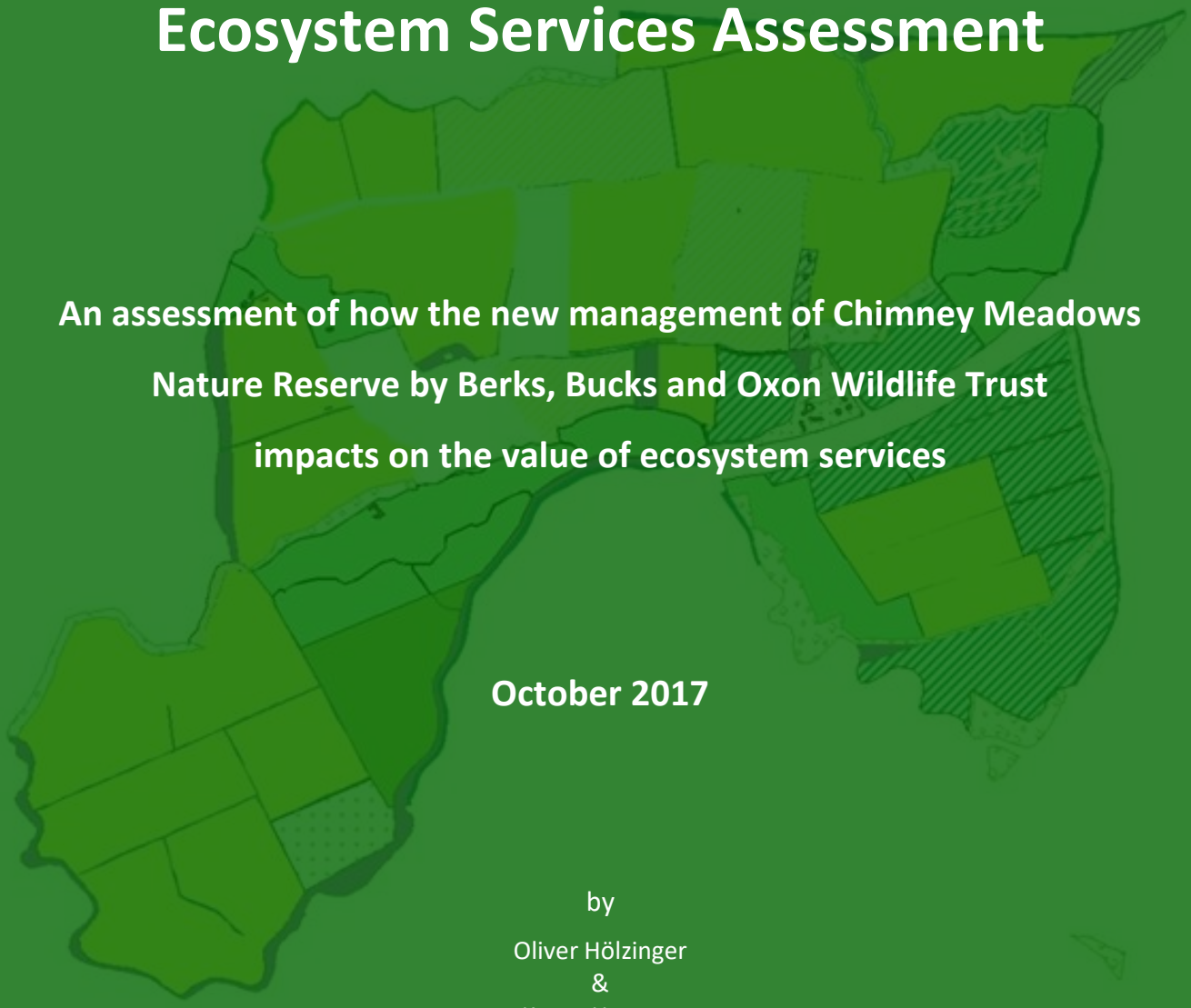
Chimney Meadows

Ecosystem Services Assessment



An assessment of how the new management of Chimney Meadows Nature Reserve by Berks, Bucks and Oxon Wildlife Trust impacts on the value of ecosystem services

October 2017

by

Oliver Hölzinger
&
Karen Haysom

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I. Executive Summary

The main aim of the project was to establish if the management instigated at Chimney Meadows Nature Reserve by Berks, Bucks & Oxon Wildlife Trust (BBOWT) for the purpose of conserving native plants and breeding waders and wildfowl would provide additional benefits in the form of ecosystem services to society. Two scenarios for the assessment period 2023-2052 were established: an aspirational (ASP) scenario reflecting the intended and already partially implemented management changes introduced by BBOWT and a business as usual (BAU) scenario assuming that the former commercial agricultural management would continue.

Table I.1 Capitalised benefits and costs for 2023-2052: BAU & ASP Scenarios

	Business as Usual (BAU)			Aspirational (ASP)		
	Private	Social	**Total Capitalised Value**	Private	Social	**Total Capitalised Value**
Benefits						
1 Flood Regulation		£840,740	**£840,740**		£2,294,596	**£2,294,596**
2 Food	£824,081		**£824,081**	£450,630		**£450,630**
3 Global Climate Regulation (only AMB)		£0	**£0**		£2,019,203	**£2,019,203**
4 Health (Walking)		£136,325	**£136,325**		£701,101	**£701,101**
5 Recreation & Aesthetics	£83,959	£95,378	**£179,337**	£10,819	£1,366,538	**£1,377,357**
6 Water Quality Regulation		£10,928	**£10,928**		£1,049,141	**£1,049,141**
7 Wild Species Diversity		£1,377,033	**£1,377,033**		£2,444,861	**£2,444,861**
Total Benefits	£908,040	£2,460,405	**£3,368,445**	£461,450	£9,875,439	**£10,336,889**
Costs						
1 Capital & Equipment	£1,128,570		**£1,128,570**	£739,185		**£739,185**
2 Labour	£988,076		**£988,076**	£1,090,601		**£1,090,601**
3 Site & Livestock Management	£69,533		**£69,533**	£323,069		**£323,069**
Total Costs	£2,186,179		**£2,186,179**	£2,152,855		**£2,152,855**
Total Net Benefits			**£1,182,266**			**£8,184,034**
Benefit-Cost Ratio (BCR)			*1.5*			*4.8*

All monetary values are stated in GBP; 2015 prices
Values are capitalised over 30 years for the period 2023-2052 applying a discount rate of 1.5%

Source: ***Author calculations***

The results summarised in Table I.1 show that both scenarios provide a net-benefit to society. However, the net-benefit of the ASP scenario of £8.2 million is £7.0 million higher than in the BAU scenario. This clearly shows that the ASP scenario would be the preferred option where the objective is to maximise social benefit. This is likely to be a very conservative estimate of the real value because many ecosystem services could not be quantified or were only partially

quantifiable. The Benefit-Cost Ratio (BCR) of the ASP scenario of 4.8 indicates that each £1 spent on annual running costs returns a benefit of £4.80 to society and is therefore good value for money. The BAU scenario on the other hand only has a BCR of 1.5. For applicable methods, calculations and caveats see the relevant sections of the main report.

To convert future costs and benefits into present values (2015 prices) a discount rate of 1.5% was applied. For comparison, a discount rate of 3.5%, the rate used by the Treasury, was also applied (see Appendix E). This showed a reduced capitalised net benefit for both scenarios, but with no significant change to the BCR.

When looking at the private benefits (excluding wider social benefits) only, the business models of both ASP and BAU scenarios are not viable. In both cases the benefits provided for society as a whole are larger than those generated for BBOWT/the farmer *per se*. Under the BAU scenario the farmer would be left with a net cost of £1.2m over the assessment period. Under the ASP scenario this would rise to £1.7m for BBOWT. This assessment shows that external funding to support the ASP state is both necessary and justifiable. Public funding and/or subsidies up to £7m (the additional net-benefit of the ASP scenario) would still provide a positive return on investment to society.

II. Acknowledgements

Many individuals and organisations contributed to this project. Without them this assessment would not have been possible. In particular, we would like to thank Lisa Lane, Louise King and Andy Fairbairn from BBOWT as well as Mike Swan from the Game & Wildlife Conservation Trust for their valuable contributions and consultations. We would also like to thank Steve Tabbitt (Thames National Trail Manager, Oxfordshire County Council), Anne Cotton (Land Management and Conservation Adviser, Natural England) and BBOWT colleagues Martyn Lane, Matt Jackson, Debbie Lewis, Neil Clennell, Anne Barrow and Rachel Powell for their help with the assessment and data collection.

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1. Introduction and Background

1.1 Project Aims and Objectives

The main aim of this project was to assess how the value of ecosystem services provided by Chimney Meadows Nature Reserve changes due to the wildlife conservation management imposed by Berks, Bucks & Oxon Wildlife Trust (BBOWT) as compared to its former agricultural-orientated management. The objectives were:

- To quantify as many ecosystem services as possible; both for the aspirational (ASP) scenario (BBOWT management) and for a business as usual (BAU) scenario in which the site would continue to be managed in its former state of mainly agricultural land-use;
- To assess the costs of management under both scenarios; and
- To compare the net-benefit (net-cost) of both scenarios to identify which management provides better value for money to society and what the added value is (change assessment).

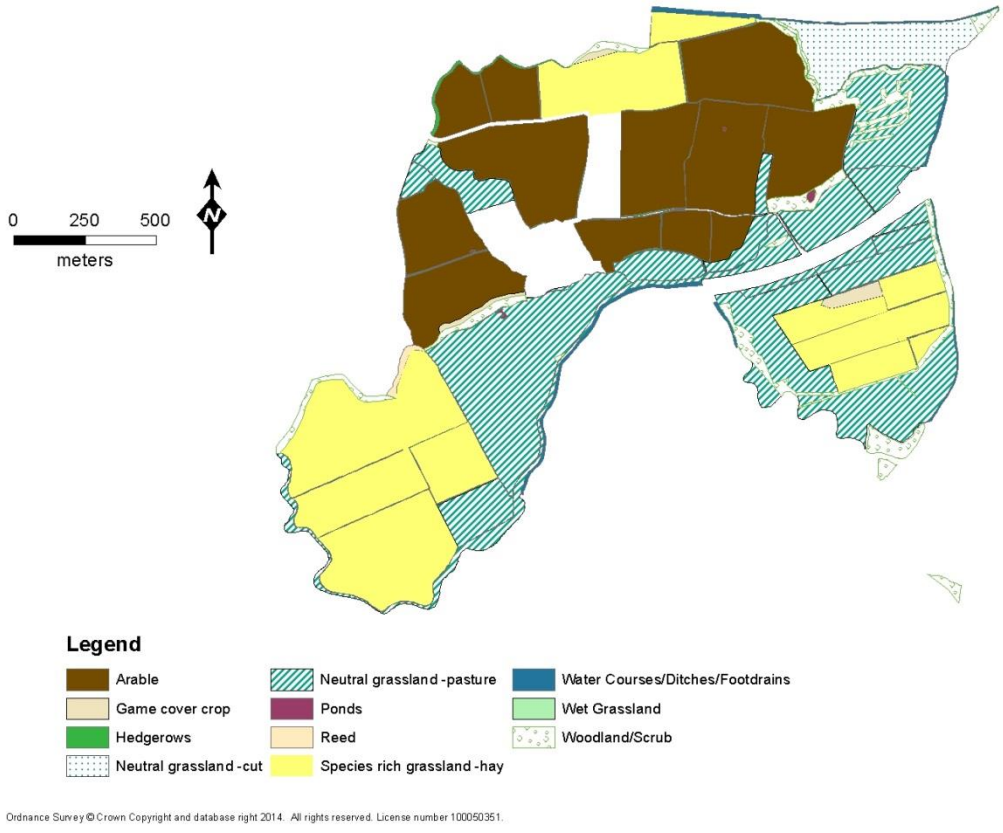
1.2 Introduction to Chimney Meadows Nature Reserve – Before and After Purchase by BBOWT

Chimney Meadows Nature Reserve is located in Oxfordshire, south-west of Oxford, and covers an area of more than 260 ha. A smaller part of 50 ha in the south-west of the reserve was designated as a Site of Special Scientific Interest (SSSI) in 1986 and declared a National Nature Reserve in 1993; mainly because of its support of a botanically rich sward and its importance for uncommon bird species. The rest of the land was mainly arable farmland in intensive management until 2003 when BBOWT purchased the land. BBOWT's ambition is to extend the area of floodplain hay meadows and to reinstate wetland features to support wading birds.

BBOWT has a clear aspiration for the future management of the site. Implementing these management changes began soon after the land was purchased. Figure 1.1 below shows the former land-use management where arable fields were dominant in the northern part of the

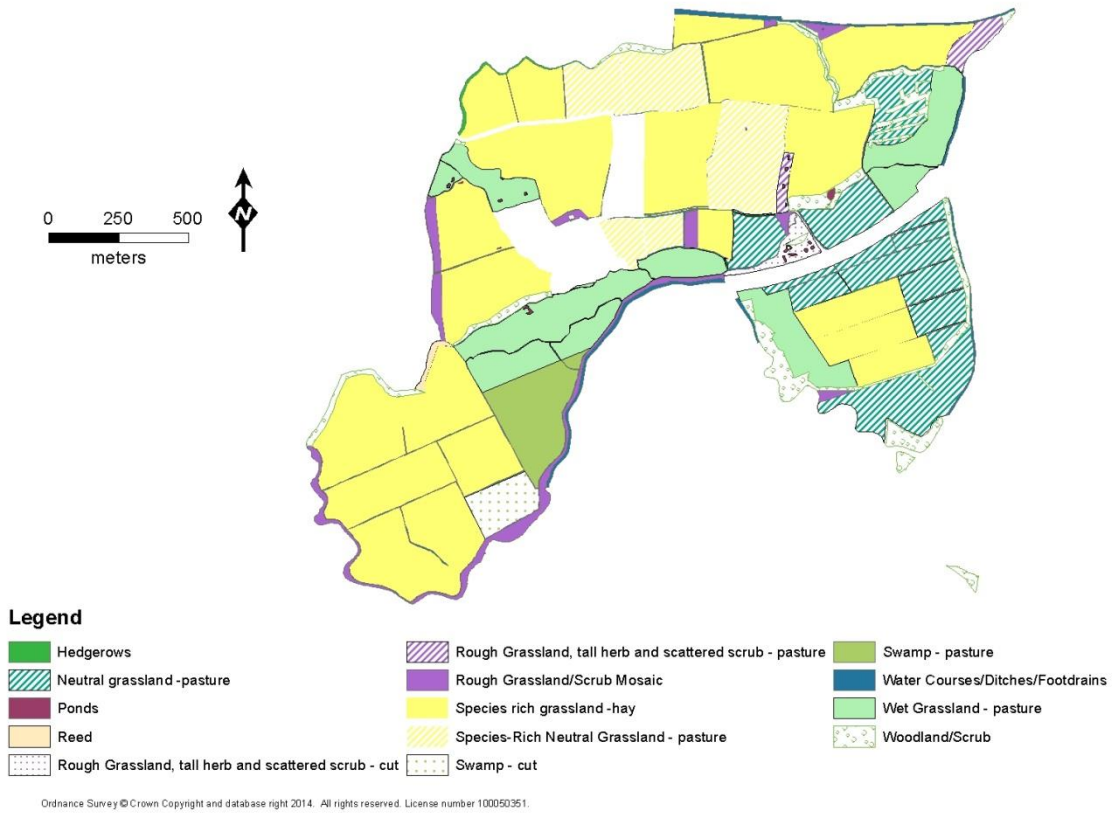
site. Figure 1.2 shows the land-use types of the aspirational future state in which the former areas of arable and game cover crop have been replaced by species-rich grasslands, in order to enhance the floristic diversity of the site. Similarly, conservation for waders and overwintering wildlfowl has resulted in the conversion of neutral grassland pasture habitats into wet grassland and swamp. While gross habitat conversions can be instigated quickly, the ecological development of the site (*i.e*. response of the target species and time taken for the designated conservation features to achieve fully the targets outlined in the conservation management plan) takes much longer. For the purpose of this exercise, it is assumed that these land-use changes and finer-scale ecological responses are mainly in place by 2023.

Figure 1.1 **Chimney Meadows Nature Reserve – Past Management**



Source: ***BBOWT***

Figure 1.2 **Chimney Meadows Nature Reserve – Aspirational Management**



Source: ***BBOWT***

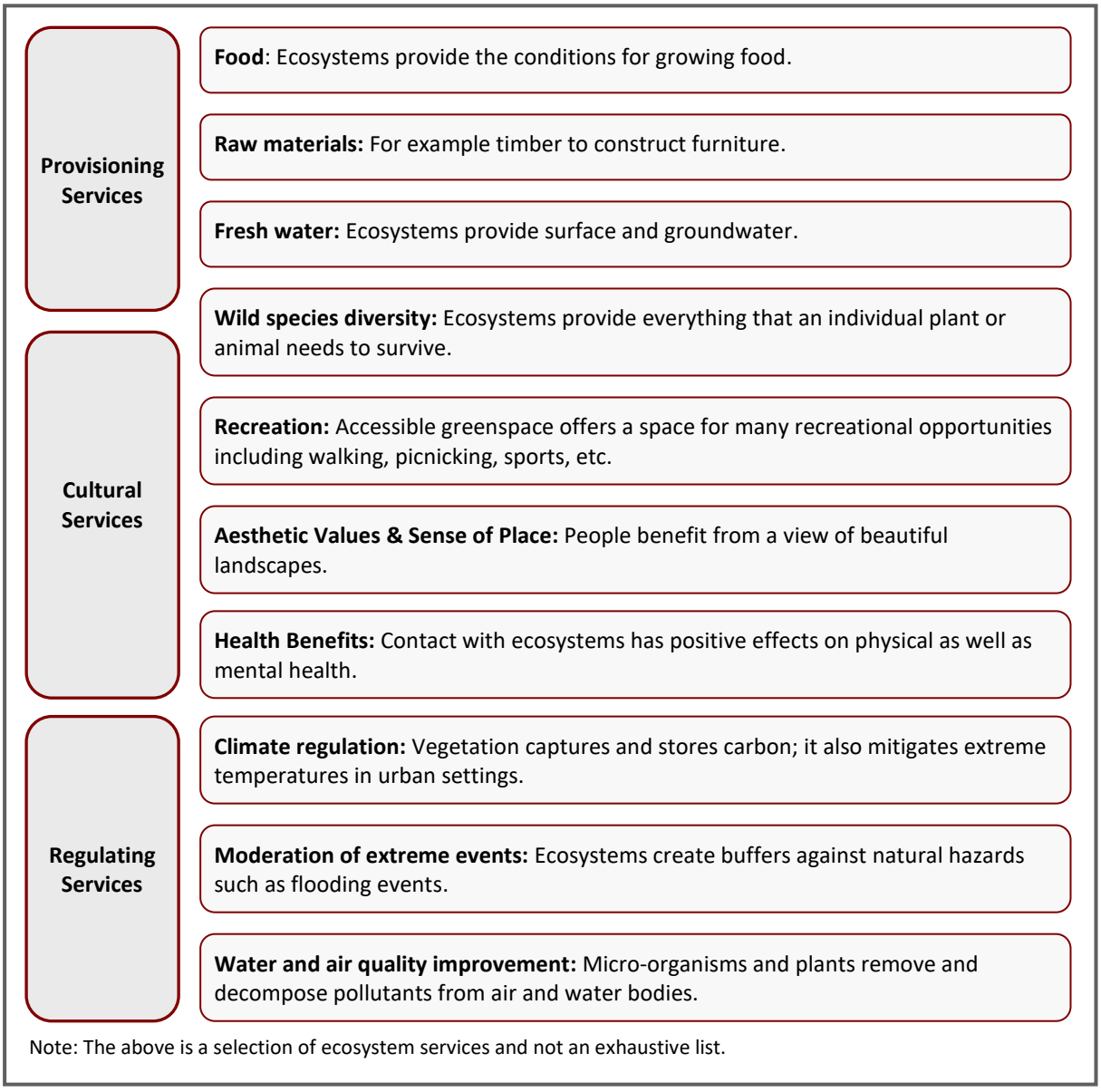
1.3 Introduction to Natural Capital, Ecosystem Services and Ecosystem Valuation

This assessment was based on the ecosystem services concept and includes ecosystem valuation. Because not everyone is familiar with these new concepts we provide a brief introduction to terminology.

The natural environment surrounding us is not just a 'nice to have' but is absolutely crucial for our human wellbeing and health. Ecosystems, such as a water catchment, a forest or even a single tree, provide us with many goods and services including food, timber, space for recreation, a pleasant amenity, water and air quality regulation functions, climate regulation benefits, and many more. The goods and services we gather or receive from nature are called ecosystem services. Ecosystem services are commonly defined as *"the benefits people obtain*

from ecosystems"[1] and many ecosystem services in the UK are already in a degraded and/or declining state[2]. For more examples of ecosystem services see Figure 1.3 below. The following sections of this report outline the ecosystem services assessed within this study in greater detail.

Figure 1.3 Examples of Ecosystem Services



Source: ***Based on TEEB, 2010 and UK NEA, 2011.***

[1] Millennium Ecosystem Assessment 2005.
[2] UK NEA 2011.

The continuing decline of Natural Capital means that we cannot keep on taking such ecosystem services for granted anymore. Natural Capital, *"the stock of natural ecosystems that yields a flow of valuable ecosystem goods or services into the future"*[3] needs to be actively protected, enhanced and managed to secure a sustainable flow of ecosystem services; and ultimately our own human wellbeing.

Ecosystem services do not represent the value of ecosystems for their own sake (intrinsic value). Rather they reflect the benefits (and in some cases disbenefits) to human wellbeing and are therefore based on an anthropocentric approach. But choosing this approach should not be interpreted as undermining or neglecting intrinsic values of nature. The two concepts are not mutually exclusive but rather complementary. However, the anthropocentric approach is the only practicable approach for quantification because *"non-anthropocentric value is, by definition, beyond any human knowledge."*[4] We should note that the anthropocentric approach can also include existence or non-use values[5], option-use values[6] and bequest values[7].

For some ecosystem services such as food and timber (provisioning services), it is comparatively easy to work out the value because they are traded on markets and therefore have a market price that indicates the value. But many ecosystem services do not have a market price. We do not have to pay trees (or those who plant/manage them) for cleaning the air we breathe or an entrance fee for accessing nature for recreational purposes, for example. If others provide these services we can benefit as 'free-riders' without paying. However, if no one pays for such ecosystem services there is also little incentive for others to provide such services in an unregulated market because they would not be paid for planting trees or managing a nature reserve. And because there is no payment there is also no market price which could indicate the value of such services.

[3] Costanza 2008.
[4] Defra 2007, 12.
[5] You might never be able to see a whale in nature, but you can nevertheless benefit from the pure existence of whales and have a preference for protecting them.
[6] You might never see a whale in nature, but you can benefit from the option to see whales in the future.
[7] You might never see a whale in nature, but you can benefit from the option of future generations being able to see whales.

But 'no price' is not the same as 'no value'. This can be clarified using a simple example. The price for the air we breathe is zero but without air we would not be able to survive which means that clean air is clearly of high value to us.

> *"In considering the task of valuing ecosystem services an important distinction needs to be drawn between the terms 'value' and 'price'. That they are not, in fact, equivalent is easy to demonstrate. Consider a walk in a local park. The market price of such recreation is likely to be zero as there are no entrance fees and anyone can simply walk in. However, the very fact that people do indeed spend their valuable time in parks shows that this is not a zero value good."*[8]

Having no price or explicit quantified value for ecosystem services often results in the misjudgement that such ecosystem services are self-evident or without value. The high complexity of ecosystem processes makes their value even more intangible and reinforces a tendency to neglect them.

> *"Because ecosystem services are largely outside the market and uncertain, they are too often ignored or undervalued…"*[9]

This undervaluation commonly results in the degradation of the Natural Capital that provides these services, leading in turn to a progressive undersupply, and finally to a decline of overall human wellbeing.

> *"The full value of goods such as health, educational success, family and community stability, and environmental assets cannot simply be inferred from market prices, but we should not neglect such important social impacts in policy making."* (HM Treasury 2003, 57)

The economic valuation of ecosystem services serves to mitigate this information bias, and also makes the value of services provided by ecosystems more tangible for non-specialists,

[8] UK NEA 2011, 1072.
[9] Costanza et al. 1997, 269.

generating awareness of such benefits. This in turn supports more sustainable decision-making, by better integrating formerly overlooked values into decision-making.

There are two main approaches to revealing the value of non-market ecosystem services. Sometimes the ecosystem value is contained within a market price (revealed preferences). This is for example the case for flood risk regulation. One can calculate the amount of water stored by a grassland site in a flooding event. The amount of damage this amount of water would have caused to properties and infrastructure if this natural water storage capacity were unavailable can then be modelled. The avoided damage costs reflect the value of the flood risk regulation service provided by the grassland site.

But not all ecosystem services can be derived from market prices. Another method to reveal the value of ecosystem services is by simply asking people what they would be willing to pay if there was a market (stated preferences). One can, for example, ask people what they would be willing to pay to access a nature reserve for recreation if there was an entrance fee.

1.4 Methods and Limitations

The main aim of this project was to establish an evidence-based assessment of the net-benefits to society provided by Chimney Meadows Nature Reserve. Benefits were quantified in monetary terms for two scenarios:

- Business as usual (BAU): This is a scenario that assumes the continuation of the intensive agricultural management that was practiced in the past, and no intervention by BBOWT.

- Aspirational (ASP): Here the assumption was that BBOWT's conservation management *i.e*. reversion of arable to species-rich grassland, restoration of wet grassland and swamp, extension of woodland and planting and restoration of hedgerows (as in Figure 1.2) will have been implemented and become ecologically functional by 2023 (the starting year of this assessment).

This assessment builds on a 'Rapid Ecosystem Services Assessment' undertaken previously by BBOWT where the magnitude of the value of ecosystem services was estimated qualitatively for both scenarios.[10]

For each scenario Natural Capital Accounts were established applying Natural Capital Accounting guidance.[11] The costs of managing the site and the benefits in terms of ecosystem services were both quantified as far as scientific evidence allowed. For the ASP scenario, the costs of managing the site were based on the current Chimney Meadows Business Plan (which covers the period April 2012 to March 2018). For the BAU scenario some assumptions were made regarding the relevance and modification of these costs to a scenario of continued intensive agricultural management.

The scientific evidence available at the time of this assessment did not allow the calculation of monetary values for the total range of services thought to be present at the site. Similarly, values that were calculated for an ecosystem service often cover only an element of the full ecosystem services value. The monetary values of ecosystem services benefits presented in this report should generally be regarded as a minimum estimate of the total or real value of ecosystem services.

To quantify benefits - ecosystem services values - in monetary terms the so called benefit transfer approach[12] has been applied. The results from studies carried out elsewhere were transferred to the assessment area (Chimney Meadows), applying suitable precautions and assumptions. This approach allowed the transfer of benefit values from primary valuation studies to our specific context. Where possible, adjustments for site-specific circumstances and socio-economic variables such as population density have been made to minimise potential transfer-errors. Carrying out original primary valuation studies as introduced in Section 1.3 was beyond the scope of this study as such studies demand extensive resources and lengthy timescales. The application of the benefit transfer approach can be seen as a practicable and cost-effective way for implementing the Ecosystem Approach in decision-

[10] Haysom 2016.
[11] Eftec 2015.
[12] Sometimes also referred as 'value transfer approach'.

making.[13] For further information about the benefit-transfer approach and how scientists calculate values for non-market ecosystem services see for example Defra's 'Introductory Guide to Valuing Ecosystem Services'.[14]

For this project only valuation methods and studies that comply with high scientific standards were chosen. Nevertheless, the model contains some limitations. For example, Willingness-To-Pay (WTP) techniques applied in primary valuation studies have their own imperfections such as social desirability bias[15] or a potential inability of survey participants to perceive hypothetical markets and goods. Another limitation may result from applying the benefit transfer approach. Usually, the study area (where primary valuation studies were carried out) and the policy area (in this case Chimney Meadows) are not entirely similar. Therefore, adjustments are needed for some socio-economic influencing variables such as income or population density as well as local context (such as the availability of substitute habitats and services). Even where these adjustments are applied as carefully as possible, a benefit transfer error can never be ruled out. For these reasons, calculated ecosystem services values should be regarded as essentially indicative of the magnitude of the service. Method-specific caveats are explained in more detail where relevant in the following Chapters and Appendices.

A mistake often made when valuing ecosystem services is double counting. Different benefits arising from the same service are counted twice during the assessment of its total value. The risk of double counting is higher when valuing a wide range of services and different habitats, as in the present study. Ecosystem interactions and relationships between different services are characterised by high complexity. Particular attention has been paid to this issue. In case of doubt, calculations are conservative to maintain validity. This principle has been applied across this study.

The costs and benefits of both scenarios were calculated over a 30 year timescale starting in 2023. The year 2023 was chosen as the starting year because this is the year when Higher Level Stewardship (HLS) objectives for bringing the site into its aspirational state are expected to be met. It is also 20 years after BBOWT purchased the site. The choice of starting year was

[13] Defra 2007.
[14] Ibid.
[15] The interviewees may like to make out that they value an ecosystem service more than they actually do

somewhat pragmatic (being the final year of an agri-environment agreement), acknowledging the difficulty of predicting when ecological restoration activities will actually achieve the target habitat condition and functionality. Some studies of restoration processes have found that it may take much longer for plant and invertebrate assemblages to resemble natural examples of the same habitat closely. This means that all calculated figures are for future costs and benefits and are therefore based on estimates, as the future is generally uncertain. This caveat should be acknowledged when interpreting the findings.

The costs and benefits assessed within the scope of this project are stated as annual values and as capitalised values over the assessment period of 30 years. To calculate the 'net present value' of future benefit it is common to apply a discount rate. This discount rate is used to convert future benefits (and costs) to present values which make them comparable across time. For the purpose of this investigation, a discount rate of 1.5% has been applied to calculate the net present value of future benefits.

Applying this discount rate was suggested in the Ecosystem Assessment Guidance[16] which was published as part of the National Ecosystem Assessment Follow-On (NEAFO)[17], even if it is not consistent with the discount rate recommended by the HM Treasury.[18] However, the German Federal Environmental Agency also recommends applying a discount rate of 1.5% for long-term assessments.[19] HM Treasury recommends a discount rate of 3.5% for periods of up to 30 years.[20] However, the interest rate proposed by HM Government is based on the assumption that *"Society as a whole, also prefers to receive goods and services sooner rather than later, and to defer costs to future generations."*[21] This does not question if this is a fair solution to deal with intergenerational issues and decisions. Future generations may well have a different view.

This Treasury approach may therefore not be the best choice for Natural Capital assessments as Natural Capital often performs ecosystem services over a long time covering more than one

[16] Hölzinger 2014.
[17] Scott et al. 2014.
[18] See for example HM Treasury 2003.
[19] See also German Federal Environment Agency 2008.
[20] HM Treasury 2003, 97.
[21] Ibid., 26.

generation. Assuming that a government is not less responsible for future generations than for the current, even if future generations are not able to participate in decision-making (e.g. elections), one could argue that the Treasury approach is inconsistent with its commitment to sustainable development.[22]

A long-term discounting approach is most ecologically relevant and equitable across generations. This is also a well-supported approach. Hence a discount rate of 1.5% was applied for the capitalised values. But because the assumption was applied for both scenarios, and for costs as well as benefits, the adjustment does not change the direction of outcomes when compared to the HM Government approach. For reference the assessment was also re-run using the discount rate recommended by HM Treasury. This assessment can be found in Appendix E.

It should be noted that for capitalised values a *ceteris paribus* (everything else remains equal) future has been assumed for both scenarios. This means that all variables such as population or impacts of climate change were set constant over time. Both population growth and climate change impacts can be expected to increase the values of ecosystem services over time due to resource scarcity considerations.

[22] For a more extensive discussion of the discount rate recommended by HM Treasury; other discount rates and criticisms of the HM Treasury discount rate see for example Stern 2006; Perino et al. 2011.

2. Benefits: Ecosystem Services Valuation

2.1 Food Production

Depending on the scenario examined, the 'food production' ecosystem services applicable for Chimney Meadows include harvesting arable crops, livestock feed and sales, and hay sales. The different elements are outlined below in more detail. Note that benefits from gamebird shooting and deer hunting, (which also generate food products), are covered in Section 2.2 below.

Arable crops

We assumed that all the land that was in arable management before BBOWT purchased the site (78.45 ha) would continue to be harvesting arable crops under the BAU scenario. This assumption was also applied to areas of arable land that may have been in set-aside in the past, because it is difficult to forecast what kind of subsidy arrangements may be in place for the assessment period 2023-2052. The area of game cover crops was not included in these calculations.

To estimate the food value of the BAU scenario, farm cropping patterns for the years 2000 to 2002 were assessed from existing European Commission Integrated Administration and Control System (IACS) records.[23] Within this timescale, the arable land was dominated by winter wheat with some farming of rape and field beans. The gross margins (excluding fixed costs which are covered separately in Section 3.1) were calculated using the estimates for average yield per ha, expected output value per ha[24] and the average variable costs per ha provided in the John Nix Farm Management Pocketbook 2016[25]. This resulted in an estimated average annual value (gross margin) of £30,633 annually. This estimate was adopted for the BAU scenario, resulting in a capitalised value of £662,874 over the total assessment period.[26] No farming of arable crops was planned for the ASP scenario.

[23] http://ec.europa.eu/agriculture/direct-support/iacs_en
[24] Based on the low estimate, acknowledging the quality of the land
[25] Redman 2015.
[26] All values in 2015 prices; applied discount rate for capitalised values: 1.5%

Hay sales

Historical IACS returns for the period 2000-2002 suggested that much of the farm's grassland was let to graziers. For the BAU scenario it was therefore estimated that only the National Nature Reserve area of species-rich hay grassland of 41.2 ha would produce hay to be sold externally. In the ASP scenario the area of species rich grassland used for hay production was extended to 124.5 ha.

It was estimated that each acre of standing hay would have a sales value of £30 per annum which results in an annual value of £3,056 in the BAU scenario and £10,700 in the ASP scenario, respectively. In the ASP scenario it should be noted that some of the hay produced would be given to other BBOWT sites. In this case, the £30 per acre value represents the hypothetical costs that other BBOWT sites would have to pay if the hay was not available from Chimney Meadows.

Income from livestock grazing (grazing rental)

In both scenarios, a certain area (BAU: 104.4 ha; ASP: 147.3 ha) was let out as a grazing resource for external livestock. For the BAU scenario it was assumed that the area could provide for 169 cows over 26 weeks at £1 per cow per week resulting in a value of £4,394 annually. For the ASP scenario, the annual value was estimated to be £1,200 as per the business plan. The much lower value estimated for the ASP scenario despite representing a larger area dedicated to grazing can be explained by the shorter grazing periods allowed in many areas, to maintain the botanical interest of these fields.

Livestock sales

For the ASP scenario, the site also produces its own (BBOWT-owned) livestock on site. It was estimated that each year on average 15 calves (£300/head), 65 lambs (£45 per head) and 25 lambs for direct sale through a meatbox scheme could be produced. This would result in an annual value of £8,925 for livestock sales. Based on historical (IACS) records it is unlikely that the former landowner owned livestock. Therefore no income from own livestock was assumed in the BAU scenario.

The findings for total food production are summarised below. Not surprisingly the value is significantly higher in the BAU scenario as the site would be predominantly managed to maximise food production whilst in the ASP scenario the focus is on providing a broader variety of services.

Table 2.1 Estimated value of food production

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Arable crops	£30,633	**£622,874**	£0	**£0**
Hay sales	£3,056	**£66,126**	£10,700	**£231,536**
Hay for grazing external livestock	£4,394	**£95,081**	£1,200	**£25,967**
Livestock sales	£0	**£0**	£8,925	**£193,127**
Total	£38,083	**£824,081**	£20,825	**£450,630**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

2.2 Recreation & Aesthetic Values (incl. Gamebird Shoot)

The ecosystem service 'Recreation & Aesthetic Values' refers to the benefits people gain when interacting with Chimney Meadows through activities such as walking, picnicing or simply enjoying the scenery and its wildlife. Gamebird shooting and hunting activities are also covered in this section as a recreational activity, although they also generate some food products. Different approaches were taken to quantify the value of these activities which are outlined below.

Gamebird shooting and deer hunting

In its former management game bird shooting was part of the business model of the site. The Game and Wildlife Conservation Trust (GWCT) prepared a report[27] to estimate the value of game shooting activities on the site before BBOWT took over management. Based on a site visit, the assessment of its game facilities and an examination of historical documents relating to game activities when Chimney Meadows was in private ownership the likely related net-values were estimated.

[27] Unpublished; for more details contact Mike Swan from the GWCT (mswan@gwct.org.uk).

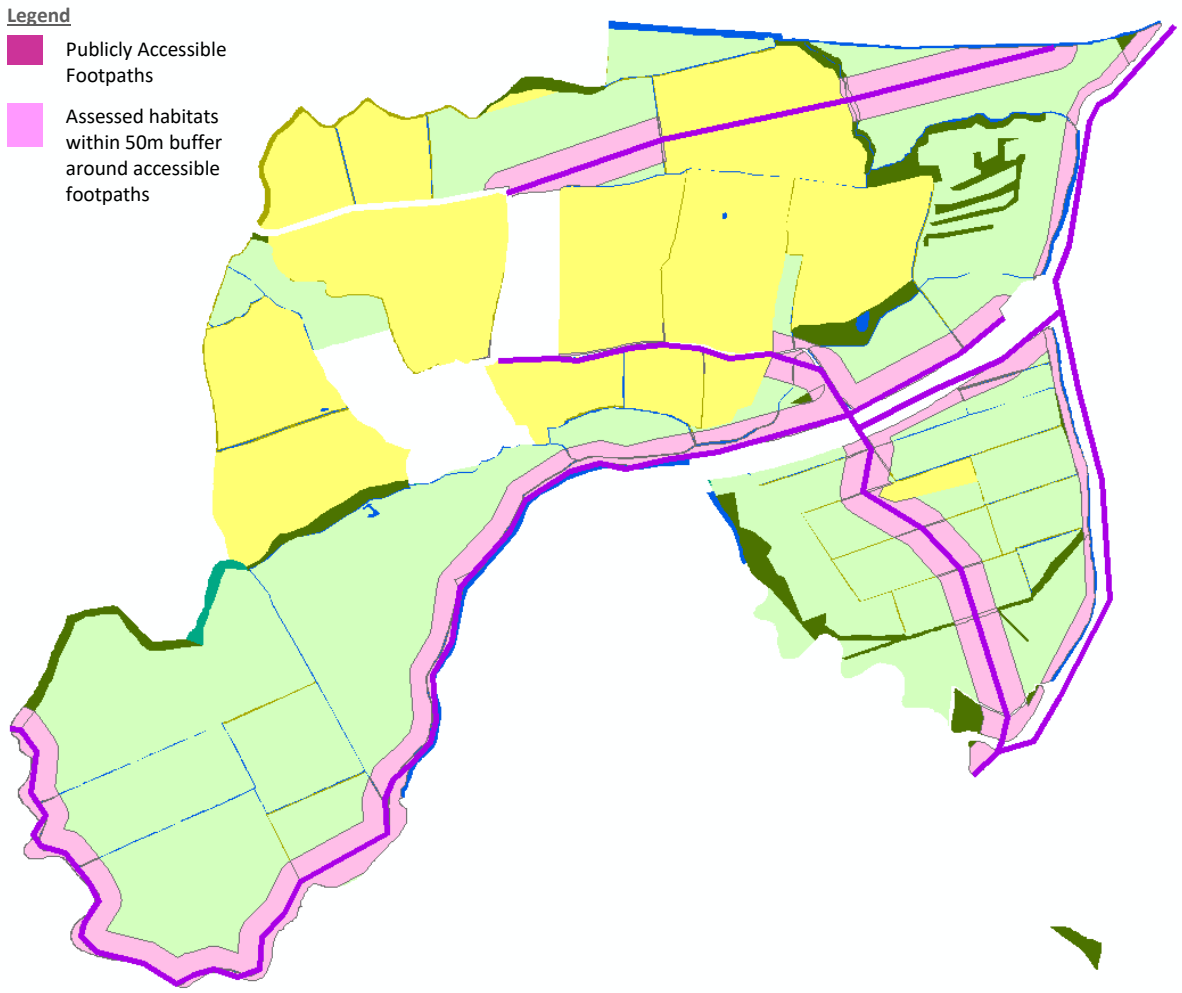
Based on the available evidence, the report estimated that each year about 150 pheasants may have been shot on site generating a net income of £2,215 per annum. Furthermore about 40 wildfowl and wader may have been shot annually generating an estimated net-income of £1,165. It is also likely that there was some limited deer hunting benefit valued at £500 per annum which results in a total annual value of £3,880. This value has also been adopted for the BAU scenario. For the ASP scenario there are no plans to allow gamebird shooting activities on the site, but the value of deer hunting of £500 per annum is likely to remain, because of the need to maintain deer populations below a level at which they could damage the site's botanical interest.

Under the former management, there was also fishing activity on site and this had an estimated annual value of more than £3,000 for fishing rights. But because benefits provided by the blue infrastructure are outside of the scope of this assessment, this value has not been included in the calculation. BBOWT does not support fishing activities on site and has no plans to reinstate them in the ASP scenario.

Other cultural services

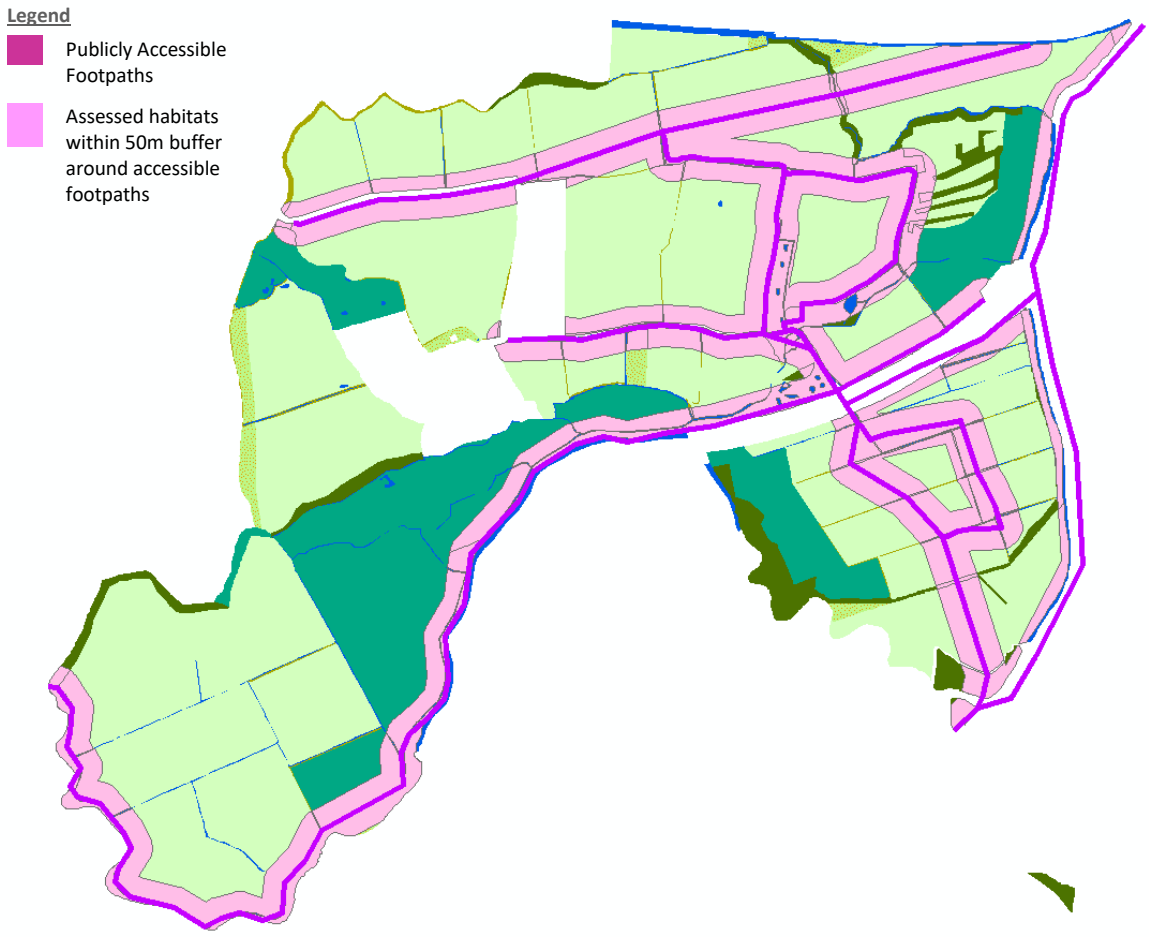
To assess the cultural services (recreation, aesthetic appreciation, education and spiritual values) of the site the findings from Christie et al. (2011) and Brander et al. (2008) were used for a benefit transfer. Because the Christie et al. model is area-based but the site is only accessible via footpaths (without physical access to the habitat areas themselves) the assumption was made that people benefit from cultural services within a 50m buffer on each side of the publicly accessible footpaths. This covers an area of 41.78 ha in the BAU scenario and 74.67 ha in the ASP scenario, respectively. The area in the ASP scenario is larger because new publicly accessible footpaths (permissive paths) were introduced by BBOWT.

Figure 2.1 Habitat Extent Assessed in the BAU Scenario



Source: ***Author assessment based on GIS data provided by BBOWT***

Figure 2.2 Habitat Extent Assessed in the ASP Scenario



Source: ***Author assessment based on GIS data provided by BBOWT***

We made the assumption that in the BAU scenario only 50% of the cultural value can be realised. This is because the former landowner was known to restrict access to the site by visitors. In contrast BBOWT actively encourages access, for example by creating site interpretation signs. The 50% assumption is rather conservative because it was estimated that the site had only about 20% of the visits when compared to visit estimates after BBOWT took over management. The findings are summarised in Table 2.2 below. For calculations and further details see Appendix A and Appendix B.

Table 2.2 **Estimated value of recreation and aesthetic values**

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Game shooting and hunting	£3,880	**£83,959**	£500	**£10,819**
Visitor-based recreation & Aesthetic values	£4,408	**£95,378**	£63,152	**£1,366,538**
Total	£8,288	**£179,337**	£63,652	**£1,377,357**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

2.3 Health Benefits

Human health is a classical cross-cutting ecosystem service and is basically influenced by all ecosystem services as all ecosystem services have an impact on human wellbeing. The World Health Organization defines health as follows:

> *""Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."* [28]

This definition of health has also been adopted within the UK NEA.[29] Therefore all ecosystem services are linked to health benefits in one way or another.

Large scale studies undertaken in the Netherlands, Sweden and Japan have provided a body of evidence suggesting that the availability of accessible local greenspace and human health are directly related.[30] About three out of four UK adults agree that green spaces are important for their general health.[31]

[28] World Health Organization 1948, 1.
[29] Church et al. 2011.
[30] Vries et al. 2003.; Grahn and Stigsdotter 2003.; Takano, Nakamura, and Watanabe 2002.
[31] Kuppuswamy 2009.

An increase in accessible greenspace close to where people live is being increasingly recognised to improve people's health by providing space for physical activity.[32] This in turn helps prevent the onset of diseases such as obesity, diabetes, heart disease and strokes. The Department of Health suggests that increasing accessible open spaces could reduce healthcare costs in the UK by more than £2 billion annually.[33]

Within the scope of this assessment the effect of 'green' physical exercise (walking) on mortality rates has been quantified in monetary terms. To estimate the health benefits of physical exercise at Chimney Meadows the Health Economic Assessment Tool (HEAT) developed by the World Health Organisation (WHO) has been used.[34] The tool was designed to assess the value of reduced mortality from walking. The tool is based on several health and economic studies and its development was informed by an international expert panel.[35]

For the HEAT model, assumptions about visit counts to the site were necessary. In the absence of visitor survey data, it was assumed that the site attracted about 5,000 visits annually after BBOWT took over the management of Chimney Meadows. As mentioned before, the former landowner did not encourage public access but rather tried to restrict it. Therefore we assumed that only about 1,000 visits were made to the site each year before the management change introduced by BBOWT. These estimates were based on consultations with the site manager. We adopted these visit counts for the ASP and BAU scenario, respectively.

Because the HEAT only calculates values for certain intensity levels of walking the underlying assumption is that two-third of walking trips to the site were at the required intensity level to be suitable for a HEAT analysis. That does not mean that walking at lower intensity does not provide health benefits, but that the version of the HEAT model available at the time of this assessment could not quantify such benefits. Furthermore we assumed that 90% of walking trips to Chimney meadows are a direct result of the existence and management of the site and would not occur otherwise.

[32] Coombes, Jones, and Hillsdon 2010.
[33] pers comm., Mallika Ishwaran, Defra, 2011, cited in UK NEA 2011, 1104.
[34] 2014 version.
[35] WHO 2014.

Based on these assumptions, the HEAT results suggest that the benefit of mortality reduction due to walking has an annual value of £6,300 for the BAU scenario and £32,400 for the ASP scenario, respectively. For capitalised values see Table 2.3 below.

Table 2.3 Estimated value of health benefits due to 'green exercise'

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Total Health Benefits	£6,300	**£136,325**	£32,400	**£701,101**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

2.4 Flood Regulation

In the UK, soil cover has changed significantly due to human activity, especially within the past 50 years.[36] The increase in surface sealing, especially in urban areas but also in rural areas due to soil compaction and other land-use changes that have reduced the extent of vegetation with high infiltration capacities, has increased soil erosion as well as reducing the natural capacity of ecosystems to retain and store water. Reduced vegetation cover also generates faster water run-off rates and so promotes flooding events.[37]

Habitats and green vegetation can help to mitigate extreme weather events, and in particular the risk of flooding. Wetland and floodplain habitats fill rapidly during flooding events, at least to a point of saturation, and then slowly filter back retained water buffering surface flows. The risk of flooding to urban and rural areas is not a new concern, but the increasing use of impermeable surfaces, rural land-use changes, population rise and more extreme weather events as a likely result of climate change is raising the frequency and intensity of flooding events as well as the number of properties at risk.

The creation of ecosystems such as wetlands can reduce the volume of water run-off. Wetlands are of particular importance for flood alleviation, contributing to suppressing flood

[36] Smith et al. 2011.
[37] Ibid.

generation, as well as damage and associated costs caused by flooding, due to their role in storing water during, and buffering flows after, flooding events.[38] To calculate the flood regulation service provided by wetland habitats the model of Brander et al. (2008) has been applied for a benefit transfer. Stating the central estimate, wetland habitats in Chimney Meadows under the ASP scenario may provide flood risk regulation benefits worth £59,832 annually or £1,294,699 capitalised. This is more than half of the total flood risk regulation value provided by all assessed habitats even if the wetland habitats only represent a fraction of the total assessed habitat area on site (see Table 2.4).

Calculated values are mainly based on replacement costs (avoided damage costs), applying a benefit transfer function.[39] However, it should be noted that flood risk regulation services are very site-specific which limits the precision of applying benefit transfer approaches in this context.[40] These uncertainties should be acknowledged when interpreting the findings. For calculations see Appendix B.

Apart from wetlands, other habitats also contribute to flood risk regulation. For these habitats, findings provided by Christie et al. (2011) have been applied to calculate a monetary value (see Appendix A for details). A summary of findings is provided in Table 2.4 below. It should be noted that the flood risk regulation services provided by arable land could not be quantified which results in an underestimate of the total value in the BAU scenario. Such differences have been accounted for in the results section. Please see Chapter 4 for how the sensitivity to the quantified area in both scenarios has been tested.

Table 2.4 Estimated value of flood risk regulation benefits

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Wetland habitats[a]	£624	**£13,503**	£59,832	**£1,294,699**
Other habitats[b]	£38,229	**£827,237**	£46,208	**£999,897**
Total	£38,853	**£840,740**	£106,040	**£2,294,596**

All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%

[a)] Quantified area - BAU: 0.47 ha; ASP: 45.09 ha. Assessment is based on Brander et al. 2008

[38] Birol et al. 2007.
[39] Brander et al. 2008.
[40] Land Use Consultants and GHK Consulting 2009.

[b] Quantified area – BAU: 172.83 ha; ASP: 208.55 ha. Assessment is based on Christie et al. 2011

Source: ***Author calculations***

2.5 Water Quality Regulation

Another significant benefit provided by ecosystems, especially wetlands, is the regulation of water quality. This occurs through processes such as the retention, removal and transformation of nutrients, organic matter and sediment, bacterially-driven denitrification, nitrification and mineralisation, plant uptake and the trapping or filtering of particulates.[41] Furthermore, wetlands can capture pesticides and other complex organic pollutants.[42]

However, the UK's wetland resource, and hence its capacity to regulate water quality, has been in long-term decline. Since Roman times 90% of UK wetlands have been lost.[43] Former wetland habitats have often been drained to make the land usable for agricultural production.[44] The concentration of nitrates and phosphate in surface waters, on the other hand, has rapidly increased over the same timescale, with intensified agriculture being one of the major causes.

Within the scope of this assessment it was only possible to value the water quality regulation services of wetland habitats within Chimney Meadows, as relevant data for other habitat types was lacking or missing. Based on the benefit transfer function provided by Brander et al. 2008 (see Appendix B for calculations), water quality regulation services provided by floodplain grazing marsh, reedbeds and swamp totalling 45.09 ha were valued at £48,484 annually or £1,049,141 capitalised for the ASP scenario. In the BAU scenario only 0.5 ha of wetlands exist which were valued at £505 annually and £10,928 capitalised. The large difference in the quantified area between the scenarios does not allow direct comparison of the values in Table 2.5. This issue has been addressed in Chapter 4.

Table 2.5 Estimated value of water quality regulation benefits

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**

[41] Maltby et al. 2011.
[42] EFTEC 2010.
[43] Maltby et al. 2011.
[44] Ibid.

Total Water Quality Regulation	£505	**£10,928**	£48,484	**£1,049,141**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

2.6 Global Climate Regulation (Climate Change Mitigation)

Since the pre-industrial era global greenhouse gas (GHG) emissions due to human activity have increased to a level unprecedented in at least the last 800,000 years. These anthropocentric GHG emissions are "extremely likely" to be the dominant cause for the observed global warming since the mid-20th century.[45]

> *"…the [Stern] Review estimates that if we don't act, the overall costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever. If a wider range of risks and impacts is taken into account, the estimates of damage could rise to 20% of GDP or more."*[46]

Ecosystems play an important role in mitigating climate change and its negative impacts by sequestering and storing carbon. The photosynthetic activities of vegetation sequester carbon dioxide from the atmosphere and therefore act as a net carbon sink, especially when carbon is stored into corresponding soils.[47]

For the purpose of this assessment, only the impacts of management and land-use changes were taken into account by applying the GHG emission mitigation effects modelled for habitat and management options in environmental stewardship by the University of Hertfordshire in 2011.[48] That study accounts not only for the carbon sequestered and stored in vegetation and soils (soil organic carbon; SOC) but also GHG emissions emitted during the management of land such as tractor fuel emissions (*i.e*. whole lifecycle analysis approach).

For this assessment, only the change from the former predominantly agricultural management to BBOWT land management for conservation has been assessed, not the net

[45] IPCC 2014.
[46] Stern 2006, vi.
[47] Read et al. 2009.
[48] University of Hertfordshire 2011.

emission of GHGs for each scenario. This means that the net emission effect of the BAU scenario has been set to zero by default and only the changes to net greenhouse gas emissions due to the BBOWT management in the ASP scenario have been calculated. This approach was chosen because of the available quantification evidence and because the stock values of carbon stored in vegetation and corresponding soils are difficult to integrate into the model for methodical reasons, as this assessment is based on flow values only. It is unclear, for example, when habitats were in a long-term carbon storage equilibrium where no additional carbon can be stored.

To estimate the changes in net GHG emission due to land-use and management changes (the difference between BAU and ASP scenario) the mean net emission factors provided by the University of Hertfordshire were used.[49] Land-use/management changes between BAU and ASP scenario were identified and then the closest environmental stewardship option for which a greenhouse gas emission factor was available, allocated to work out the likely change in the emission factor.[50] The land-use changes that had the strongest impact on the emission factor at Chimney Meadows were related to the creation of 78.7 ha of species-rich, semi-natural grassland resulting in an annual net emission factor of -465.63 tonnes CO_2 equivalent per year (*i.e*. net carbon sequestration).

To quantify the value of global climate regulation services provided by the management changes at Chimney Meadows (from BAU to ASP scenario), the price of non-traded carbon (equivalent) recommended by the Department of Energy & Climate Change (DECC)[51] has been multiplied by the tonnes of CO_2 equivalent mitigated due to the land-use and management changes. For simplification, it has been assumed that these net-emission factors apply for the whole assessment period. The findings are summarised in Table 2.6. For more detailed findings see Appendix C.

[49] Ibid. Table 3.2 and Table 3.5.
[50] Please note that the emission factors developed by the University of Hertfordshire (2011) were based on common/likely scenarios with assumptions being made about the former land-use. The available data did not allows us to exactly define the change to the emissions factor depending on the former land-use. It is a simplified approach.
[51] DECC 2009.

Table 2.6 Estimated value of global climate regulation benefits

	Change from aspirational (ASP) scenario to business as usual (BAU) scenario		
	Annual net CO_2e mitigation in tonnes	Annual value	**Capitalised value**
Lowland broadleaved woodland (creation: 0.5 ha)	-7.52	£469	£31,325
Scrub (creation: 2.3 ha)	-1.62	£101	£6,744
Lowland Meadow (creation: 55.3 ha)	-327.17	£20,422	£1,363,269
Neutral GL – Other (creation: 33.0 ha)	-145.21	£9,064	£605,084
Hedgerows (creation/enhanced management: 2.9 ha)	-3.07	£191	£12,780
Total	-484.59	£30,248	**£2,019,203**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5% acknowledging increasing CO_2e values over time (DECC 2009)			

Source: ***Author calculations***

2.7 Wild Species Diversity (Biodiversity)

The term 'biodiversity' generally describes the diversity of life on earth, both between and within species. Biodiversity underpins all ecosystem services as they all, at least partially, depend on living organisms and processes.[52]

> *"…evidence shows that, in general terms, the level and stability of ecosystem services tend to improve with increasing biodiversity."*[53]

Within the framework of this investigation, a slightly narrower definition of the valuation of biodiversity has been made, relating it in particular to areas with a high diversity of species and related additional benefits to human wellbeing.

To value the ecosystem service 'wild species diversity' for woodland, findings from Hanley et al. (2002) were used for a benefit transfer. Hanley et al. (2002) valued the non-use benefits of UK woodland as habitat for species. They revealed human preferences for the existence of

[52] Norris et al. 2011, 64.
[53] Ibid.

woodland as habitat for species in general. The Willingness-To-Pay (WTP) method was used to elucidate values for woodland habitats with different attributes, expressed by focus groups.[54] This study is considered appropriate as a source for benefit transfer, even though the sample size was comparatively small and not representative of the whole population in the United Kingdom.[55] The study has also been used as a source for valuation of the social and environmental benefits provided by woodland in Great Britain as a whole.[56] For other habitats, the findings provided by Christie et al. (2011) were used for a benefit transfer to estimate the value of Chimney Meadows as habitat for species. For more details see Appendix A. All findings are summarised in Table 2.7.

Table 2.7 Estimated value of wild species diversity benefits

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Lowland broadleaved woodland *(BAU: 12.4 ha; ASP: 12.9 ha)*	£10,222	**£221,191**	£10,618	**£229,771**
Scrub *(BAU: 0.0 ha; ASP: 2.3 ha)*			£1,910	**£41,321**
Inland marsh: Floodplain GM *(BAU: 0.0 ha; ASP: 32.4 ha)*			£17,516	**£379,038**
Inland Marsh - Reedbed *(BAU: 0.5 ha; ASP: 0.5 ha)*	£198	**£4,287**	£194	**£4,189**
Inland Marsh - Swamp *(BAU: 0.0 ha; ASP: 12.2 ha)*				
Lowland Meadow *(BAU: 69.2 ha; ASP: 147.9 ha)*	£34,530	**£747,201**	£73,782	**£1,596,564**
Neutral GL - Other *(BAU: 88.8 ha; ASP: 42.7 ha)*	£15,758	**£340,976**	£7,566	**£163,718**
Hedgerows *(BAU: 2.5 ha; ASP: 2.9 ha)*	£1,183	**£25,592**	£1,398	**£30,259**
Arable *(BAU: 80.9 ha; ASP: 0.0 ha)*	£1,746	**£37,787**		
Total	£63,637	**£1,377,033**	£112,984	**£2,444,861**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

[54] Hanley et al. 2002.
[55] Willis et al. 2003, 15.
[56] Willis et al. 2003.

3. Costs

The running costs for managing the site in the ASP scenario were mainly derived from the BBOWT business plan. The business plan outlined figures for the years 2012/13 to 2015/16 and included a forecast up to the year 2017/18. Estimates for the assessment period 2023 to 2052 were made in close consultation with BBOWT staff. For the BAU scenario records were usually not available. Therefore a range of assumptions needed to be made to estimate the costs as outlined below. If not stated otherwise, then all stated costs are average annual costs for the period 2023-2052; stated in 2015 prices. Please note that only running costs were considered in this assessment. The one-off investment costs for bringing the site into the ASP scenario management were not considered.

Labour

The annual labour costs for the ASP scenario were derived from the BBOWT business plan and include staff costs (£47,700) as well as the costs of conservation trainees (£1,200) and volunteers (£1,500). The latter figures were the estimated share of costs of trainees and volunteers working across BBOWT sites that was applicable to Chimney Meadows.

For the BAU scenario, we estimated that 2 full time equivalent (FTE) jobs would be necessary to manage the site which would likely be the farmer himself and one external employee. Referring to The John Nix Farm Management Pocketbook 2016[57] these staff costs are on average £22,831 per annum resulting in total staff costs of £45,662 for the BAU scenario. Even if the farmer himself did not receive a wage, these hypothetical costs should still be accounted for considering that the farmer could work elsewhere and then have to employ two farm workers to run the farm.

Site and livestock management

Again, most management costs for the ASP scenario were based on the BBOWT business plan. Example costs include grassland and hedgerow management, weed control, fencing gates and stiles, livestock management (veterinary fees etc.), pollarding etc. Altogether these costs were estimated to be £14,930. The management costs for the BAU scenario were often estimated

[57] Redman 2015.

as a proportion of the ASP scenario costs. However, some management costs such as water management (because there was no piped water supply), pollarding and livestock management do not apply in the BAU scenario. The overall site management costs for the BAU scenario were estimated to be £3,213 and therefore considerably lower than in the ASP scenario.

Capital and equipment costs

For the ASP scenario, the capital and equipment costs were again derived from the business plan and included property and vehicle costs, depreciation, tractor maintenance and other items amounting to £34,160 annually in total. In the BAU scenario it was assumed that the property and vehicle costs would be 1.5 times as high as in the ASP scenario. This is for example because of a larger cropping area to be managed. Depreciation was based on average estimates of £125 per ha for the management of the arable (80.9 ha) and hay (46.2 ha) areas resulting in £15,886 per annum derived from the John Nix Farm Management Pocketbook 2016[58]. A similar approach was used to estimate the tractor fuel and maintenance costs which were estimated to be £13,344. Adding other costs such as tools etc. the total capital and equipment costs were estimated to be £52,155 annually.

As for the benefits, the costs for both scenarios were also capitalised over the assessment period 2023 to 2052, applying a discount rate of 1.5%. The results are summarised in Table 3.1. For a more detailed breakdown of all cost estimates see Appendix D of this report.

Table 3.1 Estimated costs

	Business as Usual (BAU) Scenario		Aspirational (ASP) Scenario	
	Annual	**Capitalised**	Annual	**Capitalised**
Labour	£45,662	**£988,076**	£50,400	**£1,090,601**
Site & Livestock Management	£3,213	**£69,533**	£14,930	**£323,069**
Capital & Equipment	£52,155	**£1,128,570**	£34,160	**£739,185**
Total	£101,030	**£2,186,179**	£99,490	**£2,152,855**
All values are stated in 2015 prices; Capitalised values are stated for the assessment period 2023-2052 applying a discount rate of 1.5%				

Source: ***Author calculations***

[58] Ibid.

4. Results

The summary Natural Capital Accounts below outline all assessed costs and benefits for both, the aspirational (ASP) and the business as usual (BAU) scenario. Table 4.1 and Table 4.2 summarise the annual values whilst the capitalised values over the whole assessment period 2023-2052 are summarised in Table 4.3 and Table 4.4, respectively.

The accounts differentiate between private and social values. The former capture costs and benefits to the owner/manager of Chimney Meadows whilst the latter include the wider external benefits to society. In conventional accounting only private costs and benefits would be accounted for. It should be noted that benefits, especially social benefits, only represent a baseline (or minimum estimate) of the real value to society, as many ecosystem services could only be partially quantified or not quantified at all. The real net-benefits are likely to be significantly higher.

When the results for the two scenarios are compared, the annual accounts (Table 4.1 and Table 4.2) reveal several interesting findings. First, both scenarios provide a total net benefit to society. Secondly, the estimated baseline annual net benefit of the ASP scenario to society (£315,143), is more than £260,000 higher than in the BAU scenario. This clearly indicates a better outcome for people. Thirdly, the ASP scenario has a Benefit-Cost Ratio (BCR) of 4.2 which means that each £1 spent on Chimney Meadows would return a benefit of £4.20 to society indicating good value for money. The BAU BCR is only 1.5. Fourthly, when only considering the private costs and benefits, neither business model would be viable, meaning that external funding or subsidies are required and justified to realise the social benefits. In the BAU scenario this would for example include single farm payment and in the ASP scenario Higher Level Stewardship.

Table 4.1 Annual benefits and costs: BAU

Business As Usual (BAU) Scenario: Annual			
	Private	Social	**Total Annual Value**
Benefits			
1 Flood Regulation		£38,853	**£38,853**
2 Food	£38,083		**£38,083**
3 Global Climate Regulation (only AMB)		£0	**£0**
4 Health (Walking)		£6,300	**£6,300**
5 Recreation & Aesthetics	£3,880	£4,408	**£8,288**
6 Water Quality Regulation		£505	**£505**
7 Wild Species Diversity		£63,637	**£63,637**
Total Benefits	£41,963	£113,703	**£155,666**
Costs			
1 Capital & Equipment	£52,155		**£52,155**
2 Labour	£45,662		**£45,662**
3 Site & Livestock Management	£3,213		**£3,213**
Total Costs	£101,030		**£101,030**
Total Net Benefits			**£54,636**
Benefit-Cost Ratio (BCR)			*1.5*

All monetary values are stated in GBP; 2015 prices

Source: ***Author calculations***

Table 4.2 Annual benefits and costs: ASP

Aspirational (ASP) Scenario: Annual			
	Private	Social	**Total Annual Value**
Benefits			
1 Flood Regulation		£106,040	**£106,040**
2 Food	£20,825		**£20,825**
3 Global Climate Regulation (change only)		£30,248	**£30,248**
4 Health (Walking)		£32,400	**£32,400**
5 Recreation & Aesthetics	£500	£63,152	**£63,652**
6 Water Quality Regulation		£48,484	**£48,484**
7 Wild Species Diversity		£112,984	**£112,984**
Total Benefits	£21,325	£393,308	**£414,633**
Costs			
1 Capital & Equipment	£34,160		**£34,160**
2 Labour	£50,400		**£50,400**
3 Site & Livestock Management	£14,930		**£14,930**
Total Costs	£99,490		**£99,490**
Total Net Benefits			**£315,143**
Benefit-Cost Ratio (BCR)			*4.2*

All monetary values are stated in GBP; 2015 prices

Source: ***Author calculations***

The differences between the two scenarios become even clearer when looking at the capitalised figures in Table 4.3 (BAU) and Table 4.4 (ASP). Over the total assessment period 2023-2052 the ASP scenario under BBOWT management is estimated to provide a baseline net-benefit of more than £8.18 million to society; £7 million more than in the BAU scenario.[59]

This basically means that any funding/subsidy amount below £7 million to realise the transition into the ASP state and the ongoing management of the site could be justified and would still provide a positive return on investment. One may also note that the BCR for the ASP scenario is higher when capitalised (Table 4.2) as it is in the annual account (Table 4.4). This is because the value of carbon increases over time. The increasing value (£70.61 per tCO_2e

[59] This assessment applies a discount rate of 1.5% to calculate capitalised values (see Section 1.4 for more information). For reference and to provide full transparency the assessment was also re-run applying a discount rate of 3.5% as recommended by HM Treasury. This assessment can be found in Appendix E.

in 2023 to £239.75 per tCO_2e in 2052) has been implemented in the capitalised account whilst for the annual account the value of £62.42 per tCO2e in 2015 has been applied.[60]

Table 4.3 **Capitalised benefits and costs: BAU**

Business As Usual (BAU) Scenario: Capitalised			
	Private	Social	**Total Capitalised Value**
Benefits			
1 Flood Regulation		£840,740	**£840,740**
2 Food	£824,081		**£824,081**
3 Global Climate Regulation (only AMB)		£0	**£0**
4 Health (Walking)		£136,325	**£136,325**
5 Recreation & Aesthetics	£83,959	£95,378	**£179,337**
6 Water Quality Regulation		£10,928	**£10,928**
7 Wild Species Diversity		£1,377,033	**£1,377,033**
Total Benefits	£908,040	£2,460,405	**£3,368,445**
Costs			
1 Capital & Equipment	£1,128,570		**£1,128,570**
2 Labour	£988,076		**£988,076**
3 Site & Livestock Management	£69,533		**£69,533**
Total Costs	£2,186,179		**£2,186,179**
Total Net Benefits			**£1,182,266**
Benefit-Cost Ratio (BCR)			*1.5*

All monetary values are stated in GBP; 2015 prices
Values are capitalised over 30 years for the period 2023-2052 applying a discount rate of 1.5%

Source: ***Author calculations***

[60] DECC 2009.

Table 4.4 Capitalised benefits and costs: ASP

Aspirational (ASP) Scenario: Capitalised			
	Private	Social	**Total Capitalised Value**
Benefits			
1 Flood Regulation		£2,294,596	**£2,294,596**
2 Food	£450,630		**£450,630**
3 Global Climate Regulation (change only)		£2,019,203	**£2,019,203**
4 Health (Walking)		£701,101	**£701,101**
5 Recreation & Aesthetics	£10,819	£1,366,538	**£1,377,357**
6 Water Quality Regulation		£1,049,141	**£1,049,141**
7 Wild Species Diversity		£2,444,861	**£2,444,861**
Total Benefits	£461,450	£9,875,439	**£10,336,889**
Costs			
1 Capital & Equipment	£739,185		**£739,185**
2 Labour	£1,090,601		**£1,090,601**
3 Site & Livestock Management	£323,069		**£323,069**
Total Costs	£2,152,855		**£2,152,855**
Total Net Benefits			**£8,184,034**
Benefit-Cost Ratio (BCR)			*4.8*

All monetary values are stated in GBP; 2015 prices
Values are capitalised over 30 years for the period 2023-2052 applying a discount rate of 1.5%

Source: ***Author calculations***

It should be noted that there is a small difference between the quantified area for both scenarios. This is mainly because some services could not be quantified for arable land because of a lack of evidence. Multiplying the area quantified for each ecosystem service results in an area of 1,140.1 ha (BAU) and 1,252.3 ha (ASP), respectively. However, when adjusting for this difference by dividing the BAU benefits by 1,140.1 and then multiplying by 1,252.3 the change is only marginal and has no effect on the overall direction and magnitude of the results. In that case the annual net-benefits of the BAU scenario would be £69,916 (BCR: 1.7) which is still way below the annual net-benefits of the ASP scenario of £315,143 (BCR: 4.2). Also, if quantifiable then the water quality regulation of agricultural land in the BAU scenario would probably result in a disbenefit rather than a benefit e.g. because of diffuse pollution which is why the £69,916 could well be overestimating the benefits.

5. Conclusions & Recommendations

Overall one can conclude from the assessment that the aspirational (ASP) scenario for Chimney Meadows developed by the Berks, Bucks & Oxon Wildlife Trust (BBOWT) provides a much higher benefit to society than the business as usual (BAU) scenario which basically assumes that the site would have remained in mainly agricultural management under the former owner. The expected net-benefits to society of almost £8.2 million under the ASP scenario over the assessment period 2023-2052 would justify significant public funding and investment into the transition and management of the site, even if not all intended benefits could be achieved.

Notably, the ASP scenario which provides considerably higher net-benefits to society than the BAU scenario also has higher net-costs than the BAU scenario when only private benefits are taken into account (see Table 5.1). This shows that there is a certain trade-off between maximising social and private benefits. It also reveals the limitation of conventional accounts in which only private costs and benefits are accounted for when assessing projects with significant environmental/social impact. Therefore, environmental subsidies and related regulations can be well justified when accounting for the real value of projects including social benefits.

Table 5.1 Capitalised private benefits and costs

	BAU		ASP	
	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Sum of Benefits	£41,963	£908,040	£21,325	£461,450
Sum of Costs	£101,030	£2,186,179	£99,490	£2,152,855
Net-Benefits	**-£59,067**	**-£1,278,139**	**-£78,165**	**-£1,691,406**
Benefit-Cost Ratio	0.4	0.4	0.2	0.2

Source: ***Author calculations***

It should also be acknowledged that many ecosystem services benefits due to the new BBOWT management are already realised. The timescale 2023-2052 has been chosen mainly because of biodiversity considerations assuming that the main biodiversity benefits are realised by the assessment timescale.

We would recommend the expansion of this approach to other BBOWT managed sites to reveal what BBOWT contributes to society and people's wellbeing which could be used to promote the valuable work of BBOWT to members, funders, stakeholders and the interested public. Another feasible project, potentially in partnership with local authorities and other relevant stakeholders, could be to establish an Ecosystem Assessment[61] for the whole and/or parts of Berkshire, Buckinghamshire and Oxfordshire to make the value of nature and the services it provides more visible and tangible to local decision-makers, relevant Local Enterprise Partnerships (LEPs), health authorities and other organisations and individuals with a stake in the local environment.

[61] See for example the Marches Ecosystem Assessment 2016: http://ceep-online.co.uk/index.php/projects-a-publications/95-marches-ecosystem-assessment

6. Abbreviations

ASP	Aspirational (scenario)
BAU	Business As Usual (scenario)
BBOWT	Berks, Bucks and Oxon Wildlife Trust
BCR	Benefit-Cost Ratio
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
DECC	Department of Energy & Climate Change
FTE	Full Time Equivalent (job)
GHG	Greenhouse Gas
GWCT	Game and Wildlife Conservation Trust
HEAT	Health Economic Assessment Tool
LEP	Local Enterprise Partnership
NEAFO	National Ecosystem Assessment Follow-On
SOC	Soil Organic Carbon
SSSI	Site(s) of Special Scientific Interest
t	Tonnes
UK NEA	UK National Ecosystem Assessment
WHO	World Health Organisation
WTP	Willingness-To-Pay

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Appendices

A. Methods & Calculations: Habitats of Principal Importance

To calculate ecosystem services values provided by habitats of principal importance (formerly 'Biodiversity Action Plan (BAP) priority habitats') the findings of the study *"The Economic Valuation of the Ecosystem Service Benefits delivered by the UK Biodiversity Action Plan"*[62] have been recalculated for the purpose of this investigation. It should be noted that the list of habitats of principal importance was revised after that study was undertaken and therefore not all current habitat types of principal importance were included. On the other hand, improved grassland which is not classified as a habitat of principal importance was included in the study.

The aim of that primary valuation study was to estimate the value of changes in biodiversity and associated ecosystem services which result directly from the delivery of the UK Biodiversity Action Plan (UK BAP). Specific objectives were to assess the marginal value of ecosystem services per habitat associated with the UK BAP and the marginal value of conservation activities associated with different scenarios.

In the original primary valuation study values were calculated in two steps. The first step entailed a choice experiment to determine the values people place on ecosystem services delivered by UK BAP habitats. Choice experiments are surveys that present people with different policy scenarios, where scenarios are described in terms of different environmental characteristics and different 'prices'. Analysis of people's choices for these scenarios reveals values associated with the different preferences or choices. The second step entailed a weighting matrix evaluating the proportion of ecosystem service provision related to habitat and ecosystem service (group). Experts were asked to identify the relative levels of ecosystems services delivered by the habitats with which they were most familiar across 19 UK BAP habitats. These results were then pooled. Experts were also asked to identify the proportion of ecosystem service values that were directly attributed to UK BAP conservation activities.

[62] Christie et al. 2011.

The primary outcome was the marginal change of ecosystem services provided by different UK BAP priority habitats in relation to different scenarios.[63]

Although the data warrant some caveats, it has been judged sufficiently robust to inform this investigation. The study results have been applied in cases where no other robust primary valuation data was available. For the purpose of this investigation the total ecosystem services value rather than the value of management/conversation interventions was needed. Therefore the values for a marginal change in conservation activities needed to be recalculated. Fortunately the available data allowed this step. Below I outline the calculation using the example of wild food provided by native woodland. The following paragraphs should be read in line with Christie et al. (2011).

In the first step, marginal change from scenario D (UK with BAP, but no further spending) to scenario A (full delivery of the UK BAP) has been calculated by adding the values from Table C30 and C31.[64] In the second step, the non-marginal WTP associated with scenario D has been calculated. The marginal value from above has been divided by the weighting score (Table C26) for 'additional service due to BAP' and then multiplied by the 'services without BAP'. In the next step the average value of the current level of ecosystem services provided by UK BAP priority habitats has been calculated by adding up the WTP associated with scenario D and the marginal value for the current spent scenario (change from scenario D to C; Table C31). In a last step the average value per hectare was calculated by dividing the total value by area of habitat from Table C56.

However, just applying average per-hectare values is not always the best solution. Additional assumptions have therefore been made for each ecosystem service. The calculations and main assumptions are summarised below for each ecosystem service assessed.

Cultural Services

In the Christie et al. (2011) study the category 'sense of place' captures all cultural services such as aesthetic, spiritual, educational and recreational benefits. Wild species diversity which can also be categorised as a 'cultural service' is not included. Here, assuming a direct

[63] Ibid., 11.
[64] Tables with the 'C' refer to tables in Christie et al. (2011)

relationship between the area of habitat and value would bias outcomes because cultural values are strongly related to the number of people who can benefit from such services.[65] To take this factor into account the average value per hectare has been adjusted by population density.

In the absence of alternatives, the average value per hectare has been divided by the average population density per km^2 in the UK (263.0/km^2) and then multiplied by the average population density in Oxfordshire (251.4/km^2). However, this approach has only been applied for the value 'within own region'. For the WTP stated for 'outside own region' it was assumed that this value is more related to non-use values and therefore not related to population density. Therefore the average value per hectare has been applied for the latter. The underlying assumption is that the proportion of BAP Priority Habitats in Chimney Meadows in favourable condition is similar to the UK average. Even if the proportion in favourable condition in Chimney Meadows in favourable condition may be higher it was not possible to adjust for such differences. The findings are summarised in Section 2.2 with a more detailed breakdown provided in Appendix D.

Wild Species Diversity

The quantification of services flowing from wild species diversity is often inadequate due to limited data and scientific evidence.[66] Furthermore some valuation approaches are considered controversial.[67] Nevertheless, some authors calculate values for 'wild species diversity' and often refer to 'biodiversity' or 'habitat for species'. When they do so, they often refer to the occurrence of charismatic species. This usually reflects a non-use value of preferences for the pure existence of a species without using (watching/experiencing) them. This approach requires true altruism and its quantification is therefore considered controversial; assigning absolute values also raises theoretical problems. Additionally,

[65] See also Church et al. 2011.
[66] Norris et al. 2011, 65.
[67] UK NEA 2011, 1186.

overlaps with use-values can occur.[68] However, human preferences for the pure existence and survival of species can also be explained by option-use values[69] or bequest values[70].

Some authors calculate values explicitly for 'biodiversity' or 'wild species diversity'. Therefore, we adopt this category but findings should be interpreted with care. Within this exercise we tried to rule out overlaps with services like recreation and aesthetic appreciation as far as possible.

For quantifying wild species diversity, findings from Christie et al. (2011) have been used. Christie et al. (2011) made a distinction between 'charismatic species' and 'non-charismatic species'. The former include terrestrial mammals, birds, amphibians, reptiles, butterflies, and moths. The latter incorporates vascular plants, non-vascular plants, terrestrial invertebrates (excluding butterflies and moths), and fungi (including lichens).[71] Not surprisingly the average WTP for charismatic species is significantly higher than for non-charismatic species. To maintain consistency within this investigation the two categories have been combined as 'wild species diversity'. In the absence of alternatives, an assumption has been made that this ecosystem service relates directly to the area of habitat. The findings are summarised in Section 2.7, with a more detailed breakdown provided in Appendix D.

It should be noted that because these are non-use values, people often have problems in expressing their own preferences.[72] Such values are abstract and sometimes hard to grasp for non-specialists. Also, the WTP for this form of ecosystem service is a very small fraction of income which often leads to a comparatively wide variation of expressed values. Furthermore, the form of moderation of focus groups and the information provided about the habitats can have a strong influence on the expressed WTP.

Flood regulation

A direct link between the area of habitat and the provision of flood risk regulation services has been assumed in Christie et al. (2011). Within the Christie et al. (2011) study 'water regulation'

[68] Ibid.
[69] You might never see a whale in nature, but you can benefit from the ability to see whales in the future.
[70] You might never see a whale in nature, but you can benefit from the ability of coming generations to see whales in the future.
[71] Christie et al. 2011, 131.
[72] See also Saraev 2012.

stands for the ecosystem service 'flood regulation' as defined in this investigation. The ecosystem services water quality regulation and water provision are not covered within this category.[73]

For the purpose of this calculation the WTP 'within own region' and 'outside own region' has been applied as distant areas could also benefit, for example when water levels of downstream rivers are reduced. Flood risk regulation values were available for a range of habitat types (see below). It should be noted that the value for lowland meadows has also been applied to other neutral grassland habitats as these are likely to perform similarly in terms of flood risk regulation benefits. Findings are summarised in Section 2.4. For a more detailed breakdown see Appendix D.

[73] Christie et al. 2011, 126.

B. Methods & Calculations: Wetland Benefits

To calculate the benefits provided by wetlands in Chimney Meadows a benefit transfer function created by Brander et al. (2008) has been used. They established a meta-analysis function utilising 78 European studies. It is acknowledged that this introduces uncertainties as it is based on a coarse assessment of several services. However, more precise methods on a service-by-service basis are lacking. For this reason, the same value transfer function was also applied for the UK National Ecosystem Assessment:

> *"A review of recent meta-analyses of wetland valuation concludes that Brander et al. (2008) provide the most appropriate benefit transfer function for the UK case."*[74]

The valuation techniques involved in the studies included by Brander et al. (2008) are hedonic pricing, the travel cost method, contingent valuation, choice experiments, market prices, net factor incomes, production functions, replacement costs and opportunity costs.[75]

The Brander et al. (2008) value transfer function allows different socio-economic variables and context-specific attributes to be taken into account. Table A.1 below outlines how the Brander et al. (2008) benefit transfer function has been applied for the ASP scenario for Chimney Meadows. Assessing the BAU scenario followed similar methods. The underlying assumptions and variables are also explained in the comments section of this table.

[74] Hulme and Siriwardena 2010, 7.
[75] EFTEC 2010, 125.

Table A.1 Value Function and Corresponding Assumptions

Variable	Coefficient value	Value of explanatory variable	Comment
Constant a	-3.078	1	
Wetland type: Inland marsh	0.114	1	
Wetland size:	-0.297	*ln* 11.3	Average size of wetland sites
Flood risk reduction and storm buffering:	1.102	1	These services are occurring independently from accessibility of the site.
Water quality improvement:	0.893	1	
Surface and ground water supply:	0.009	1	
Biodiversity:	0.917	0/1	These services only occur if the wetland site is accessible. Therefore the variable has only been applied for accessible sites. Note that recreational fishing has a negative influence on the total value.
Recreational fishing:	-0.288	0/1	
Non-consumptive recreation:	0.340	0/1	
Amenity and aesthetic services:	0.452	0/1	
GDP per capita (2003 US$):	0.468	*ln* 45,881	GDP is approximated from the Oxfordshire level with €40,100 (in 2003, real prices, NUTS 2 level, source: Eurostat). Converted to 2003 US$ using OECD purchasing power parity (PPP) exchange rates. This resulted in US$45,881.
Population density per km^2 within 50 km:	0.579	*ln* 251	Simplifying the population density of Oxfordshire of 251/km^2 for Oxfordshire has been used.
Wetland area within 50 km:	-0.023	*ln* 3,000	Considering the marginal influence on the result it has conservatively been allowed a generous wetland area of 3,000 ha within 50 km radius of each wetland site.

Source: ***Brander et al (2008) and author assumptions/calculations.***

Applying the benefit function for inland marsh, both for accessible as well as inaccessible areas, the annual value of the ecosystem services of flood regulation, water supply, water quality regulation as well as recreation, aesthetic appreciation and biodiversity provided by wetland on Chimney Meadows has been calculated. In the next step, the value attributable to each ecosystem service can be approximated. This step is not necessary but has been chosen to maintain consistency within this study. By setting every variable standing for an ecosystem service to zero and viewing the difference in the sum, an estimate can be made of the value

attributable for each ecosystem service.[76] The findings are summarised in the relevant sections of Chapter 2 with more detailed breakdowns provided in Appendix D.

[76] The negative influence of recreational fishing has been distributed equally to recreation, amenity and biodiversity.

C. Detailed Findings: Global Climate Regulation

Below you can find a detailed assessment of how the value of greenhouse gas emission mitigations were calculated for each assessed land-use. Please read in line with Section 2.6 of this report.

Land-Use Change

Land-Use	Area (ha)			Closest ELS/HLS Scenario	Mean CO2e emissions (tCO2e/unit/year)	Applicable Area (ha)	Total Annual CO2e Impact	Total Capitalised CO2e Impact	Annual Value (2015 Prices)	Capitalised Value (2015 Prices)
	BAU	ASP	Change							
Hedgerows	2.45	2.89	0.45	UB14 - Hedgerow restoration - gapping up	-1.83	0.45	-0.82	-24.49	£51	£3,402
Neutral GL - other	0.00	1.79	1.79	EK3 - Permanent grassland with very low inputs	-0.70	1.79	-1.25	-37.49	£78	£5,207
Neutral GL - other	0.00	2.47	2.47	EK3 - Permanent grassland with very low inputs	-0.70	2.47	-1.73	-51.95	£108	£7,215
30% Scrub	0.00	2.31	2.31	EK3 - Permanent grassland with very low inputs	-0.70	2.31	-1.62	-48.55	£101	£6,744
70% Neutral GL - other	0.00	5.39	5.39	EK3 - Permanent grassland with very low inputs	-0.70	5.39	-3.78	-113.29	£236	£15,735
Neutral GL - Other	0.00	23.39	23.39	HK8 - Creation of species-rich, semi-natural grassland	-5.92	23.39	-138.46	-4153.67	£8,642	£576,927
Neutral GL - Lowland Meadow	69.19	124.46	55.26	HK8 - Creation of species-rich, semi-natural grassland	-5.92	55.26	-327.17	-9815.06	£20,422	£1,363,269
Lowland broadleaved woodland	12.38	12.86	0.48	HC10 - Creation of woodland outside the LFA	-15.66	0.48	-7.52	-225.53	£469	£31,325

Improved Land-Use Management

Land-Use	Area (ha)			Closest ELS/HLS Scenario	Mean CO2e emissions (tCO2e/unit/year)	Applicable Area (ha)	Total Annual CO2e Impact	Total Capitalised CO2e Impact	Annual Value (2015 Prices)	Capitalised Value (2015 Prices)
	BAU	ASP	Remain							
Hedgerows	2.45	2.89	2.45	EB3 - Enhanced hedgerow management	-0.92	2.45	-2.25	-67.52	£140	£9,378

D. Detailed Value Breakdown Including Comments for Benefits and Costs

Category		Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
	Land-use	BAU	ASP	Change	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Benefits																
Food	Hay sales incl. hay produced for other BBOWT sites	41.24	124.46	83.22	*Based on £30 per acre valued as standing crop*	*P*	*41.24*	*Species-rich grassland - hay. Assuming that only the NNR area has been used for hay production*	*£3,056*	*£66,126*	*Business Plan*	P	*124.46*	*Species-rich grassland - hay*	*£10,700*	*£231,536*
	Livestock sales incl. production for other BBOWT sites	0.00	100.58	100.58	*N/A (unlikely that the farmer had own livestock - only let for grazing)*	*P*	*0.00*		*£0*	*£0*	*15 calves @£300/head + 65 lambs @£45/head + 25 lambs for meat box @£60/head*	P	*100.58*	*Overlay with hay as grazed after hay is harvested*	*£8,925*	*£193,127*
	Grazing (let for external livestock)	104.38	147.27	42.89	*169 cows x 26 weeks x £1/week*	*P*	*104.38*		*£4,394*	*£95,081*	*Business Plan*	P	*147.27*	*Overlay with hay as grazed after hay is harvested*	*£1,200*	*£25,967*
	Farming	78.45	0.00	-78.45	*BAU Cropping Summary. The assumption underlies that in the BAU scenario all mapped arable land (incl. set-aside etc.) will be managed for food production.*	*P*		*Based on total arable area (excl. game cover crops)*	*£30,633*	*£662,874*	*N/A*	P			*£0*	*£0*
	Total All	**224.07**	**372.31**	148.24			372.31	Area adjusted to ASP because no other benefits identified.	£38,083	£824,081			372.31		£20,825	£450,630
	Total Private	224.07	372.31	148.24			372.31		£38,083	£824,081			372.31		£20,825	£450,630

Category		Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
	Land-use	BAU	ASP	Change	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Benefits																
Recreation & Aesthetics (incl. Game Bird Shoot)	Lowland broadleaved woodland	12.38	12.86	0.48	Christie et al. 2011	S	2.62	Incl. aesthetics etc.; Assumption: 50% of benefit because of access restrictions etc.	£392	£8,486	Christie et al. 2011	S	4.25		£1,271	£27,499
	Scrub	0.00	2.31	2.31			0.00		£0	£0	Christie et al. 2011	S	1.33		£399	£8,626
	Inland marsh: Floodplain GM	0.00	32.42	32.42			0.00			£0	Brander et at. 2008	S	4.50		£27,179	£588,129
	Inland Marsh - Reedbed	0.48	0.47	-0.01			0.00			£0			0.00			£0
	Inland Marsh - Swamp	0.00	12.20	12.20			0.00			£0	Brander et at. 2008	S	3.59		£21,675	£469,030
	Lowland Meadow	69.19	124.46	55.26	Christie et al. 2011	S	12.41	Assumption: 50% of benefit because of access restrictions etc.	£1,262	£27,302	Christie et al. 2011	S	31.67		£6,442	£139,394
	Neutral GL - Other	88.82	66.03	-22.79	Christie et al. 2011	S	26.39	Assumption: 50% of benefit because of access restrictions etc.	£2,684	£58,070	Christie et al. 2011	S	28.16		£5,728	£123,949
	Hedgerows	2.45	2.89	0.45	Christie et al. 2011	S	0.36	Assumption: 50% of benefit because of access restrictions etc.	£70	£1,521	Christie et al. 2011	S	1.17		£458	£9,913
	Whole site				Game & Wildlife Conservation Trust	P		Net-income from game stoot; incl. deer. Area difficult to define as whole site contributes...	£3,880	£83,959	Game & Wildlife Conservation Trust. Included as per email from 21st Oct	P		Deer only; not directly related to game shoot cover. Area difficult to define as whole	£500	£10,819
	Total All	**173.32**	**253.65**	80.33			74.67	Area adjusted to ASP because no other benefits identified.	£8,288	£179,337			74.67		£63,652	£1,377,357
	Total Private						0.00		£3,880	£83,959			0.00		£500	£10,819

Category		Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
	Land-use	BAU	ASP	Change	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Benefits																
Health Benefits	Total walking			0.48	HEAT; based on 1,000 trips; 67% at right intensity; 90% directly related to GI	S	74.67	Area based on 50m buffer around paths in AMB because inaccessible areas in BAU provide £0 benefit	£6,300	£136,325	HEAT; based on 5,000 trips; 67% at right intensity; 90% directly related to GI	S	74.67	Area based on 50m buffer around paths.	£32,400	£701,101
	Total All	**0.00**	**0.00**	0.00			74.67	Area adjusted to ASP because no other benefits identified.	£6,300	£136,325			74.67		£32,400	£701,101
	Total Private	0.00	0.00	0.00			0.00		£0	£0			0.00		£0	£0
Flood Regulation	Lowland broadleaved woodland	12.38	12.86	0.48	Christie et al. 2011	S	12.38		£6,594	£142,694	Christie et al. 2011	S	12.86		£6,850	£148,229
	Scrub	0.00	2.31	2.31			0.00		£0	£0	Christie et al. 2011	S	2.31		£1,232	£26,657
	Inland marsh: Floodplain GM	0.00	32.42	32.42			0.00		£0	£0	Brander et al. 2008	S	32.42		£43,019	£930,884
	Inland Marsh - Reedbed	0.48	0.47	-0.01	Brander et al. 2008	S	0.47		£624	£13,503	Brander et al. 2008	S	0.47		£624	£13,503
	Inland Marsh - Swamp	0.00	12.20	12.20			0.00		£0	£0	Brander et al. 2008	S	12.20		£16,189	£350,312
	Lowland Meadow	69.19	124.46	55.26	Christie et al. 2011	S	69.19		£13,642	£295,197	Christie et al. 2011	S	124.46		£24,538	£530,976
	Neutral GL - Other	88.82	66.03	-22.79	Christie et al. 2011	S	88.82		£17,512	£378,934	Christie et al. 2011	S	66.03		£13,019	£281,724
	Hedgerows	2.45	2.89	0.45	Christie et al. 2011	S	2.45		£481	£10,412	Christie et al. 2011	S	2.89		£569	£12,311
	Arable	80.85	0.00	-80.85						£0						£0
	Total All	**254.16**	**253.65**	-0.52			173.31		£38,853	£840,740			253.65	£999,897	£106,040	£2,294,596
	Total Private						0.00		£0	£0			0.00		£0	£0
Water Quality Regulation	Lowland broadleaved woodland	12.38	12.86	0.48						£0						£0
	Scrub	0.00	2.31	2.31						£0						£0
	Inland marsh: Floodplain GM	0.00	32.42	32.42			0.00			£0	Brander et al. 2008	S	32.42		£34,861	£754,354
	Inland Marsh - Reedbed	0.48	0.47	-0.01	Brander et al. 2008	S	0.48		£505	£10,928	Brander et al. 2008	S	0.47		£505	£10,928
	Inland Marsh - Swamp	0.00	12.20	12.20			0.00			£0	Brander et al. 2008	S	12.20		£13,118	£283,859
	Lowland Meadow	69.19	124.46	55.26						£0						£0
	Neutral GL - Other	88.82	66.03	-22.79						£0						£0
	Hedgerows	2.45	2.89	0.45						£0						£0
	Arable	80.85	0.00	-80.85						£0						£0
	Total All	**254.16**	**253.65**	-0.52			0.48		£505	£10,928			45.09		£48,484	£1,049,141
	Total Private						0.00		£0	£0			0.00		£0	£0

Category	Land-use	Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
		BAU	ASP	Change	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on...	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Benefits																
Global Climate Regulation	Lowland broadleaved woodland	12.38	12.86	0.48		S	12.86	Only change has been analysed so BAU is set to '0'. Quantified area matches AMB.		£0	University of Hertfordshire 2007/11	S	12.86		£469	£31,325
	Scrub	0.00	2.31	2.31		S	2.31			£0		S	2.31		£101	£6,744
	Inland marsh: Floodplain GM	0.00	32.42	32.42		S	32.42			£0		S	32.42		£0	£0
	Inland Marsh - Reedbed	0.48	0.47	-0.01		S	0.47			£0		S	0.47		£0	£0
	Inland Marsh - Swamp	0.00	12.20	12.20		S	12.20			£0		S	12.20		£0	£0
	Lowland Meadow	69.19	124.46	55.26		S	124.46			£0		S	124.46		£20,422	£1,363,269
	Neutral GL - Other	88.82	66.03	-22.79		S	2.89			£0		S	2.89		£9,064	£605,084
	Hedgerows	2.45	2.89	0.45		S	2.89			£0		S	2.89		£191	£12,780
	Arable	80.85	0.00	-80.85			0.00			£0			0.00		£0	£0
	Total All	**254.16**	**253.65**	-0.52			190.50		£0	£0			190.50		£30,248	£2,019,203
	Total Private						0.00		£0	£0			0.00		£0	£0
Wild Species Diversity	Lowland broadleaved woodland	12.38	12.86	0.48	Hanley et al. 2002	S	12.38		£10,222	£221,191	Hanley et al. 2002	S	12.86		£10,618	£229,771
	Scrub	0.00	2.31	2.31			0.00				Hanley et al. 2002	S	2.31		£1,910	£41,321
	Inland marsh: Floodplain GM	0.00	32.42	32.42			0.00				Christie et al. 2011	S	32.42		£17,516	£379,038
	Inland Marsh - Reedbed	0.48	0.47	-0.01	Christie et al. 2011	S	0.48		£198	£4,287	Christie et al. 2011	S	0.47		£194	£4,189
	Inland Marsh - Swamp	0.00	12.20	12.20			0.00									
	Lowland Meadow	69.19	147.85	78.65	Christie et al. 2011	S	69.19		£34,530	£747,201	Christie et al. 2011	S	147.85	For wild species diversity only 'species rich neutral grassland - pasture' is treated as	£73,782	£1,596,564
	Neutral GL - Other	88.82	42.65	-46.17	Christie et al. 2011	S	88.82		£15,758	£340,976	Christie et al. 2011	S	42.65		£7,566	£163,718
	Hedgerows	2.45	2.89	0.45	Christie et al. 2011	S	2.45		£1,183	£25,592	Christie et al. 2011	S	2.89		£1,398	£30,259
	Arable	80.85	0.00	-80.85	Christie et al. 2011	S	80.85		£1,746	£37,787			0.00			
	Total All	**254.16**	**253.65**	-0.52			254.16		£63,637	£1,377,033			241.45		£112,984	£2,444,861
	Total Private						0.00		£0	£0			0.00		£0	£0
SUM OF TOTAL BENEFITS: ALL							**1140.10**		**£155,666**	**£3,368,445**			**1252.34**		£414,633	£10,336,889
SUM OF TOTAL BENEFITS: PRIVATE ONLY							372.31		£41,963	£908,040			372.31		£21,325	£461,450

Category		Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
	Land-use	BAU	ASP	Change	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Costs																
Labour	Staff				Assuming 2 FTE jobs (incl. hypothetical for farmer family). Average FTE costs of 22,831 as per John Nix Pocket Book	P			£45,662	£988,076	Business Plan	P			£47,700	£1,032,176
	Conservation trainee costs - share of county approx				N/A	P			£0	£0	Business Plan	P			£1,200	£25,967
	Volunteer costs - share of county approx				N/A	P			£0	£0	Business Plan	P			£1,500	£32,458
	Total								£45,662	£988,076					£50,400	£1,090,601
Site & Livestock Management	Water Management				N/A	P			£0	£0	Business Plan	P			£560	£12,118
	Bird food				N/A	P			£0	£0	Business Plan	P			£170	£3,679
	Pollarding					P			£0	£0	Business Plan	P			£800	£17,311
	Grassland management				Assuming average per-ha AMB costs apply 10 ha of cut neutral GL.	P		Varable costs of hay is already included in benefit calculation	£445	£9,623	Business Plan	P		About 132 ha (cut and hay areas)	£5,900	£127,670
	Hedgerow Management				Assuming same per-ha costs as benefits are also per-ha	P			£1,269	£27,452	Business Plan	P			£1,500	£32,458
	Livestock management				N/A	P		Only grazing rental	£0	£0	Business Plan	P			£1,240	£26,832
	Tree Safety				N/A	P			£0	£0	Business Plan	P			£550	£11,901
	Fencing Gates & Stiles				Lower than AMB because excludes arable areas	P			£1,000	£21,639	Business Plan	P			£1,680	£36,353
	Weed Control				BBOWT estimate	P		Only for grassed areas as arable weed control is already included in variable costs of benefit (gross margin). The assumption is that weed control would be conducted by staff so only pesdicide costs.	£500	£10,819	Business Plan	P			£1,680	£36,353
	Livestock Vet				N/A	P		No own livestock	£0	£0	Business Plan	P			£400	£8,656
	Livestock Feed				N/A	P		No own livestock	£0	£0	Business Plan	P			£200	£4,328
	Fallen Stock				N/A	P		No own livestock	£0	£0	Business Plan	P			£250	£5,410
	Total								£3,213	£69,533					£14,930	£323,069

Category		Area (ha)			Business as Usual (BAU) Scenario						Aspirational (ASP) Scenario					
	Land-use	BAU	ASP	Change	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)	Based on…	Private / Social	Area Quantified	Comments	Annual Value (Real, 2015 prices)	Capitalised Value 2023-2052 (2015 Prices)
Costs																
Capital & Equipment	Property and vehicle costs				Assuming 1.5 times the AMB scenario in absense of data	P		Likely to be more than AMB. Farmer's house not within assessment scope.	£21,750	£470,646	Business Plan	P			£14,500	£313,764
	Depreciation				Based on John Nix Pocketbook estimate of £125 per ha for arable (80.85 ha) + NNR species rich hay in management (46.24 ha)	P		Only applied for arable and NNR hay land as rest is rented out.	£15,886	£343,749	Business Plan	P		Excl. solar panels	£12,595	£272,542
	Car parks and vehicular tracks				N/A	P			£0	£0	Business Plan	P			£1,120	£24,236
	Fuel tractor				Based on John Nix Pocketbook estimate of approx. 50% of £105 per ha for arable (80.85 ha) + NNR species rich hay (46.24 ha; area in hay management).	P		Only applied to arable land and NNR hay as other areas are rented out. Includes all machinery.	£6,672	£144,374	Business Plan	P			£1,680	£36,353
	Tractor Maintenance				Based on John Nix Pocketbook estimate of approx. 50% of £105 per ha for arable (80.85 ha) + NNR species rich hay (46.24 ha; area in hay management).	P		Only applied to arable land and NNR hay as other areas are rented out. Includes all machinery.	£6,672	£144,374	Business Plan	P			£3,090	£66,864
	Equipment & Tools				Assumption: same as AMB	P			£515	£11,144	Business Plan	P			£515	£11,144
	Personal protective equipment				Assumption: same as AMB	P			£100	£2,164	Business Plan	P			£100	£2,164
	Equipment maintenance				Assuming similair in absense of data	P			£560	£12,118	Business Plan	P			£560	£12,118
	Total								£52,155	£1,128,570					£34,160	£739,185
SUM OF TOTAL COSTS: All=Private									**£101,030**	**£2,186,179**					**£99,490**	**£2,152,855**

E. Capitalised Findings Applying the HM Treasury Discount Rate

The main assessment of this report is based on a discount rate of 1.5% for future benefits and costs which is different from the HM Treasury recommendation of applying a discount rate of 3.5% for assessments of up to 30 years (see Section 1.4 for a justification of applying the 1.5%).

To provide as much transparency as possible and also to allow better comparison with other assessments applying the HM Treasury discount rate we re-ran the assessment here for reference only. Below you can find the assessment findings applying the alternative discount rate of 3.5% as recommended by HM Treasury.[77]

Table A.2 Capitalised benefits and costs applying the HM Treasury discount rate: BAU

Business As Usual (BAU) Scenario: Capitalised			
	Private	Social	**Total Capitalised Value**
Benefits			
1 Flood Regulation		£563,263	**£563,263**
2 Food	£552,102		**£552,102**
3 Global Climate Regulation (only AMB)		£0	**£0**
4 Health (Walking)		£91,332	**£91,332**
5 Recreation & Aesthetics	£56,249	£63,900	**£120,149**
6 Water Quality Regulation		£7,321	**£7,321**
7 Wild Species Diversity		£922,558	**£922,558**
Total Benefits	£608,351	£1,648,374	**£2,256,725**
Costs			
1 Capital & Equipment	£756,097		**£756,097**
2 Labour	£661,972		**£661,972**
3 Site & Livestock Management	£46,584		**£46,584**
Total Costs	£1,464,653		**£1,464,653**
Total Net Benefits			**£792,071**
Benefit-Cost Ratio (BCR)			*1.5*

All monetary values are stated in GBP; 2015 prices
Values are capitalised over 30 years for the period 2023-2052 applying the HM Treasury discount rate

Source: ***Author calculations***

[77] HM Treasury 2003, 97.

Table A.3 **Capitalised benefits and costs applying the HM Treasury discount rate: ASP**

Aspirational (ASP) Scenario: Capitalised			
	Private	Social	**Total Capitalised Value**
Benefits			
1 Flood Regulation		£1,537,289	**£1,537,289**
2 Food	£301,905		**£301,905**
3 Global Climate Regulation (change only)		£1,007,877	**£1,007,877**
4 Health (Walking)		£469,710	**£469,710**
5 Recreation & Aesthetics	£7,249	£915,526	**£922,775**
6 Water Quality Regulation		£702,883	**£702,883**
7 Wild Species Diversity		£1,637,960	**£1,637,960**
Total Benefits	£309,153	£6,271,245	**£6,580,398**
Costs			
1 Capital & Equipment	£495,225		**£495,225**
2 Labour	£730,660		**£730,660**
3 Site & Livestock Management	£216,443		**£216,443**
Total Costs	£1,442,328		**£1,442,328**
Total Net Benefits			**£5,138,070**
Benefit-Cost Ratio (BCR)			*4.6*

All monetary values are stated in GBP; 2015 prices
Values are capitalised over 30 years for the period 2023-2052 applying the HM Treasury discount rate

Source: ***Author calculations***

When comparing the HM Treasury discount rate findings here with the findings from the main assessment applying a discount rate of 1.5% (Table 4.3 & Table 4.4) one can observe the effects of changing the discount rate.

As expected, capitalised values are lower here because future benefits and costs have been discounted at a higher rate. The total net benefit is reduced from £1.18m to £0.79m for the BAU scenario and from £8.18m to £5.14m for the ASP scenario, respectively.

The Benefit-Cost Ratio (BCR) for both scenarios are not significantly affected. With a BCR of 1.5 it remains the same for the BAU scenario and with a BCR of 4.6 it is only slightly reduced from 4.8 for the ASP scenario. The difference in the ASP scenario can be explained by how the global climate regulation value is calculated which is more complex than for other ecosystem services.

Concluding one can say that, as expected, adjusting the discount rate has an effect on the absolute capitalised values but has no or very little effect on the BCR and therefore on the main question to hand – which scenario is most beneficial and how does the BCR differ between scenarios.