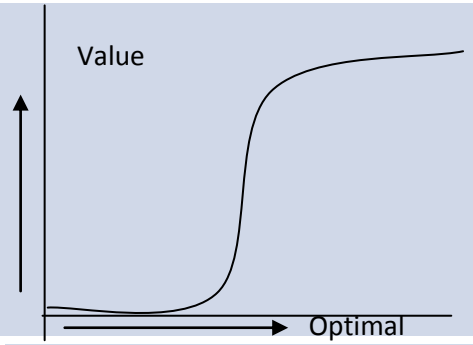
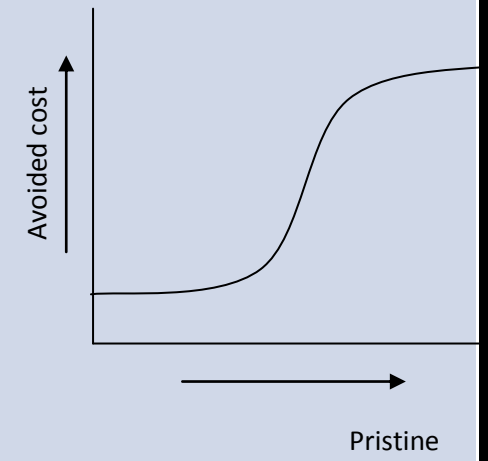
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			low. As this increases, the value will significantly increase up to an optimal point, where after further improvements in quality will no longer give such substantial increases in benefit value. Most improved grassland is managed to provide food for livestock, mainly sheep and beef and dairy cattle. It is typically in the form of 'improved' pasture or long-term leys, managed using herbicides, fertilisers, ploughing, reseeding, liming and drainage to favour competitive, nitrogen-responsive grasses which provide silage to feed livestock over the winter and grazing for the rest of the year (Fuller 1987) (UK NEA, pg 201) Crop pollinators - Key driver is the loss of flower-rich, semi-natural landscape elements in farmland (Tscharntke et al. 2005; Winfree et al. 2009; Le Féon et al. 2010) such as flower-rich field margins, species-rich meadows and arable plants in crops. The loss of grass and clover leys, and the legumes they contain, has also been important (Carvell et al. 2006), and pesticides have been shown to have lethal and sub-lethal effects on bees (Morandin et al. 2005), resulting in local losses in bee diversity (Brittain et al. 2010) (UK NEA, pg 218). Crop yield = f [**species** (crop type); **soils** (agricultural Grade I – V, erosion); **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall),		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			freshwater (groundwater); **minerals** (potassium, magnesium); **ecological communities** (pollination, invasive species/disease); **material capital** (management practices e.g. irrigation, pest/disease control, nutrient enrichment, aeration of soil, crop rotation, GM crops)] Livestock = f [**soils**; **species** (grass, cows, sheep, pigs etc); **land** (altitude, gradient); **atmosphere** (rainfall, temperature); **minerals** (potassium, magnesium); **material capital** (re-sowing, nutrient enrichment, breeding stock selection)]		[redacted]
EF	Clean water	Quantity	The relationship is considered to be -NL (major). EF habitats cover 60% of England (SoNE, 2008). Agriculture accounts for about 60% of nitrates in rivers (Hunt et al. 2004) and, consequently, influences coastal water quality and fisheries (EEA 2001). Agriculture was responsible for 28% of the damage to rivers due to phosphorous and 61% due to nitrogen in 2012 (Defra, 2013c). It also contributes to approximately 75% of sediment getting into watercourses (Reducing and controlling agricultural pollution, Defra website). A third of waterbodies are at risk from eroded soil (Environment Agency, Corporate Strategy 2010-2015). Under baseline quality conditions, as the area of enclosed farmland increases the detrimental effect to water		[redacted]

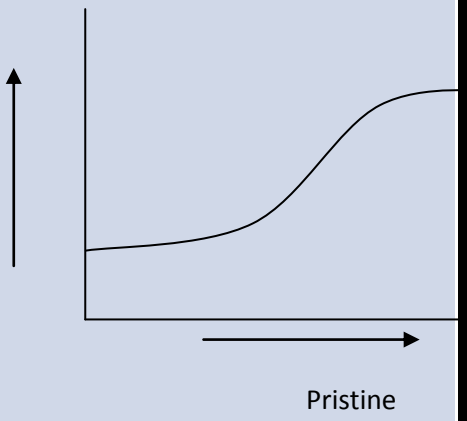
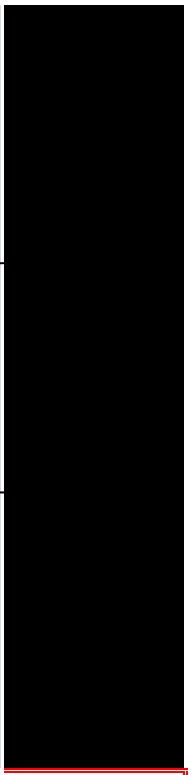
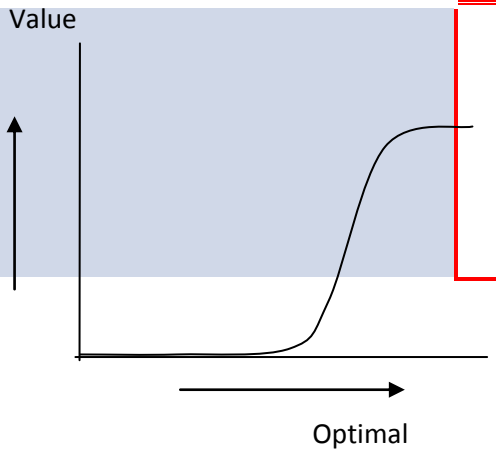
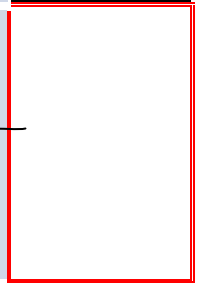
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			quality will also increase and this is considered to be significant.		[redacted]
		Quality	The relationship is considered to be +NL (major). The quality of EF can significantly affect clean water through improvements in water quality e.g. through use of buffer strips to capture pollutants before they enter watercourses, reduced application of fertilisers will reduce nutrient enrichment of watercourses. Water quality = f [**species**; **ecological communities** (pollination, pollutant uptake); **soils** (exposure); **freshwater** (temperature, suspended sediment); **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall, wind); **material capital** (management practices e.g. use of buffer strips, reduced application of fertilisers, ploughing direction to reduce soil erosion, crop rotation to maximise uptake of nutrients for different plant species)]		[redacted]
EF	Hazard protection	Quality	The relationship is considered to be +NL (major). The quality of the habitat is considered to affect the potential for flooding downstream, with degraded habitats being affected by soil erosion which can be		[redacted]

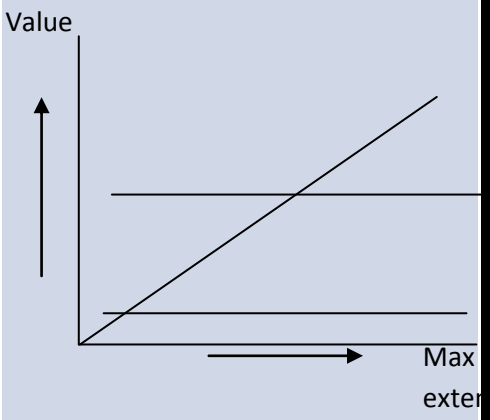
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			transported to the river networks by surface water runoff. Agriculture contributes to approximately 75% of sediment getting into watercourses (Reducing and controlling agricultural pollution, Defra website). A third of waterbodies are at risk from eroded soil (Environment Agency, Corporate Strategy 2010-2015). Soil erosion = f [**species**; **ecological communities** (pollination); **soils**; **land** (aspect, altitude, gradient, exposure to wind); **atmosphere** (temperature, rainfall, wind); **material capital** (management practices e.g. use of buffer strips, ploughing direction to reduce soil erosion, field drainage)]		
EF	Wildlife	Quantity	The relationship is considered to be +NL (major). EF habitats cover 60% of England (SoNE, 2008). Under baseline quality conditions, as the area of enclosed farmland increases the detrimental effect to wildlife will also increase and are likely to be significant.		

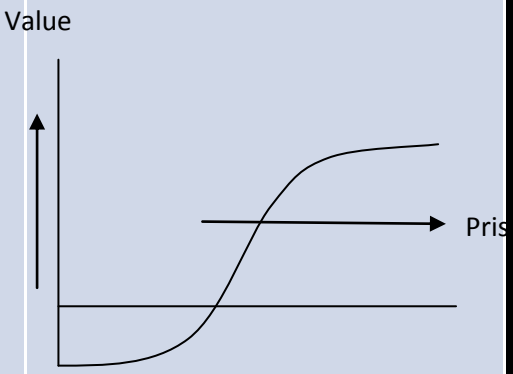
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
					[redacted]
		Quality	The relationship is considered to be +NL (major). The quality of the habitat can significantly affect the wildlife value e.g. using buffer strips, set aside lands, increase number of waterbodies on land, reduce use of pesticides, reduce monoculture farming. There has been a catastrophic decline in the distribution of arable flowering plants during the last half century and they are now amongst the most threatened elements of our flora (Smith 1989; Rich & Woodruff 1996; Sutcliffe & Kay 2000; Wilson & King 2000; Preston et al. 2002b) (SoNE, 2008) By 2000, the numbers of specialist farmland birds had fallen to 40% of their 1970 levels, and they have fallen a further 4% since then (UK NEA, pg 199). Wildlife = f [**species**; **ecological communities** (pollination); **soils**; **land**; **atmosphere**; **material capital** (management practices e.g. use of buffer strips, set aside schemes, creation of waterbodies, reduction in pesticide application, reduction in monoculture)]		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). EF and hedgerow connectivity is important in allowing wildlife to move not only around the EF MLC but between		[redacted]

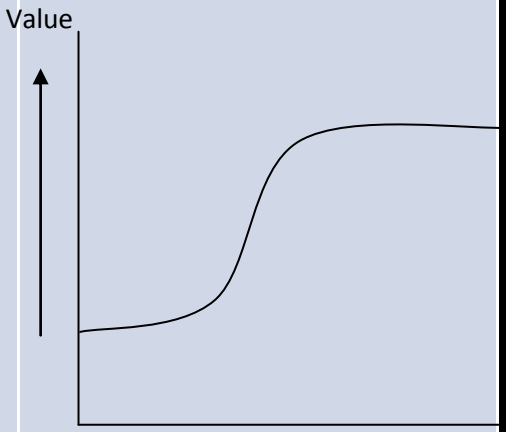
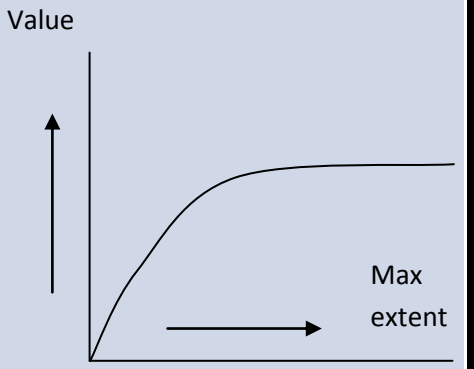
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			other MLCs that are separated by EF e.g. woodland, semi-natural grassland.		[redacted]
EF	Equable climate	Quality	The relationship is considered to be +NL (major). UK agriculture generates net greenhouse gas emissions, with emissions from agriculture accounting for around 7.0% of the UK total (although variation between countries) - nitrous oxide (53% of total agriculture emissions in 2008) and methane (38% of total agriculture emissions in 2008). To improve equable climate, a greater proportion of crops should be grown compared to livestock, thereby taking in CO_2 and reducing methane emissions. However, the realisation of this change in quality would be driven by a change in consumer demand which would constrain change. To reduce NOx emissions, changes should be made to the amount of fertiliser applied and timing, manure left on soils, etc which affect emissions. Grassland soils are		[redacted]

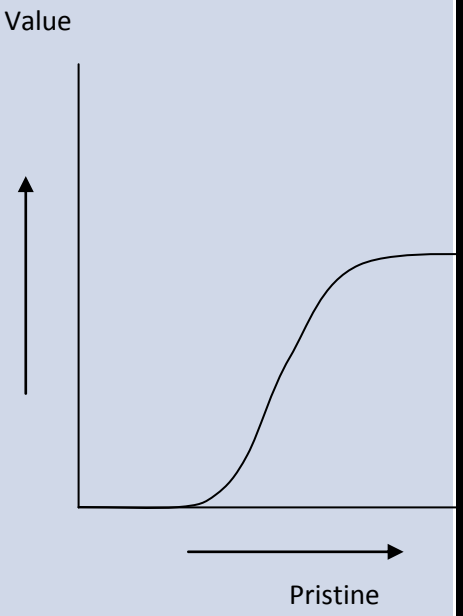
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			important carbon stores and the level of tillage can affect the amount of carbon released. The emissions can be driven by the number of livestock animals, the characteristics of those animals (i.e. their breed, size, yield, digestive systems, etc.), what livestock are fed (for example, a diet with a higher maize content can maintain animal performance while decreasing the production of methane), and how manures are managed (CCC 2010). There is potential to reduce greenhouse gas emissions from arable systems through improved soil, fertiliser and agrochemical management (Smith et al. 2008; Macleod et al. 2010). Nitrous oxide emissions arising from crops and soils can be decreased by good nutrient planning, including improving efficiency in using fertiliser by, for example, taking full account of nitrogen in manure applications, timing applications to match crop requirements, using composts and straw-based manures in preference to slurry where practical, and separating slurry and mineral nitrogen application (UK NEA, pg 216). Equable climate = f [**species** (arable vs livestock, livestock breed); **soils**; **material capital** (management practices - tillage, fertilisers, breed selection, stocking densities)]		

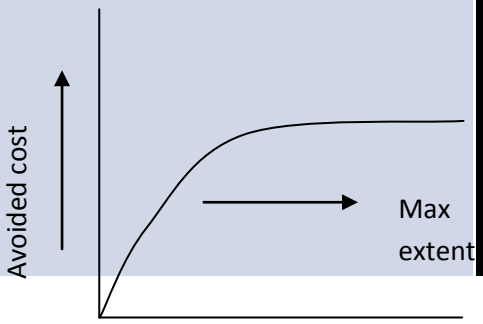
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
SNG	Aesthetics	Quality	The relationship is considered to be +NL (major). The quality of SNG can affect the 'sense of experience' gained from the MLC. Although the value of SNG for aesthetics will largely be determined by the land form which cannot be influenced by society, appropriate management of the habitats e.g. removal of scrub could be considered as enhancing views, with degraded habitats not offering the same 'scenery' as good or pristine habitats. (Note, the aesthetic appeal of special plant and animal life is considered under the 'wildlife' benefit) The initial unit of semi-natural grasslands will be valued, and as the quality improves, this will increase. However, after a certain level of improvements to the habitat, any additions are no longer as valued i.e. the marginal increase is less. Aesthetics = f [**land** (topography, altitude); **material capital** (management practices - grazing, scrub clearance)]		
		Spatial configuration	The relationship is considered to be +NL (major). Although the spatial configuration of the MLC cannot be easily changed by human management as it is generally defined by geology, the extent of it, and therefore aesthetic appeal, can be interrupted if the landscape is fragmented by urban area, tall structures or other land		

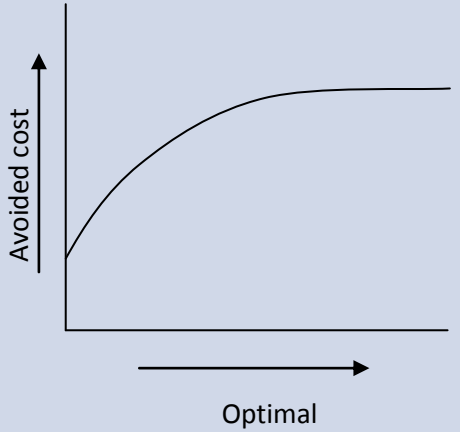
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			uses i.e. anything that interrupts the view. A continuous landscape is considered to be highly valued for aesthetics.		
SNG	Wildlife	Quantity	The relationship is considered to be +NL (major). It is assumed that all SNG could be replaced with another MLC however the potential to increase the extent of the MLC is considered to be limited as it is dependent on underlying geological conditions. Therefore any changes in extent will be small. The quantity will be important in determining the size of a population that can be supported i.e. carrying capacity. As the area increases, although only at the margins, there is potential to increase the abundance of species (note that quality is probably more important in determining the variety of species).		

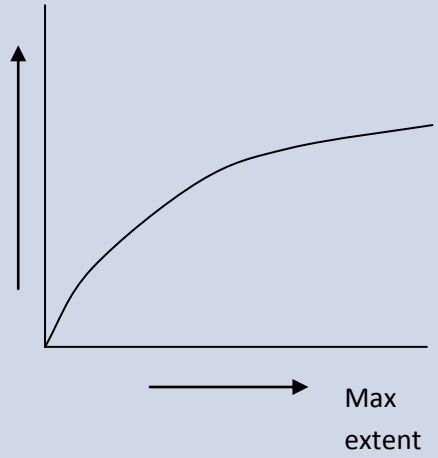
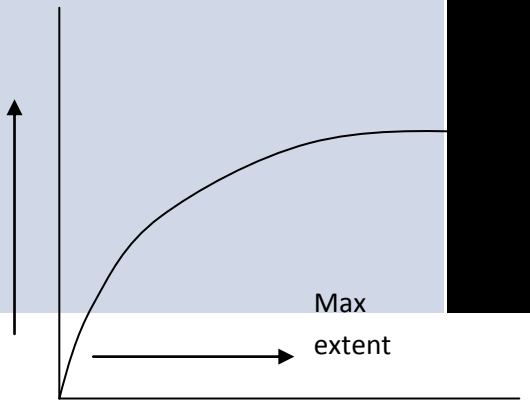
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Quality	The relationship is considered to be +NL (major) Lowland grassland priority habitats (dry acid and calcareous grasslands, lowland meadows, purple moor-grass and rush pastures) are home to 206 UK BAP species, while upland grassland priority habitats (calcareous grasslands and upland hay meadows) are home to 41 (UK NEA). The main adverse factors affecting SSSI condition are undergrazing, poorly timed grazing and lack of scrub control. These factors allow increased dominance of rank grasses and scrub at the expense of more desirable but less competitive species (SoNE Report, 2008) Wildlife = f [**species** (high diversity); **ecological communities** (pollination); **soils**; **land** (topography); **atmosphere** (rain, temperature); **material capital** (conservation management - grazing, cutting, scrub management)]		
SNG	Equable climate	Quality	The relationship is considered to be +NL (major) (uncertain) The Countryside Survey (Carey et al. 2007) estimates, and accounting for their land cover, that acid and neutral grasslands contain 144 Tg and 149 Tg, respectively, of the UK carbon store in the top 15 cm soil layer (Chamberlain		(?)

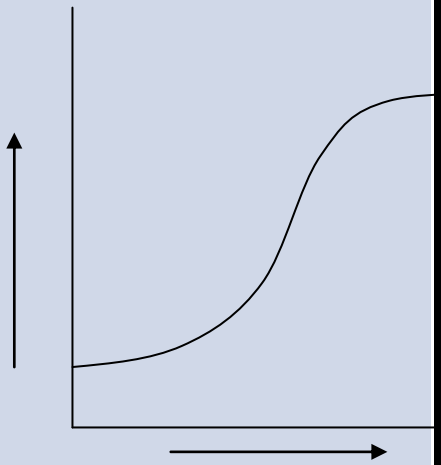
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			et al. 2010). These figures account for 21% of the soil carbon across the Countryside Survey broad habitats (UK NEA, pg 181). Poor management of the habitats could lead to a release of this stored carbon e.g. soil erosion. However, it is unclear how quickly carbon would be released - carbon stock is in the upper 15cm of soil. Carbon storage = f [**ecological communities**; **soils**; **land** (topography, exposure) **atmosphere** (temperature, rainfall, CO_2, SO_2); **pressures** (grazing, cutting, scrub management)] **Given the uncertainty of the relationship, this has been upgraded to major and will therefore be taken forward for further consideration in the risk register.**		
W	Fibre	Quantity	The relationship is considered to be +NL (major). The quantity of the MLC can be changed, with the potential for all areas of woodland to be converted to a different land use. Therefore the first unit of woodland will be highly valued. However, there will be a point where the area of woodland satisfies market demand, and any increase in quantity thereafter will not be as valued. The quantity of woodland is considered to be the		

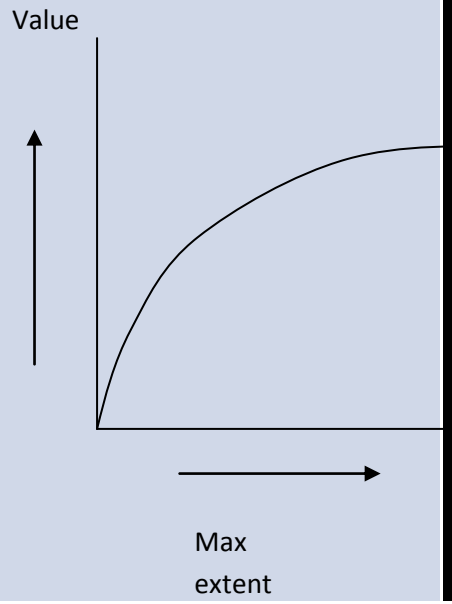
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			determining factor in amount of time produced and therefore changes in quantity of the MLC will be significant.		[redacted]
		Quality	The relationship is considered to be +NL (major). The quality of the MLC can affect the yield of timber. In a poor quality environment e.g. high levels of acidification, low nutrient cycling, tree growth will be poor and therefore limit yield. It is considered that the costs and effort in harvesting this poor growth would considerably outweigh the value, and in these circumstances it is considered that timber would not be harvested. As the quality of the MLC increases, the potential for tree growth also increases. It may be possible to select the species that are grown, to select those with quickest growth rates. Improvements in material capital to harvest the timber will also increase the amount of output. However, there will be critical point where after further increases in quality will produce marginal benefits. Timber yield = f [**species** (hardwood and softwood), **ecological communities** (invasives, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation,		[redacted]

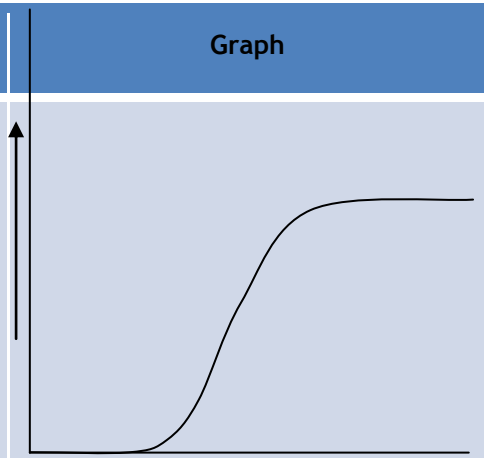
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			nutrient cycling); **freshwaters** (groundwater); **land** (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); **minerals** (potassium, magnesium); **material capital** (management - coppicing, felling, crop rotation, irrigation, processing timber, machinery transport, pest control, nutrient enrichment, pollution - SO_2)]		
W	Clean water	Quantity	The relationship is considered to be NL (major) (uncertain) No woodland is likely to mean a high level of run-off, erosion and soil failure which would have a significant negative effect on water quality. Benefits are gained quickly once some woodland is there (binding soils), with benefits slowing down once the woodland is planted. Woodland provides a purification role by intercepting pollution, and reduces sediment inputs to watercourses (requirement to remove suspended sediment).		(?)

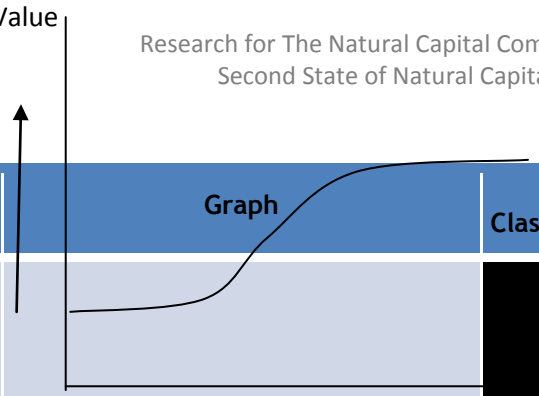
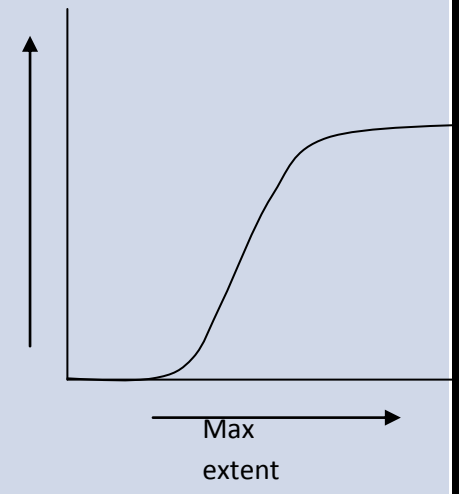
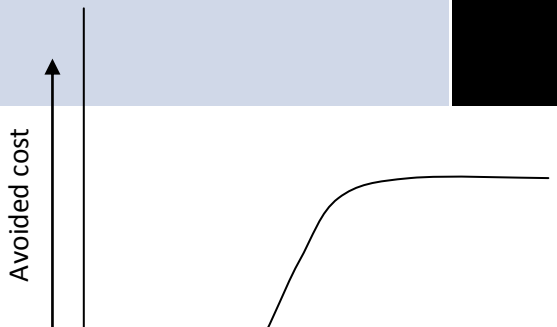
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			It is unclear how woodland effects the yield of water. It is likely that woodland would reduce the quantity of water available downstream through evapotranspiration, and indirect effect with water held by roots/interception of foliage with trees present. The effect on total yield is uncertain. **Given the uncertainty of the relationship, this has been upgraded to major and will therefore be taken forward for further consideration in the risk register.**		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). The afforestation of uplands, which are a significant source of water (quantity) could adversely affect the amount of clean water obtainable. Afforestation in lowland areas, around towns, could act as interceptors to pollution before it reaches the watercourse. The potential for spatial configuration of woodlands to affect clean water benefit (quality and quantity) is therefore considered to be significant.		[redacted]

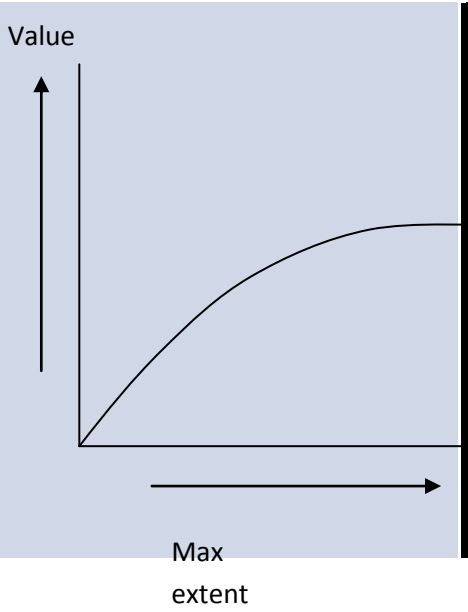
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
W	Clean air	Quantity	The relationship is considered to be +NL (major). Woodland can absorb pollutants internally or adsorb pollutants externally on to leaf and bark surfaces, and provides an overall role in production of 0_2 required for the air we breathe (UK NEA 2011). As the quantity of woodland increases, the ability to clean air also increases, although this is most highly valued with the initial units of woodland. There is no critical mass with regard the potential for woodlands to clean air, and therefore this will keep increasing.		
W	Recreation	Quantity	The relationship is considered to be +NL (major). Woodland is listed as one of the most popular destinations for countryside visits (~250 million day visits per year) (UK NEA 2011, pg 268) It is assumed that all woodland could be replaced with another MLC therefore the value crosses the origin. The first units of woodland will be highly valued, however, at a critical amount i.e. enough woodland to satisfy		

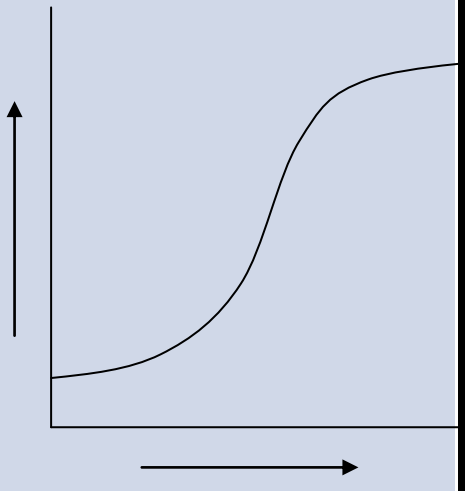
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			recreational demands, any increases over this will not be as valued.		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). Only 55% of population have access to woods greater than 20ha within 4km, and 10% have access to woods greater than 2ha within 500m of their home (UK NEA 2011, pg 268) Woodland as recreational resource will be more valued when close to populations. However, there will be a certain distance which the majority of people will be happy to travel, and this will be highly valued, with anything closer being valued but with only marginal benefits.		[redacted]

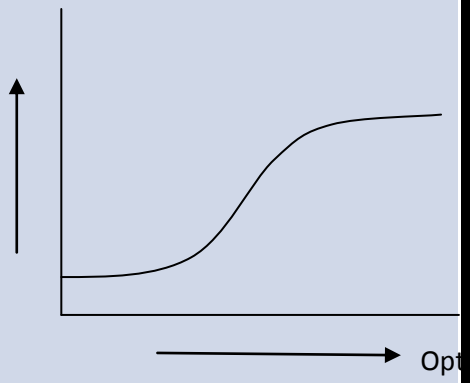
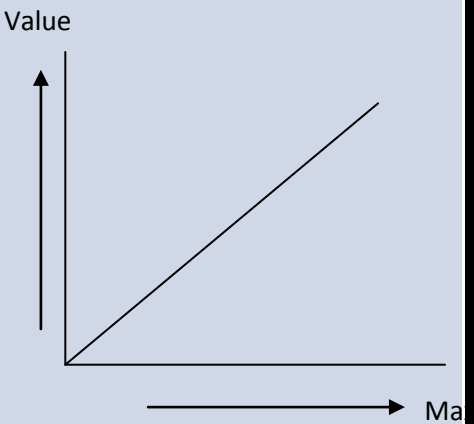
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
W	Aesthetics	Quantity	The relationship is considered to be +NL (major). It is assumed that all woodland could be replaced with another MLC therefore the value crosses the origin. The first units of woodland will be highly valued, however, at a critical amount i.e. enough woodland to satisfy recreational demands, any increases over this will not be as valued.		
		Quality	The relationship is considered to be +NL (major) There is some association between perceptions of landscape value and woodland characteristics: for example, woodland type (broadleaves tend to be more favoured than conifers), tree age (large, old trees tend to be favoured over young ones), openness (valued more than dense, closed areas) and diversity (mixtures and variation valued over uniformity) (Willis *et al*. 2003) (UK NEA, pg 269).		

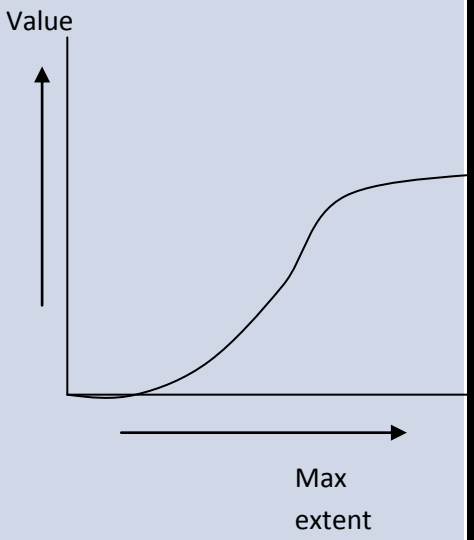
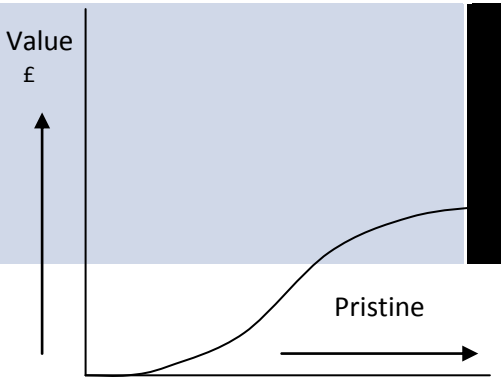
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			Ancient woodlands and veteran trees are historic features in their own right and provide a link to past society and culture (Rackham 2013). Many 'Royal Forests' have hundreds of years of history, tradition, myth and legend associated with them, helping to create important historic landscapes. Ancient woodland is also increasingly appreciated for its archaeological content. The initial unit of woodlands will be valued, and as the quality improves, this will increase. However, after a certain level of improvements to the habitat, any additions are no longer as valued i.e. the marginal increase is less. Aesthetics = f [**species** (broadleaved vs coniferous, varied age structure); **land**; **material capital** (management practices - coppicing, felling)]		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). There is greater aesthetic value of woodlands where there are numerous plots in the landscape rather than a continuous belt. There is also considered to be greater value if people have views of woodland from their properties. Society has the potential to significantly influence the location of new woodland creation over the next 25 years.		[redacted]

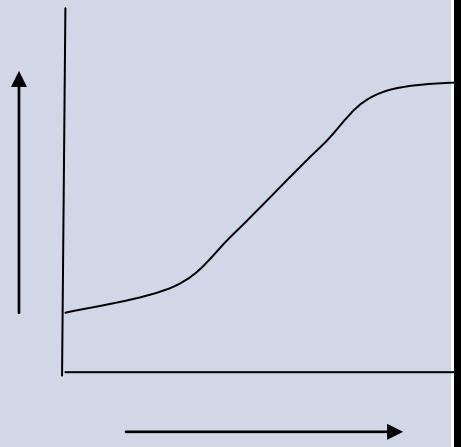
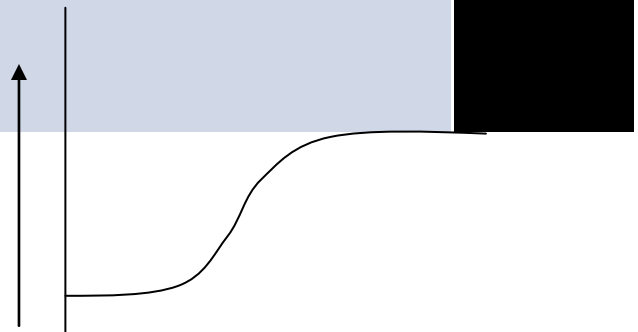
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
					
W	Hazard protection	Quantity	The relationship is considered to be +NL (major). Woodland provides protection from flooding and soil failure by regulating the quantity of water downstream and stopping soil erosion. Forests and woodland have long been associated with an ability to slow down run-off and reduce downstream flooding. There are three ways that trees can assist flood risk management; by reducing the volume of runoff, by promoting rainfall infiltration into the soil and reducing the rate of runoff, and by delaying the downstream passage of flood flows. As woodland cover in a catchment increases, the avoided cost of protection will also increase. However, there will be a critical point after which any further increases in area will only have a marginal increase in benefits.		
		Spatial configuration	The relationship is considered to be +NL (major). It is important to locate woodland in an appropriate area		

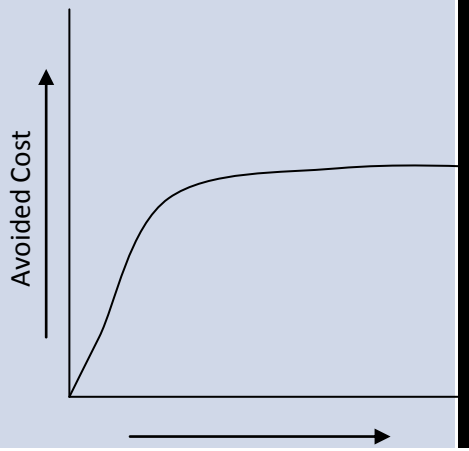
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			of the catchment to maximise influence on flooding, through interception of rainfall and regulate base flows. Woodland in upland parts of the catchment are therefore considered optimal, whilst extensive areas on floodplains may be considered non-optimal due to the effect of water displacement.		[redacted]
W	Wildlife	Quantity	The relationship is considered to be +NL (major). The quantity of the MLC can be changed, with the potential for all areas of woodland to be converted to a different land use. Assuming baseline quality of the MLC, the first unit will be highly valued, and this will continue to increase with the area of woodland. However, there will be a point where the area of woodland is sufficient, but the quality of the habitat will limit species diversity and abundance, and any increase in quantity thereafter will not be as valued. The quantity will be important in determining the size of a population that can be supported i.e. carrying capacity. As the area increases, although only at the margins, there		[redacted]

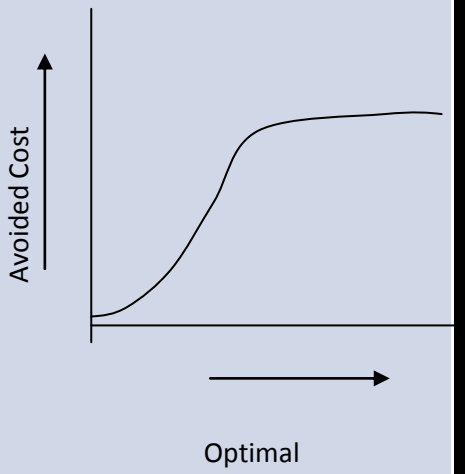
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			is potential to increase the abundance of species (note that quality is probably more important in determining the variety of species).		[redacted]
		Quality	The relationship is considered to be +NL (major). As the quality of the habitat increases, the potential to support a range of species and high abundance of species will increase. Improvements in diversity will be attributable to management e.g. coppicing and felling, dead log piles, as well as decreases in pollution and pests. A certain level of species diversity and abundance will be highly valued, however after this, increases in more specialised species or general abundance will be of lowering value. Wildlife value = f [**species** (diversity), **ecological communities** (invasives, pests and disease); **soils** (decomposers, nitrifying bacteria - nitrogen fixation, nutrient cycling); **freshwaters** (groundwater); **land** (altitude, gradient); **atmosphere** (rain, temperature, nitrogen, carbon dioxide, wind); **minerals** (potassium, magnesium); **material capital** (management -coppicing, felling, restocking with native species, dead log piles, pest control); **pressures** (pollution - SO_2)]		[redacted]

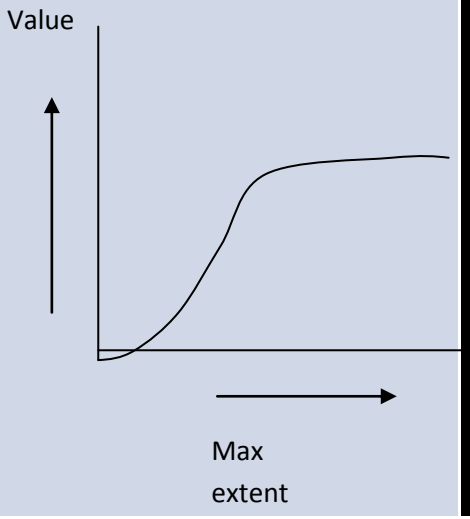
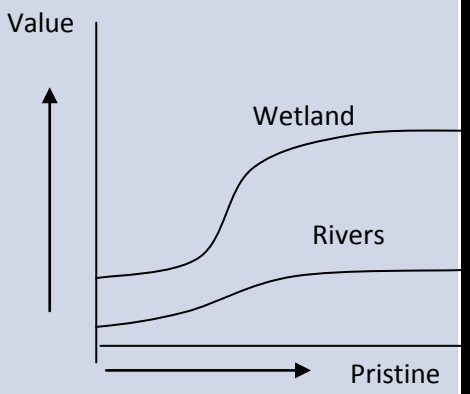
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
		Spatial configuration	This relationship is considered to be +NL (major). With a higher connectivity of woodlands, the species diversity and abundance will increase. It is also possible to create woodland closer to people, and therefore the recreational and aesthetic value of wildlife could increase when in closer proximity to people.		[redacted]
W	Equable climate	Quantity	The relationship is considered to be +L (major). Woodland is a carbon store, taking up and locking carbon dioxide through photosynthesis. With no woodland, there would be no benefit to equable climate. However, as the area of the woodland increases, the potential to store carbon would also increase (assuming wood is not used as a biofuel).		[redacted]

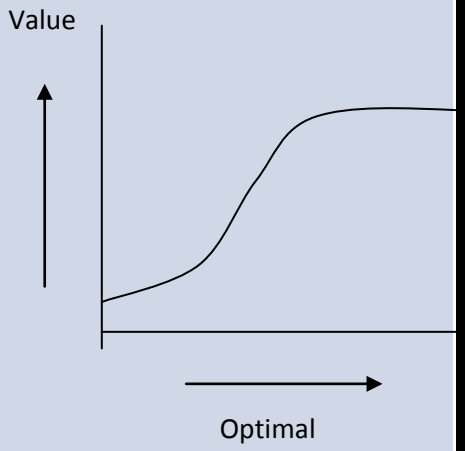
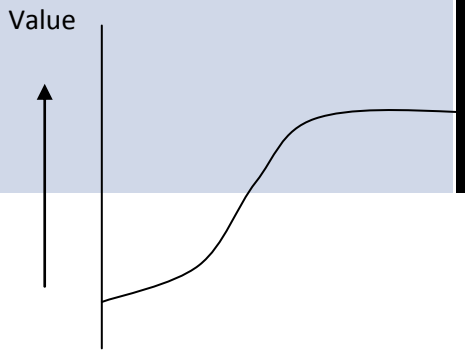
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Clean water	Quantity Wetlands	The relationship is considered to be +NL (major) Wetland habitats have a role in purification - they trap and filter particulates. Wetland systems, particularly reedbeds, have combinations of highly oxic and anoxic sites within their soils due to stratification in the sediment or soil profile and/or the release of oxygen from plant roots; these conditions are conducive to the breakdown and transformation of many pollutants including organic and inorganic compounds derived from agriculture and denitrification (a major mechanism for 'cleaning' groundwaters of their nitrogen content). An increase in wetlands could therefore significantly improve clean water quality.		
		Quality	The relationship is considered to be +NL (major).		

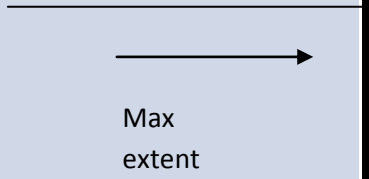
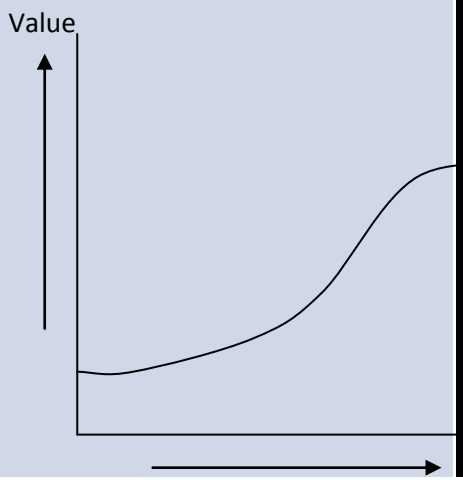
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Recreation	Quality	The relationship is considered to be +NL (major). Quality can be affected by access restrictions e.g. reservoir not open to public, angling season reduced, low volume of water e.g. drought conditions which limits potential for kayaking etc, and water quality which could deter contact recreation e.g. swimming, angling, or habitat degradation which could restrict walking opportunities. In degraded/poor environment (e.g. no water, no fish), there would be no recreation opportunities. As the quality of freshwater increases the value will also increase. However, this will only be up to a certain level of improvements and after this the marginal increase in value will become less. Recreation = f [**freshwater** (water - volume, flow velocity, nutrients, bacteria, aquatic vegetation), **land** (gradient, altitude), **species** (fish), **material capital** (access, signage/waymarks)]		
FW	Aesthetics	Quality	The relationship is considered to be +NL (major). The degradation of habitats is considered to be of key importance when valuing the aesthetics e.g. heavily		

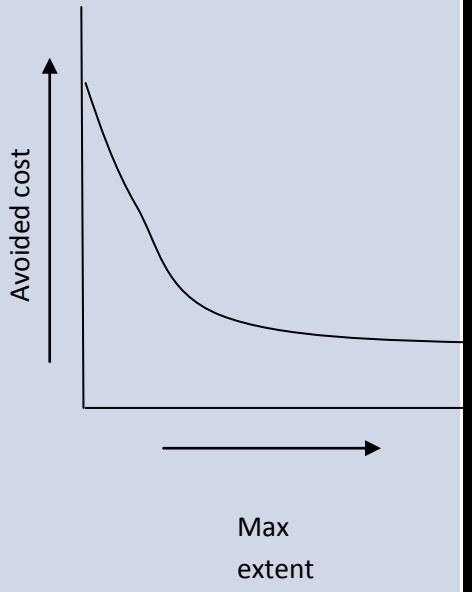
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			modified river channel vs natural meandering channel. As the quality of freshwater increases (i.e. naturalisation of the river channel improves) the value will also increase. However, this will only be up to a certain level of improvements and after this the marginal increase in value will become less. Aesthetics = f [**freshwater** (water - volume, flow, nutrients, floodplain connectvity), **land** (gradient, altitude), **species**, **material capital** (pollution e.g. oil, litter, absence of significant modifications)]		[redacted]
FW	Hazard protection	Quality Wetlands (incl. floodplain)	The relationship is considered to be +NL (major). In a degraded/poor environment e.g. low permeability of floodplain, the avoided cost of flood protection will be low. However, as the quality increases, the avoided cost will also increase. At a critical point, further improvements will not significantly avoid costs of protection. Flood protection = f [**freshwater** (floodplain connectivity, extent and permeability, water - volume, flow velocity, suspended sediment), **land** (gradient), **atmosphere** (rainfall), **species** (woody debris), **material capital** (flow		[redacted]

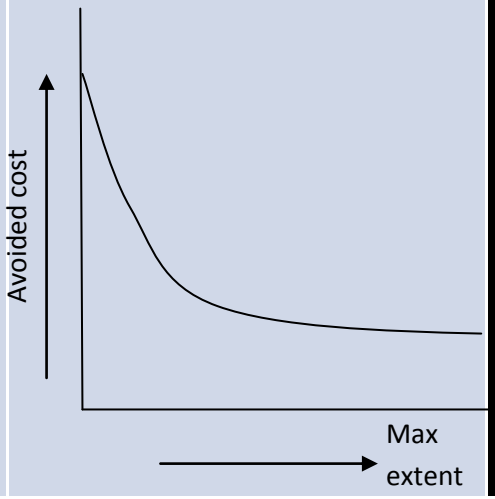
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			regulation, storage reservoirs, channel modification)]		[redacted]
		Spatial configuration Wetland (incl. floodplain)	The relationship is considered to be +NL (major). Floodplains will be found next to their respective rivers, however their capacity to hold flood waters will be determined by the area available and connectivity with the river. Reservoirs with the aim of regulating flow will need to be optimally positioned in relation to the population they are protecting. Therefore optimal positioning of the wetland and standing open water subcomponents will have a positive impact on avoided flood protection costs. This is considered to be significant. The quantity will be important in determining the size of a population that can be supported i.e. carrying capacity. As the area increases, although only at the margins, there is potential to increase the abundance of species (note that quality is probably more important in determining the variety of species).		[redacted]

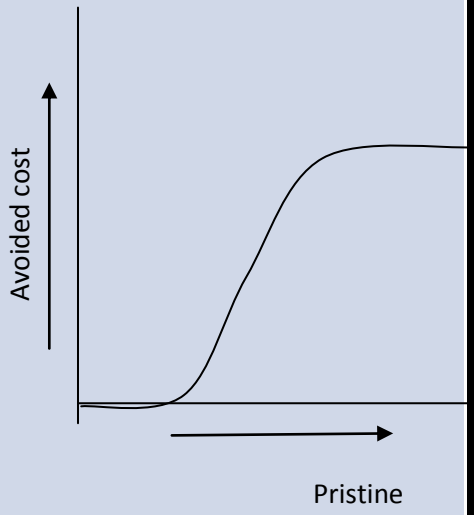
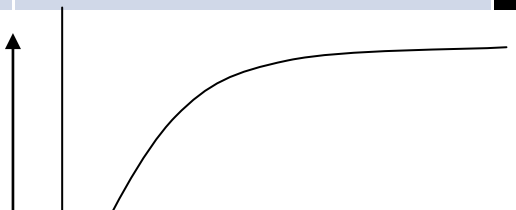
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
FW	Wildlife	Quantity Wetlands	The relationship is considered to be +NL (major). It is considered that you cannot significantly change the area of the MLC, just around the margins such as the wetland subcomponent. These changes in area will however, give rise to a significant change in wildlife value.		[redacted]
		Quality Rivers and streams Wetlands	The relationship is considered to be +NL (major). As the quality of freshwater increases the value will also increase. However, this will only be up to a certain level of improvements and after this the marginal increase in value will become less. The degradation of habitats is considered to be of key importance when valuing the wildlife benefit e.g. heavily modified river channel vs natural meandering channel. Wetlands are very sensitive to subtle changes in water supply and quality, including acidity, nutrient levels and water table fluctuations (Wheeler & Shaw 2001) (UK NEA,		[redacted]

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			pg 332) Wildlife = f [**freshwater** (water - volume, flow, nutrients, floodplain connectivity, suspended sediment, nutrient levels, acidity, groundwater); **land** (gradient, altitude); **species** (woody debris); **pressures** (pollution e.g. oil, litter, flow regulation, channel modification)]		
		Spatial configuration	The relationship is considered to be +NL (major). With a higher connectivity of freshwater habitats, the species diversity and abundance will increase. It is also possible to create some freshwater habitats closer to people, although limited e.g. new waterbodies, however it is considered that the recreational and aesthetic value of wildlife could increase when in closer proximity to people.		
FW	Equable climate	Quantity Wetlands	The relationship is considered to be +NL (major). Natural England (2010) estimated that the remaining lowland fen in English peatlands stored 1,004-2,576 tonnes of carbon/ha, and raised bog peats stored 1,575-		

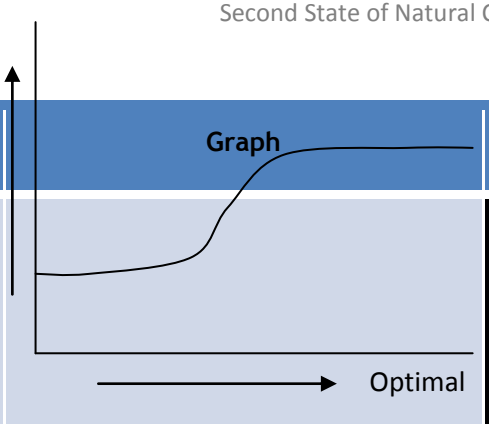
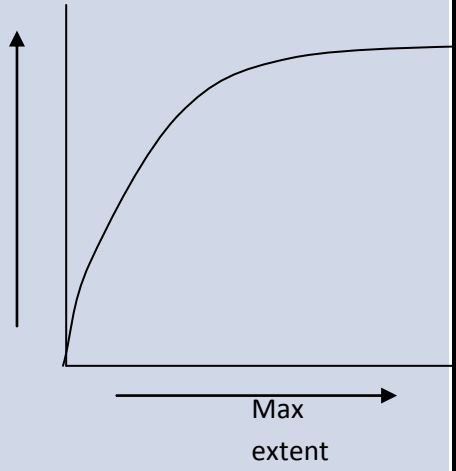
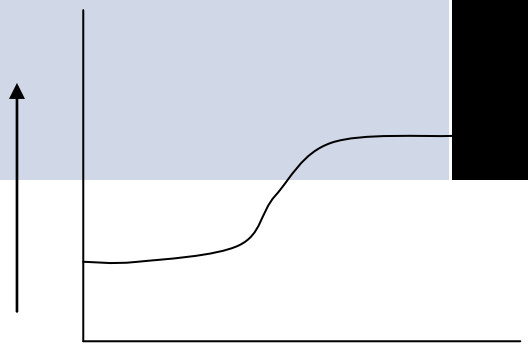
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			1,629 tonnes of carbon/ha (UK NEA, pg 310). Therefore change in quality of these systems could increase release of carbon. It is considered that you cannot significantly change the area of the MLC, just around the margins such as the wetland subcomponent (e.g. through afforestation, conversion to enclosed farmland). These changes in area will however, give rise to a change in equable climate value i.e. more wetland area, more potential to sequester carbon (overall low when compared to other MLCs e.g. marine) and greater area of open water/rivers and streams the more potential there is to moderate extreme temperatures and cool urban areas.		
		Quality	The relationship is considered to be +NL (major) Plankton biomass takes in carbon which is then locked in sediment. The health of the plankton community may govern diversity and biomass, and therefore amount of carbon uptake. Natural England (2010) estimated that the remaining lowland fen in English peatlands stored 1,004-2,576 tonnes of carbon/ha, and raised bog peats stored 1,575-1,629 tonnes of carbon/ha (UK NEA, pg 310). Therefore change in quality of these systems could increase release of carbon.		

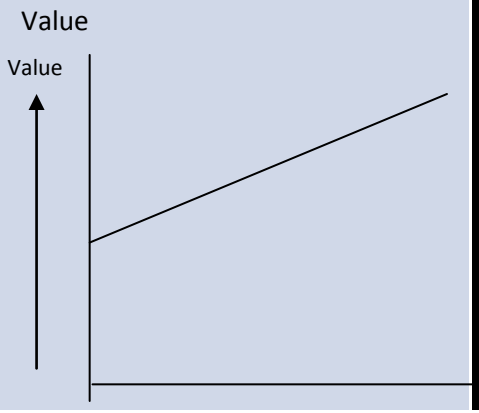
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			Carbon sequestration = f [**species** (plankton biomass); **freshwater** (water - volume, flow, nutrients, floodplain connectivity, suspended sediment, nutrient levels, acidity, groundwater); **land** (gradient, altitude); **atmosphere** (temperature); **pressures** (pollution e.g. oil, flow regulation, channel modification)]		[redacted]
U	Clean water	Quantity	The relationship is considered to be -NL (major). The built urban subcomponent of the MLC is considered to have a detrimental effect on clean water. Urban rivers are typically the receiving waterbodies for sewage treatment plant effluent and stormwater discharge. As the area of the built urban environment increases the potential for pollution incidents increases and therefore the potential for avoided treatment cost will decrease.		[redacted]

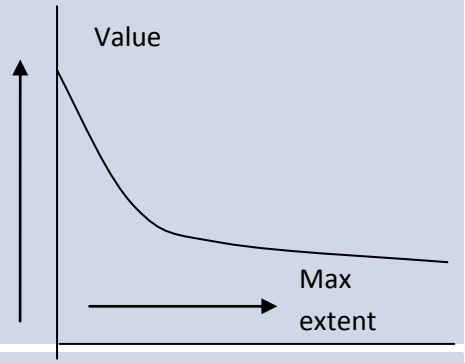
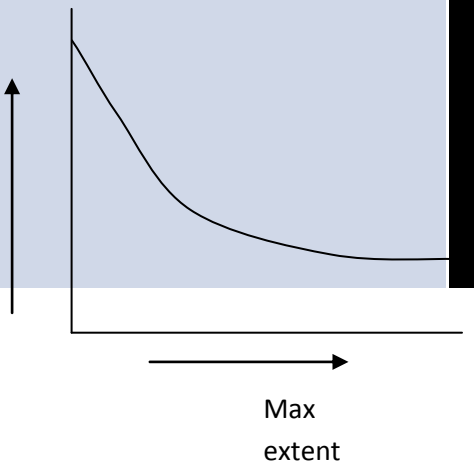
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
U	Clean air	Quantity	The relationship is considered to be -NL (major). As with clean water, the built urban subcomponent of the MLC is considered to have a detrimental effect on clean air. With an increase in urban extent, it is assumed that there is an associated increase in population size, and therefore an increase in vehicle emissions, emissions from plant associated with residential/office/ retail space (e.g. CHP plants) and a proportionate increase in construction (dust) as the extent of the urban area increases - PM_{10}, NO_x etc.		[redacted]
		Quality	The relationship is considered to be +NL (major) The built urban subcomponent of the MLC is considered to have a detrimental effect on clean air through its contribution to pollution - PM_{10}, NO_x, CO_2 etc. However policy drivers can help to reduce impacts by targeting improvements in air quality (Low Emission Zones), and urban greenspaces with trees can scavenge air pollutants. = f [**species** (London plane trees); **atmosphere**; **material**		[redacted]

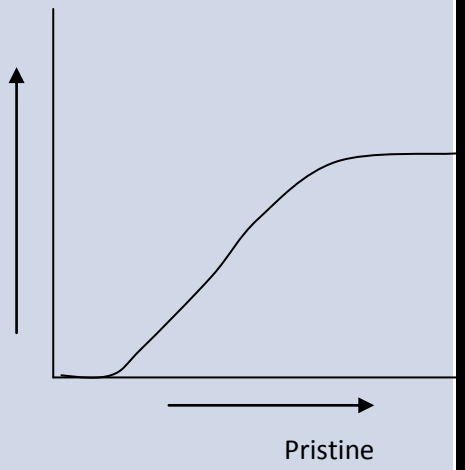
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			capital (policies to cap emissions - PM_{10}, NO_2, SO_2, reduction in car useage, proportion of green space to built urban)]		
U	Recreation	Quantity Greenspace	The relationship is considered to be +NL (major). For this characteristic we are considering the amount of greenspace available within the urban environment. This is not considered to be substitutable with other greenspace (i.e. other MLC such as woodland, semi-natural grasslands). The initial unit of greenspace within the urban will be		

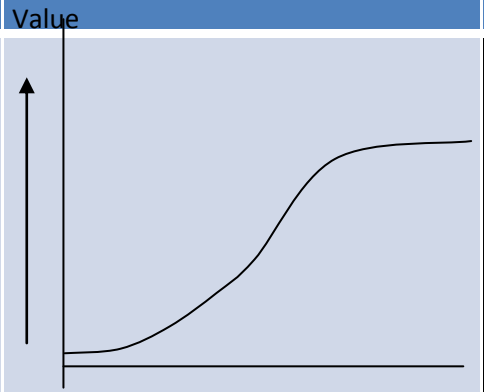
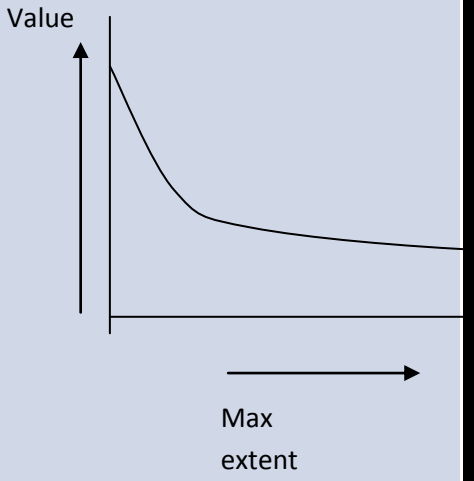
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			highly valued, and the relationship will follow the case of diminishing returns as the amount of greenspace increases i.e. there will be a critical amount of greenspace that is valued the most, and after this there will only be slight increases in value.		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). The value of a greenspace is highly dependent upon its proximity to the population which uses it. It is also considered that new green spaces could be positioned in an area of high population densities to maximise value. However, this is not considered to be an increasing positive relationship - there will be an optimal distance, and after this other limiting factors will come into play		[redacted]

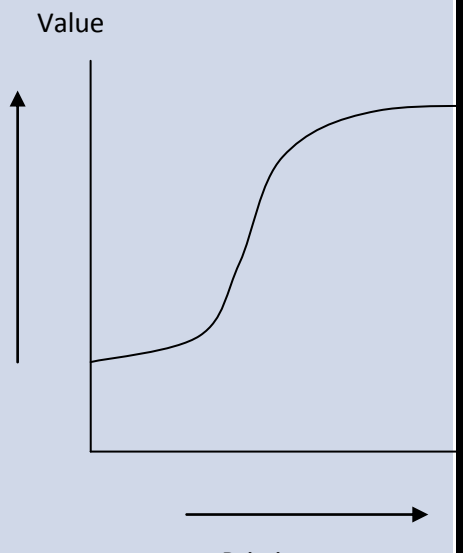
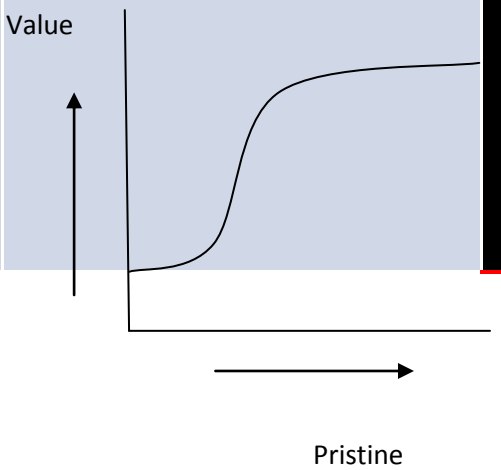
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			e.g. quality.		
U	Aesthetic	Quantity	The relationship is considered to be +NL (major). For this characteristic we are considering the amount of greenspace available within the urban environment. This is not considered to be substitutable with other greenspace (i.e. other accounting units such as woodland, semi-natural grasslands). The initial unit of greenspace within the urban will be highly valued there will be a critical amount of greenspace that is valued the most, and after this there will only be slight increases in value as quantity increases.		
		Quality	The relationship is considered to be +NL (major). Poor quality greenspace is considered to be that which is dominated by litter, graffiti, and visually unattractive. It is considered that some urban greenspaces may be too		

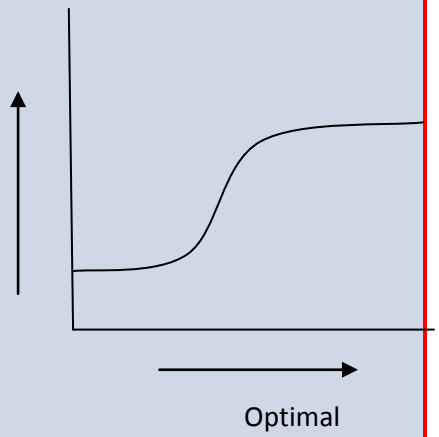
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			small to have significant recreational value, but do have aesthetic value (Forest Research, undated). The initial unit of greenspace within the urban environment will be highly valued, and as the quality improves, this will increase. However, after a certain level of improvements, any additions are no longer as valued i.e. the marginal increase is less. = f [**ecological communities** (urban greenspace - parks, gardens, towpaths), **material capital** (litter, graffiti management practices e.g. stocking of plants, maintenance of trees)]		[redacted]
		Spatial configuration	The relationship is considered to be +L (major). The aesthetic value of a greenspace is derived from proximity to a population and ability to see green space. Therefore optimal positioning of urban green space will be in densely populated areas to maximise the number of people who can see it.		[redacted]

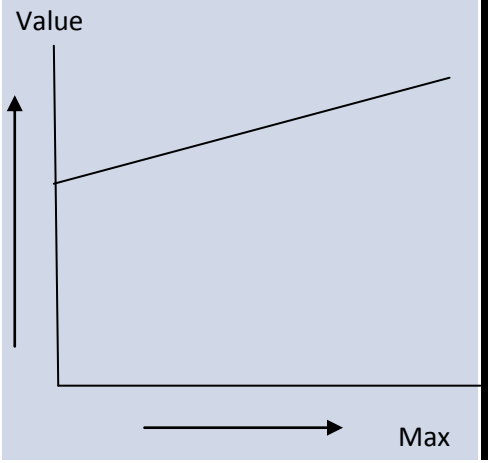
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
					
U	Hazard protection	Quantity	The relationship is considered to be -NL (major). Surface water flooding is a key issue in urban areas due to the extent of impermeable surfaces (concrete, compacted soils). Therefore as the quantity of urban area increases (assuming baseline quantity), the cost of implementing effective flood protection would also increase. The impact of increased urban areas is considered to be significant.		
U	Wildlife	Quantity	The relationship is considered to be -NL (major). The built urban subcomponent of the MLC is considered to have a detrimental effect on wildlife, whilst an increase in urban greenspace would be considered as a positive for the wildlife benefit. However, it is considered that the rate of urbanisation and expansion of the built urban subcomponent outweighs any increases in		

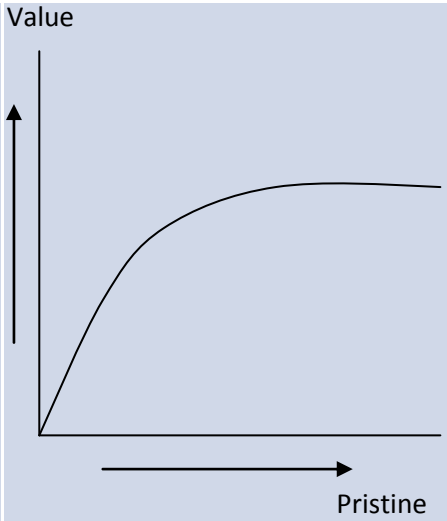
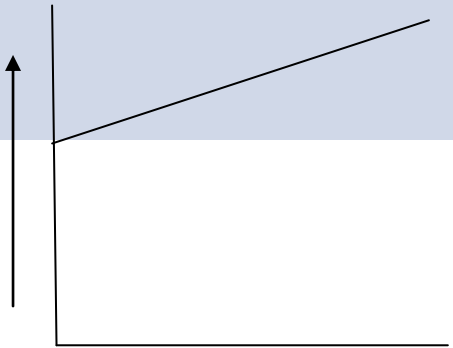
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			greenspace and therefore the overall effect is negative.		[redacted]
		Quality	The relationship is considered to be +NL (major). The quality of the urban environment can be improved by increasing the area and quality of the urban greenspaces as species such as birds and mammals have minimum area thresholds in order to survive. To improve wildlife in an urban area, measures should be undertaken to promote native species rather than ornamentals, set aside areas of grassland to be allowed to grow up/increase wildflowers, remove alien/invasive species, pick up litter etc. Wildlife = f [**species** (native); **ecological communities** (pollination); **soils**; **material capital** (green space, management practices e.g. mowing regime altered to create different sward heights, areas for wildflower recovery, removal of alien/invasive species)]		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). To increase abundance and diversity, urban greenspaces should be connected to allow movement of species		[redacted]

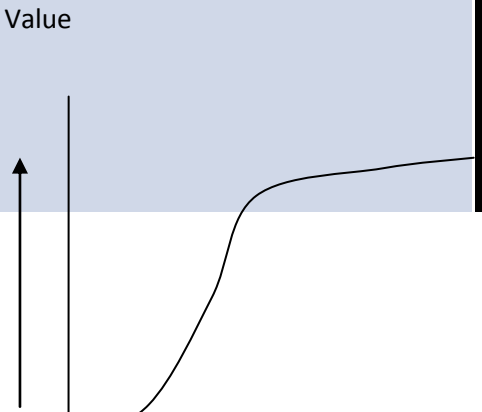
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			between areas. Fragmented habitat, and therefore fragmented populations, are less sustainable.		[redacted]
U	Equable climate	Quantity	The relationship is considered to be -NL (major) The built urban subcomponent of the MLC is considered to have a detrimental effect on the climate, whilst urban greenspaces are considered to positively effect the climate through CO_2 uptake and heat regulation. With an increase in urban extent, it is assumed that there is an associated increase in population size, and therefore an increase in CO_2, ozone emissions, heat islands and wind tunnelling due to an increase in the built element. The cost to treat these effects is also considered to increase as the extent of the urban area increases. These impacts are considered to outweigh the benefits of urban greenspace.		[redacted]

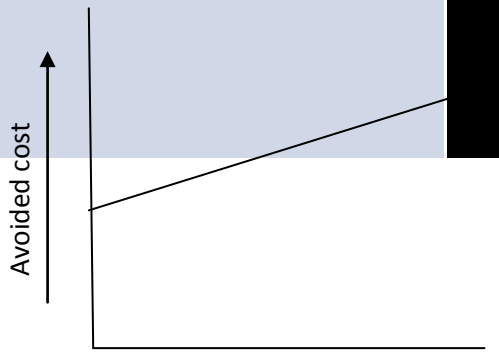
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
CM	Recreation	Quality	The relationship is considered to be +NL (major). The quality of coastal margins could significantly affect the active enjoyment of them e.g. litter, poor bathing water standards. The initial unit of coastal margins will be valued, and as the quality improves, this will increase. However, after a certain level of improvements, any additions are no longer as valued i.e. the marginal increase is less. Recreation = f [**coasts** (limits on bacteria levels (E.coli and streptococci, limits on levels of cyanobacteria, phytoplankton, macro-algae); **material capital** (management practices e.g. litter collection, maintenance of coastal footpaths, signage/waymarks, maps, information boards, waste bins, toilets, modification for golf courses)]; pressures (industrial, wastewater and sewage related discharges).		
CM	Aesthetic	Quality	The relationship is considered to be +NL (major). The quality of coastal margins could significantly affect the enjoyment of them. It is considered that people will value a heterogeneous landscape with good quality habitats and limited hard engineering structures. The initial unit of coastal margins will be valued, and as		

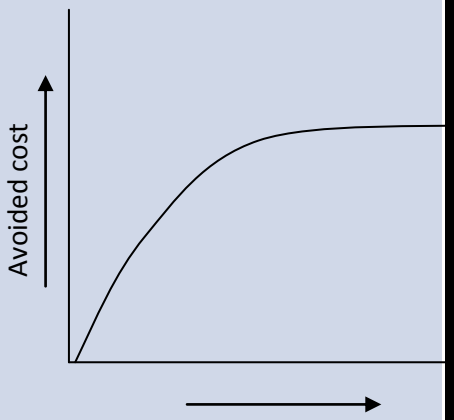
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			the quality improves, this will increase. However, after a certain level of improvements, any additions are no longer as valued i.e. the marginal increase is less. Aesthetics = f [**coasts** (abundance of habitats); **oceans** (view, sense of being at seaside); **ecological communities** (wildlife associated with habitats); **material capital** (hard engineering, cultural memories, archaeology and heritage)]		[redacted]
		Spatial configuration	The relationship is considered to be +NL (major). The aesthetic appeal can be interrupted if the landscape is fragmented by urban area, tall structures or other land uses i.e. anything that interrupts the view. A continuous and connected landscape is considered to be highly valued for aesthetics.		
CM	Hazard protection	Quantity	The relationship is considered to be +L (major). The coastal margin protects from erosion, wave and tide damage and coastal flooding. Vegetated saltmarsh can attenuate wave energy; an 80m strip can reduce the		[redacted]

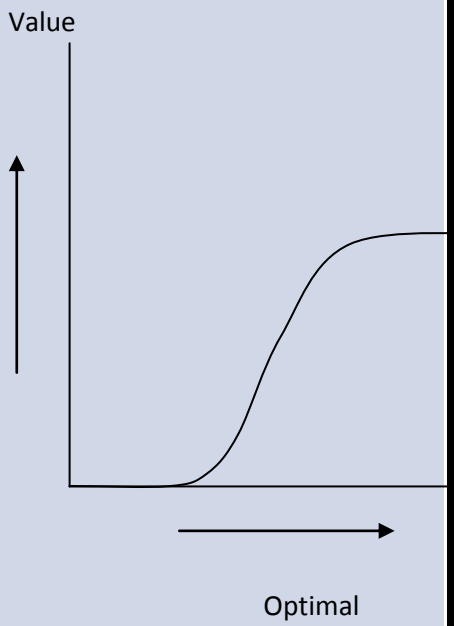
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			height of landward seawalls from 12m to 3m (UK NEA Technical Report). Sand dunes and shingle banks dissipate energy and if wide enough, can replace the need for artificial defences. With schemes such as managed realignment, substantial areas of saltmarsh can be created. The area of these same habitats can be reduced by change in land use e.g. drainage for enclosed farmland, changes for recreational benefits e.g. golf courses, and also reduced through hard engineering flood defence schemes. Therefore the contribution of coastal margins to flood defence is considered to be high, with potentially large increases in area possible which are significantly valued.		[redacted]
		Quality	The relationship is considered to be +NL (major). It is assumed that a poor quality habitat would not have the structural integrity to provide effective flood protection e.g. width not sufficient, pioneer communities with limited ability to bind sediments (dunes and saltmarsh). As discussed in the UK NEA for sand dunes, vegetation cover and root mass bind substrate, promote sand deposition and help to build wider and higher dunes. A poor quality habitat would also be vulnerable to erosion		[redacted]

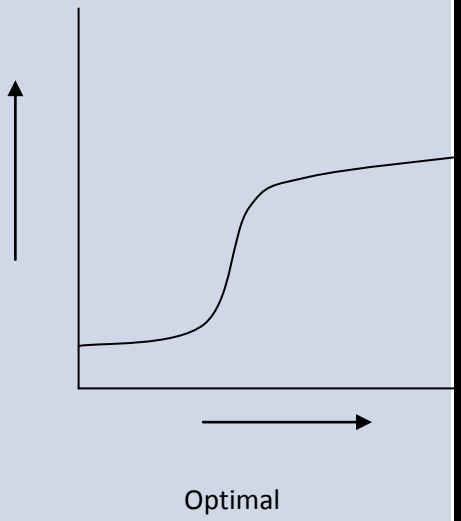
MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			and therefore there is a link between quality and quantity. As the quality increases, the amount spent on manufactured capital flood defence will reduce. Although it is considered that the accounting unit can substantially reduce the cost of manufacture capital flood defence, there will always be situations where additional protection is required. Protection from hazards = f [**species**; **coasts** (feature is wide and elevated, low creek density (saltmarsh)); **ecological communities** (colonisers such as *Salicornia*, sand dune stabilisers e.g. marram grass, tall and dense vegetation); **freshwater** (sediment); **land** (coastal morphology, aspect); **ocean** (tidal submergence, tidal current velocity, salinity, temperature); **material capital** (hard engineering structures)]		[redacted]
CM	Wildlife	Quantity	The relationship is considered to be +L (major). The MLC quantity can be increased and decreased in relation to some of the subcomponent habitats e.g. saltmarsh, sand dunes etc. With schemes such as		[redacted]

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			managed realignment, substantial areas of saltmarsh can be created. The area of these same habitats can be reduced by change in land use e.g. drainage for enclosed farmland, changes for recreational benefits e.g. golf courses. Therefore the contribution of coastal margins to wildlife is considered to be high, with increases in area possible which are significantly valued.		[redacted]
		Quality	The relationship is considered to be +NL (major). 'Pristine' coastal margins are those which have a high level of heterogenity, supporting a mosaic of habitats, including early successional habitats. These in turn support a range of highly specialised species which can tolerate the harsh conditions (salinity, inundation etc). In habitats such as shingle banks, lichen live on the pebbles and therefore any level of disturbance can affect this. It is considered that people will highly value habitats nearing 'pristine' and although the contribution of additional species may only be of marginal value after		[redacted]

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			this, the value will still increase. Wildlife = f [**species** (specialised, native, range of successional species); **ecological communities** (mosaic of habitats, range of successional stages, maintenance of stable systems); **freshwater** (sediment); **land** (coastal morphology incl. aspect and gradient); **atmosphere** (wind); **oceans** (tidal submergence, water velocity, turbulence, salinity levels, nutrient levels); **coasts** (stable systems, sediment, soil pH); **material capital** (management regimes e.g. light grazing, scrub clearance, lack of disturbance on shingle,)pressures (air pollution - acidification from sulphur and nitrogen deposition))]		
CM	Equable climate	Quantity Saltmarsh Sand dune	The relationship is considered to be +L (major). – MAJOR Climate regulation provided by habitats where there is rapid soil development or sediment accumulation (sand dune and saltmarsh). UK saltmarsh have high rates of		(?)

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			carbon sequestration storing 0.64-2.19 t c/ha/yr The ability to increase the quantity of the accounting unit is limited; only the proportion of subcomponent habitat that could change. Therefore the contribution of coastal margins to equable climate (carbon storage in saltmarsh) is considered to be high, with small increases in area that are possible but which are significantly valued.		
		Quality Saltmarsh Sand dune	The relationship is considered to be +NL (- MAJOR) Sand dune and saltmarsh act as carbon sinks, storing carbon as sediment accumulates and soils develop, with early successional systems having a greater potential to store (UK NEA Technical Report). However, these habitats also release methane and NO_x. The net effect on climate regulation is considered to be beneficial, however the overall contribution is limited by the quantity of these habitats. Potential release from degradation however is considered to be significant. Carbon storage =f **[coasts** (early successional stages);		(?)

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			atmosphere (wetter conditions); **ecological communities** (vegetation fixes CO_2)] pressures (development erosion).		
M	Food	Quality	The relationship is considered to be +NL (major). The quality of the MLC can affect the yield of fish, shellfish etc. In a poor quality environment e.g. acidified ocean, high salinity levels, low phytoplankton, the numbers of fish etc that could be harvested would be very low, and considerable effort and inputs would be required to harvest this low number. As the water quality improves, the system will become more productive and therefore number of fish/shellfish etc that it can support will increase. Similarly the value of the output from the MLC will increase. However, there will be a critical point where after any further increases in quality will produce marginal benefits. There is an important link with coasts as saltmarsh provide a nursery ground for fish species. Fish/shellfish yield = f [**species** (fish, shellfish), **coasts** (nursery ground for fish species), **atmosphere** (wind), **oceans** (salinity, currents, tides, waves, temperature, pH), **ecological communities** (population regulation, food web dynamics), **land** (morphology), **material capital**		

MLC	Benefit	Characteristic	Relationship Justification	Graph	WGB Classification
			(harvesting effort, harvesting preferences - policy driven, equipment)pressures(pollution)].		
M	Wildlife	Quality	The relationship is considered to be +NL (major) The abundance and diversity of marine wildlife will be primarily determined by the quality of the water. This will increase up to a critical point, after which any increase in quality, and therefore associated species diversity and/or abundance, will be less valued. Wildlife = f [**species**; **ecological communities** (population regulation, food web dynamics); **land** (topography, elevation); **atmosphere** (wind), **oceans** (salinity, tides, currents, waves, temperature, pH); **pressures**(pollution (e.g. oil spills, sewage effluent), invasive species (e.g. ballast water), fish by-catch, damage to benthic communities through trawl fishing)].		

Definitions for metrics and risk register work

DRAFT v3 (Final definitions in NCC, 2014)

Natural Capital Definitions

Species
All living organisms including plants, animals, fungi and micro-organisms. The product of ongoing evolutionary processes.

Ecological Communities
A group of actually or potentially, interacting species living in the same place. A community is bound together by the network of influences that species have on one another. Groups of interacting species in form persistent and distinctive assemblages interacting with their physical environment (e.g. pollination).

Soils
The combination of weathered minerals, organic materials, and living organisms and the interactions between these.

Freshwaters
Freshwater bodies (rivers, lakes, ponds and ground-waters) and wetlands. Includes water, sediments, living organisms and the interactions between these.

Land
The physical surface of the Earth and space for human activity. Includes the various landforms and processes which shape these (weathering and erosion).

Atmosphere
The layer of gases surrounding the Earth including oxygen, carbon dioxide and nitrogen used by all living organisms, and the processes which give rise to climate, weather (wind, precipitation) and temperature regulation.

Minerals and sub-soil assets
Naturally occurring non-living substances in the Earth's crust with a specific chemical composition and those formed by geologic processes e.g. stone, salt, sand, metals (gold, magnesium etc), coal.

Oceans
Saline bodies of water that occupy the majority of the Earth's surface. Includes water, sediments, living organisms and the interactions between these.

Coasts
The transitional zone between land and oceans. Includes water, sediments, living organisms and the interactions between these.

Major Land-Use Categories Definitions

The following land use types broadly correspond to the 8 UK NEA habitat types. These are considered too broad in many cases and so have been sub-divided into meaningful units. The selection of units has been based on the following principles:

- Data on extent and quality should be available at the unit level (for water and marine habitats units follow the Water and Marine Strategy Framework Directives)
- There should be a link between unit and benefits (to be determined as metrics work progresses)
- Habitats with important benefits or specific pressures should be separated out e.g. blanket bog
- If information is not available at the proposed level we can re-combine

Major Land Use Category (UKNEA Broad Habitat)	**Possible Sub-units**	**Scope**
Mountains, Moorlands and Heaths	Blanket Bog	Rainfall-fed bog in upland environments
	Mountains, Moorlands and Upland Heaths	Upland heath, montane habitats and associated wetlands (flushes, fens). Also include rock and scree habitats such as limestone pavements.
	Lowland Heath	Lowland habitats dominated by heather family or dwarf gorse species
Semi-natural grasslands	Semi-natural grasslands	All grasslands unimproved for agricultural purposes
Enclosed farmland	Enclosed farmland	Arable, horticultural land and improved grassland as well as associated boundary features e.g. hedgerows
Woodlands	Woodlands	Includes broadleaved and coniferous woodlands both natural woods and planted. (Wet woodland included here)
Freshwaters	Standing open waters	Lakes,ponds, reservoirs and canals
	Rivers and streams	Streams and rivers down to the tidal limit
	Groundwaters	Aquifers and significant quantities of below ground water.
	Wetlands	Lowland fens, raised bogs, swamps, reedbeds and floodplain wetlands
Urban	Built urban	The built environment elements of urban space e.g. buildings, roads, industrial works.
	Green space	The natural environment elements of built up areas e.g. parks, gardens, towpaths, urban trees.
Coastal Margins	Coastal dunes and sandy shores	Dune systems and the upper zone of sandy shores.
	Saltmarsh	The upper zone of vegetated intertidal habitat - transition into other intertidal habitats.
	Transitional and coastal waters	Estuaries, coastal lagoons and other near shore waters (Water Framework

		Directive definition)
Marine[a]	Intertidal rock	Bedrock, boulders and cobbles which occur in the intertidal zone. Colonised by mussels/barnacles and seaweeds depending on exposure.
	Intertidal sediment	Shingle (mobile cobbles and pebbles), gravel, sand and mud in the intertidal zone.
	Subtidal rock	Bedrock, boulders and cobbles in the subtidal zone colonised by seaweeds (infralittoral zone) or animal communities (circalittoral zone).
	Shallow subtidal sediment	Shingle (mobile cobbles and pebbles), gravel, sand and mud in the subtidal zone.
	Deep sea bed	The sea bed beyond the continental shelf break.
	Pelagic water column	The water column of shallow or deep sea; beyond the coastal waters.

[a] Marine accounting units based on EUNIS habitat classification and proposals for Marine Strategy Framework Directive reporting. These could be amalgamated to give: intertidal, subtidal, deep sea bed and pelagic.

Benefits Definitions

Note: Some benefits are the product of natural capital and other capital inputs e.g. most food is prepared or processed before being consumed

Food
Plant, animal and fungi consumed by people. Both wild and cultivated sources.

Fibre
Plant and animal materials used by people for building, clothing and other objects, including timber.

Energy
All sources of energy used by people (fossil fuels, wind, tidal, wave, hydro, biomass and solar).

Clean water
Water for human use (e.g. drinking, bathing, industrial processes); a combination of quality and quantity.

Clean Air
Air quality that has no adverse impact upon human health or wellbeing.

Recreation
Active enjoyment of the natural environment e.g. walking, fishing, canoeing

Aesthetics
Passive enjoyment of the natural environment e.g. landscape appreciation and views

Wildlife
Wild species diversity and abundance which has aesthetic and recreational value and has cultural and spiritual significance. (Distinct from the natural capital assets, species and ecological communities, in that these represent the species that are significant to England and that people care about)

Protection from hazards
Natural regulation of extreme events such as flooding, drought and landslips.

Equable climate
A comfortable climate that has no adverse impact upon human health or wellbeing. The result of both global scale and local scale effects (e.g. urban cooling by trees)