

**The Wildlife Trust
for Birmingham and
The Black Country**



Valuation Case Study:

**The Economic Evaluation
of Moseley Bog & Joy's
Wood LNR**

2012

Oliver Hölzinger

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I. Abstract

Moseley Bog & Joy's Wood LNR attract worldwide awareness because J. R. R. Tolkien expressed this site was an inspiration for his books *The Lord of the Rings* and *The Hobbit*. This case study evaluates the value of ecosystem services the site provides to human wellbeing with focus on the major improvements the Wildlife Trust for Birmingham and the Black Country is undertaking. Ecosystem services and the benefits they provide to human welfare are still ignored or strongly undervalued and not adequately assessed in planning and policy. One reason is that most benefits are not marketable. Economic valuation of ecosystems can help to mitigate this undervaluation and is receiving increasing attention by academia and politics. Monetarisation makes ecosystem services more tangible for decision makers and planners.

Moseley Bog & Joy's Wood LNR will provide services to human wellbeing valued at £226,604 annually after the improvements will be finished and visitor counts will be reached. This is almost double as much as before and not all services have been evaluated in scope of this case study. It is predicted that the investment in the improvements and activities will generate net benefits of almost £1.4 million until 2035 and will pay off in 2018.

II. Acknowledgements

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V. List of Abbreviations

BG	Best Guess
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
GIS	Geographic Information System
NEA UK	National Ecosystem Assessment
NEWP	Natural Environment White Paper
UHIE	Urban Heat Island Effect
UHI	Urban Heat Island
WTP	Willingness-To-Pay
LNR	Local Nature Reserve

1. Introduction and Background

1.1 Moseley Bog & Joy's Wood Local Nature Reserve

Moseley Bog & Joy's Wood LNR¹ is located in the South-East of Birmingham², owned by Birmingham City Council and managed by the Wildlife Trust for Birmingham and the Black Country. The habitat extends to about 11 ha and comprises an old, damp woodland and bog, on the site of a former mill pond and Joy's Wood - woodland and grassland created in the early 1980s. The woodland area of the site is about 9.4 ha and therefore the majority of the habitat. A smaller fragment of 1.4 ha has been identified as neutral grassland. Additional small fragments of fen, scrub, tall herb and open water can be found on the site.

Within the scope of this case study the whole area is classified as woodland. The Forestry Commission definition of woodland includes the involvement of other vegetations such as grassland:

“Land under stands of trees with a canopy cover of at least 20% [...], or having the potential to achieve this, including integral open space [...].”³

In cases a distinction is necessary this will be made in the regarding sections. Map 1.1 shows a habitat map.

The site was renamed in 2000 after the urban conservation campaigner Joy Fifer ran the ‘Save Our Bog’ campaign in the 1980’s to save the site from development and is now a Local Nature Reserve (LNR) and Site of Importance for Nature Conservation (SINC). It is home to a rich diversity of habitats, including the bog itself, various dry woodlands and a high number of species including birds, invertebrates and small mammals. In addition, the site also has important cultural and archaeological significance including two Bronze Age burnt mounds with Scheduled Ancient Monument (SAM) status, and a former mill pool dam, a pond and a former water mill.

¹ In the future simplifying stated as Moseley Bog.

² Moseley Bog and Joy's Wood lie approximately 3 miles south of Birmingham City Centre, situated between Sparkhill and Billesley, Hall Green and Moseley or between Yardley Wood Road and Wake Green Road. Location: Yardley Wood Road, Moseley, Birmingham, West Midlands, B13 9YP (nearest)

³ Forestry Commission 2010, 165.

Map 1.1 Moseley Bog and Joy's Wood LNR



Source: EcoRecord

Major improvements lead by the Wildlife Trust for Birmingham and the Black Country are underway. This includes for example access improvements for people of all abilities. Work includes hedgerow restoration, meadow management, and tree safety, as well as improvements to boardwalks, steps, pathways, and signage around the site. Volunteers and members of the Moseley Bog Conservation Group play a key role in developing the site. Interpretation material has also been improved. Main capital works have already been completed. The Improvements will be outlined in more detail in the referring sections.

The majority of the funding for the project has been provided by the Heritage Lottery Fund (HLF) as well as Natural England through Advantage West Midlands. The project started in July 2010 and will end in late summer 2013. However, a second phase to provide additional improvements is already in development.

1.2 Objectives of this Case Study

In the UK, natural habitats are under pressure. Economic austerity in the course of profound changes in public administration is not expected to mitigate the pressure on the natural environment. This study values the benefits to human wellbeing provided by Moseley Bog with focus on changes of benefits due to the improvements. More exactly it values a range of ecosystem services the site provides. An ecosystem service describes a way that human wellbeing is influenced by the natural environment. Woodland for example provides space for recreation which in turn improves physical and mental health. On the one hand it mitigates climate change by capturing and storing carbon dioxide and on the other hand it helps adapting to climate change by reducing extreme temperatures and mitigating extreme weather events. These are only some examples.

The ecosystem provides a manifold range of services and is in fact the basis for human existence. This is often underestimated or simply ignored and accepted as self-evident. Valuing these services makes the benefits visible and comparable. The Department for Environment, Food and Rural Affairs (Defra), subscribes to the opinion that

“...the benefits the natural environment provides are not yet valued properly in policy and project appraisal across government.”⁴

This can lead to decisions detrimental to the natural environment and finally to a decline of net human wellbeing. The economic valuation can mitigate this circumstance. This statement is also main outcome of the recently published Natural Environment White Paper (NEWP) as well as the National Ecosystem Assessment (NEA UK).⁵

The aim of this case study is to evaluate the range of ecosystem services Moseley Bog LNR provides as far as the scientific evidences and data availability allows that. Furthermore it evaluates the direct and indirect effects of the project improvements and activities on the ecosystem services the site provides concluding with a cost-benefit analysis for the invested funding. To evaluate the (projected) improvements a

⁴ Defra 2007, 2.

⁵ HM Government 2011; UK National Ecosystem Assessment 2011.

timescale from the beginning of the project in July 2011 until the end in late summer 2013.

2. Methodical Approach and Limitations

The economic valuation of ecosystem services always concentrates on human welfare or wellbeing. This is the only practicable approach because “*non-anthropocentric value is, by definition, beyond any human knowledge.*”⁶ However, that does not mean that wildlife and biodiversity has no intrinsic value. The approach can involve for example existence values (non-use values)⁷, option values⁸ or bequest values⁹ as a matter of course.

Many people have difficulty with a monetary value for environmental goods in general. The criticism is that you can not or should not sell the environment. However, to make social, environmental and economical issues comparable, you need a common denominator. A sacrifice of monetary valuation usually leads to a neglect of environmental protection.

To value ecosystem services provided by Moseley Bog the benefit or value transfer approach has been applied. That means that findings from other primary valuation studies were transferred to our specific context. Primary valuation studies are very time and cost intensive and therefore not applicable for a wider range of ecosystem services and habitats. The value transfer approach is widely accepted for this kind of valuation.

Underlying primary valuation studies used for a value transfer within this case study are mainly contingent valuation techniques. Such techniques derive people's preferences by asking them their willingness-to-pay (WTP) for a specific environmental feature. This can be a hypothetical entrance fee to a site or a theoretical funding fee to protect specific habitats.

Whilst valuing the site, thought has been given to the “Introductory Guide to Valuing Ecosystem Services”, published by the Department of Environment, Food and Rural Affairs as well as the “Practical Guidelines for the Use of Value Transfer in Policy and

⁶ Defra 2007, 12.

⁷ You might never be able to see a whale in nature, but you can nevertheless benefit from the pure existence of whales.

⁸ You might never see a whale in nature, but you can benefit from the ability to see whales in the future.

⁹ You might never see a whale in nature, but you can benefit from the ability of coming generations to see whales in the future.

Project Appraisal” provided by the Economics for the Environment Consultancy.¹⁰ Using these guidelines it has been ensured that the outcomes of this case study match the state of the art techniques as well as transparency and comparability with other studies.

It has to be noted that all valuation studies implicate some limitations. Related willingness-to-pay techniques for example have their own imperfections such as the social desirability bias (the interviewees may like to make out that they value an ecosystem service more than they actually do) or a lack of imagination of hypothetical markets and goods. However, questioning techniques are advanced enough to gather resilient outcomes.¹¹

Another limitation may occur by applying the value transfer approach. Usually, the study sites (primary valuation studies) and the policy site (in this case Moseley Bog LNR) are not similar. Even if some socio-economic influencing variables such as income or population density and the availability of substitutes can be adjusted, a benefit transfer error can never be ruled out. Some adjustments such as for cultural distinctions are hardly possible. Further limitations are linked to general scientific uncertainties such as for future impacts of climate change. To take these circumstances into account within this research, a sensitivity analysis has been applied.

“Sensitivity analysis is core to any appraisal exercise and should be employed to compensate for the limitations and uncertainty concerning the data informing the assessment.”¹²

Therefore, every value is stated as “best guess” with a range, following best practice recommendations. If not noted otherwise stated values in the different sections are best guesses for annual values. Values are generally given in 2010 prices.

The valuable ecosystem services are not only stated as an annual value; they are also stated as capitalised value over 100 years. To value an annual ecosystem benefit over time it is usual and reasonable to apply a discount rate. This discount

¹⁰ Defra 2007; EFTEC 2010b.

¹¹ For more information see EFTEC und EFL 2006.

¹² EFTEC 2010a, 35.

rate is used to convert the benefits to present values. UK government recommends a discount rate of 3.5 percent for periods up to 30 years. After 30 years this rate is declining to 3.0 percent and after 75 years to 2.5 percent.¹³ The derivation for this rate, however, seems out-dated and underlying assumptions are questionable.

Within this case study the discount rate recommended by HM Treasury is only applied for the low boundary of the sensitivity analysis. For the best guess a discount rate of 1.5 percent has been applied. The rate has been set to zero for the high boundary of the sensitivity analysis. Both are recommendations of the German Federal Environmental Agency.¹⁴ For a more extensive discussion of discounting as well as more in-depth information about ecosystem services and its valuation see Hölzinger (2011).¹⁵ Further assumptions, limitations and uncertainties will be discussed in the regarding chapters.

¹³ HM Treasury 2003, 97.

¹⁴ German Federal Environment Agency 2008.

¹⁵ Hölzinger 2011, 19.

3. Benefits

3.1 *Air Pollution Control*

Trees have an effect on the local air quality, especially in urban areas such as Birmingham. They absorb, through deposition and chemical reactions, deleterious pollution such as carbon monoxide (CO), sulphur dioxide (SO_x), nitrogen dioxide (NO₂), ozone (O₃) and fine particulates (PM₁₀) which are responsible for dangerous illnesses e.g. respiratory ailments, heart disease and cancer.¹⁶ The main sources for this pollution are vehicle exhausts and conventional power stations. Generally, the benefit provided by trees could be valued by the avoided healthcare costs. Research carried out in New York suggests that a high tree density per square kilometre significantly reduces asthma prevalence in very young children, to note only one example.¹⁷

However, benefits provided by air pollution absorption are still uncertain. An economic valuation was not feasible in scope of this case study. In 2002 the annual health benefits from air pollution provided by woodland in the West Midlands Region was estimated to be only £30,000.¹⁸ The latest improvements to the site have no significant influence on this ecosystem service.

3.2 *Local Climate*

The urban forest has a significant influence on the local climate. Urban areas are usually several degrees warmer than their surroundings. This Urban Heat Island Effect (UHIE) is caused by the massive use of materials retaining heat, which is released during the nights, as well as the concentration of waste heat from warming and cooling. In the future, the UHIE will combine with global warming caused by climate change. In summer 2006 during a heatwave, for example, the UHIE caused more than 4 degrees of additional warmth within the central business district (most built up area) of Birmingham. Around Sutton Park the temperature was about 3 degrees lower.¹⁹ Therefore woodland can play a vital importance in mitigating the

¹⁶ McPherson, Nowak, und Rowan 1994, 63.

¹⁷ Lovasi u. a. 2008, 647.

¹⁸ Willis u. a. 2003, 28.

¹⁹ Tomlinson 2009, 180.

negative effects of climate change. Reducing the urban heat island effect also helps reducing air pollution.²⁰ However, the scientific evidence to date does not allow to calculate a monetary value for this effect.²¹

3.3 Climate Change Mitigation

Woodland plays an important role in mitigating climate change and its negative influences by capturing and storing carbon. Trees, as well as green plants in general, use photosynthesis to take up carbon dioxide from the atmosphere.

“Woodlands and forests are a net sink of CO₂, i.e. they remove CO₂ from the atmosphere, except during tree harvesting and for a relatively short period thereafter (the duration depending on soil type and other site factors).”²²

The Forestry Commission estimates that UK woodland could contribute an emission abatement equivalent to 10% of the total UK greenhouse gas inventory in 2050. A requirement is the replanting of 4% of the land cover.²³ However, this potential is more related to rural areas than to urban areas.

To estimate carbon captured and stored in Moseley Bog, look-up tables provided by the Forestry Commission have been applied.²⁴ They provide statistics with sequestration rates for tree biomass as well as corresponding soils for different periods of the tree lifetime. Annual sequestration rates are anything but constant over time.

The greatest extent of the woodland at Moseley Bog has been planted in mid 19th century. Dominant species are Birch, Hazel, Field Maple and Oak. Following we assume that the woodland is over 150 years old and captures no significant additional amount of carbon dioxide anymore. Joy's Wood, however, was planted in the early 1980's. Dominant species in this area are Willow, Ash, Oak and Sycamore.

²⁰ Beckett, Freer-Smith, und Taylor 1998.

²¹ Forest Research 2010, 90.

²² Read u. a. 2009, xii.

²³ Ebd., ix.

²⁴ West und Matthews 2010.

Tree spacing in this area is about 2m and the yield class is between 4 and 6. This part of the woodland is regularly thinned.

Applying the Forestry Commission look-up tables, species have to be categorised. Birch, Hazel, Maple, Willow, Ash and Willow all fall into the SAB category. Only the carbon uptake by Oak has to be calculated separately. It has been estimated that Oak covers about 20 percent of the woodland area. The assumptions have been summarised in table 3.1 below.

Tab. 3.1 Assumptions for the Forestry Commission look-up tables for Joy's Wood				
	Effectively assumption	Low scenario	Best Guess	High scenario
Species	~20% Birch, Oak, Hazel, Field Maple and others, each.	80% SAB, 20% Oak		
Spacing	~2m	SAB: 1.5m Oak: 1.2m	2.0m	2.5m
Yield class	4-6	4	5	6
Additional captured tCO ₂ e/ha over next 100 years		454.0	581.6	709.2
£/tCO ₂ e		£26	£52	£78
Annual value of carbon captured		£182	£466	£851
Capitalised value of carbon Captured		£5,428	£24,408	£85,124

Source: DECC (2009), West, V., Matthews, R. (2010) and own assumptions

Following these assumptions Joy's Wood will uptake about 581.6t CO₂ within the next 100 years. To value the external costs of CO₂-equivalent we use the recommendation of the Department of Energy and Climate Change (DECC).²⁵ For a short term non-traded price in 2010 of carbon they suggest £52 per tonne of CO₂-equivalent with a 50% range for sensitivity analysis.²⁶ The value of average annual

²⁵ DECC 2009.

²⁶ Ebd., 57.

CO₂ captured by Joy's Wood can be valued at £466.²⁷ One can see that this is ecosystem service is minor compared to other services.

3.4 Habitats for Species (Biodiversity)

In this section the non-use benefits of Moseley Bog LNR as habitat for species are valued. Other authors often use the category "biodiversity benefits". To avoid overlaps, it is important to isolate the non-use value from recreation and landscape benefits. The main resource for this kind of valuation within the UK is a study provided by Hanley et al. (2002), which is considered appropriate even though the sample size was comparatively small and not representative for the whole population in the United Kingdom.²⁸ They valued the Willingness-To-Pay (WTP) for woodland habitats with different attributes, expressed by focus groups. This study has also been applied to value the social and environmental benefits provided by woodland in Great Britain as a whole.²⁹

Handley et al. (2002) valued the benefits based on the preferences expressed by focus groups. The interpretation of the expressed values is complex because the focus group participants were asked explicitly for their WTP for an increase of woodland and not for the protection of already existing woodland. However, the perception is permissible that keeping established woodland is worth equivalent or more than planting new woodland. If the amount of woodland and therefore the habitat for species declines, the marginal value increases. Furthermore, the biodiversity in established woodlands is higher than in new planted woodlands. Following these arguments applying the values for an expansion of woodland, seems to be justifiable for the existing woodland in Moorcroft Wood LNR.

The woodland area of Moseley Bog LNR is planted lowland broadleaved woodland. The mean WTP to plant an area of 12,000 ha new lowland broadleaved woodland was £0.84 per household (in 2002 prices).³⁰ With inflation adjusted to 2010 price

²⁷ Because of the comparative minor effect a simplified calculation has been applied to value the climate change mitigation value.

²⁸ Willis u. a. 2003, 15.

²⁹ Willis u. a. 2003.

³⁰ Hanley u. a. 2002, 18.

levels, this results in £1.01 per household. Because this is a non-use value, the benefits are not restricted to local residents.

“There is no reason within standard economic theory why non-use values would [...] decrease with distance.”³¹

We calculate the benefits for UK households. However, because the non-use benefits do not end at the national border, this can be interpreted as underestimation. To calculate the value of Moseley Bog LNR as habitat for species the WTP has been multiplied by the number of UK households and then broken down to the area of woodland in Moseley Bog LNR.

Considering the unclear definition of woodland in Hanley et al. (2002) a sensitivity analysis has been applied to estimate the attributable area of woodland. For the low value estimate only the area with stand of trees has been considered. The high estimate includes other features such as embedded areas of grassland and shrub (not open water and fen) as well.³² The mean area of 10.16 ha has been adopted as best guess. Consequently an annual value of **£17,411** has been calculated for the woodland of Moseley Bog LNR, representing the best guess. A summary can be seen in table 3.2 below.

Tab. 3.2 Valuation of woodland in Moseley Bog LNR as habitat for species			
	Low estimate	Best Guess	High estimate
Area	9.37 ha	10.16 ha	10.94 ha
WTP per household for 12,000 ha (price level 2010)	£1.01		
UK households	20,407,000		
Range for sensitivity analysis	70%		
Annual value of woodland in Moorcroft Wood LNR	£4,819	£17,411	£31,886
<i>Source: Own calculations based on Hanley et al. (2002), ONS (2010) and EcoRecord data</i>			

Because these are passive- or non-use values, people often have problems in expressing their own preferences. On the one hand the topic is very abstract and

³¹ Brander u. a. 2008, 18.

³² The Forestry Commission definition for woodland includes both.

hard to grasp. On the other, the WTP for this form of ecosystem service is a very small fraction of income which 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. Additionally, the comparatively small sample size makes the application of a wide range of 70% for the sensitivity analysis reasonable. This results in a range from £4,819 up to £31,886 annually.

3.5 Aesthetic Appreciation

The visual amenity of woodland is valuable and can have significant influences. In environmental landscapes with trees, property values can increase by an average of 7%. This also leads to increasing council taxes.³³ Another study in Berlin, Germany, found that street trees can increase land values by up to 17%.³⁴ Research in the USA suggests that a view of woodland can also improve mental health by breaking down stress.³⁵ Ulrich (1984) found that the view of woodland from hospitals has a positive effect on recovery times.³⁶

Within this case study, the best method to value the landscape benefits provided by woodland is to transfer the findings from Garrod (2002), who valued the Willingness-To-Pay for woodland views from home, applying a stated preference method. This represents the most actual primary study in Great Britain.³⁷ An additional advantage of this study is that overlaps with other benefits like recreation have been avoided.³⁸ Referring to these findings, the annual WTP per household for a view of urban fringe broadleaved woodland from home is estimated to be £322.60 in 2010 (inflation adjusted by £268.79 in 2002).³⁹

Unfortunately, a GIS viewshed-analysis was not feasible within this project to estimate the amount of households with an actual view of Moseley Bog LNR. The number of private households has been estimated by a map interpretation. Based on

³³ Forest Research 2010, 19.

³⁴ Luther und Gruehn 2001, 23.

³⁵ Ulrich und Simons 1986.

³⁶ Ulrich 1984.

³⁷ Forest Research 2010, 22.

³⁸ Garrod 2002, 2.

³⁹ Ebd., 12.

number and size of the private houses surrounding Moseley Bog LNR the number of households with direct view on the site has been estimated with 80. For this best guess only directly adjoining buildings have been taken into account. Multiplied by £322.60 this results in an amenity value of £25,808 per year. Because the number of households can only be approximated applying a map analysis and households in the second row may also have a good view on the site a range from 60 to 120 households has been applied for the sensitivity analysis.

It should be noted that the sample size of completed questionnaires is comparative small and no socio-economic adjustment is possible because corresponding information is not available.⁴⁰ Nevertheless, the findings for peri-urban broadleaved woodland are estimated to be sufficiently robust.⁴¹ To take uncertainties into account, a 70% range has been applied for the sensitivity analysis. Table 3.3 below summarises the assumptions and findings.

Tab. 3.3 Valuation of amenity benefits provided by Moseley Bog LNR			
Woodland Type	Low estimate	Best Guess	High estimate
Households with view on Moorcroft Wood LNR	60	80	120
WTP per household per year (price level 2010)	£322.60		
Range for sensitivity analysis	70%		
Annual value of Moorcroft Wood LNR (good quality assumption)	£9,678	£25,808	£58,069

Source: Own calculations based on Hanley et al. (2002) and EcoRecord data

Many studies also suggest that woodland and greenspace in general have manifold positive influences on the economy. A well developed Green Infrastructure attracts inward investments. The environmental surrounding is estimated to play a significant role for companies regarding to their location decision. It also attracts and retains especially high-skilled employees. The importance of green aesthetic amenity at work can also be clarified by the fact that employees without a view on a green

⁴⁰ Ebd., 9 & 13.

⁴¹ Forestry Commission 2010, 23.

environment more often hang up pictures of natural scenes.⁴² However, the scientific evidence does not allow a quantitative analysis of these effects.⁴³

3.6 Recreation

Non-Consumptive Recreation and leisure such as walking or relaxing within woodland generates numerous benefits. First, recreation raises individual wellbeing and is therefore a value in itself. Additionally, an increase of accessible woodland close to home is estimated to improve people's health by providing space for physical activity such as jogging.⁴⁴ About $\frac{3}{4}$ of the adults agree that green spaces are important for health.⁴⁵ The annual costs of physical inactivity in England are estimated to be about £10.7 billion.⁴⁶ However, recreation has not only a positive effect on physical health. It also has restorative effects and contributes to mental health.⁴⁷

*"The ecosystem goods and services that could potentially be derived from urban greenspace are substantial. In the past, the importance of these areas for the health and general well-being of society was not appreciated and their potential not realised. It is not just the limited extent and variable quality of greenspaces, but also their spatial distribution, connectivity, functionality and accessibility that currently create barriers to their optimisation."*⁴⁸

Referring to the Woodland Trust in Birmingham only 9% of the population has access to a woodland site of at least 2ha within 500m from home.⁴⁹ Improving accessibility is one of the main aims of the actual activities at Moseley Bog LNR. This includes the provision of signage, interpretation and paths which allow visitors of all abilities to properly experience all the distinctive areas and key features of the site. Information material, a website and special events shall also attract additional visitors.

⁴² Heerwagen und Orians 1986, 623.

⁴³ Regeneris 2009, 24.

⁴⁴ Coombes, Jones, und Hillsdon 2010.

⁴⁵ Kuppuswamy 2009, 64.

⁴⁶ Department of Health 2004, 9.

⁴⁷ Kaplan 1995.

⁴⁸ UK National Ecosystem Assessment 2011, 74.

⁴⁹ Woodland Trust Appendix I.

A user survey undertaken in 2004/05 indicated that the reserve had approximately 55,000 visits per year before the programme started.⁵⁰ Because of the accessibility improvements, information materials and promotion of the site visitor counts have already been increased, referring to the reserve manager. The Wildlife Trust aims to increase the visits to Moseley Bog LNR to between 110,000 and 165,000 annually. The assumption is reasonable that these additional visits of about 82,000 per annum will be directly related to programme activities.

To value the recreational benefits from Moseley Bog LNR, a benefit transfer of the findings of Scarpa, R. (2003) has been applied. This data is based on different primary contingent valuation studies from 1994 and 2002. Visitors of many woodland sites were asked how much they were willing to pay, if there were to be a charge for access. The results show that the willingness-to-pay for a visit increases with the distance travelled to the site. The inflation adjusted WTP (price level 2010) per visit is summarised in table 3.4 below.

Tab. 3.4 Mean Willingness-To-Pay per woodland visit by distance travelled

	Mean WTP per visit (2010 prices)
Distance travelled <10 miles	£1.08
Distance travelled 11 - 25 miles	£1.80
Distance travelled 26 - 75 miles	£2.16
Distance travelled 76 - 100 miles	£2.52
Distance travelled 101 - 150 miles	£3.00
Distance travelled >150 miles	£2.88

Source: Scarpa (2003), p. 16

Unfortunately no evaluation of from how far people travel to the site is available. The best available statistics about distance travelled for visits to woodland is for Birmingham and the Black Country which has been made available from “the national survey on people and the natural environment” provided by Natural England.⁵¹ These data are based on a survey undertaken between March 2009 and February 2010.

⁵⁰ The Wildlife Trust for Birmingham and the Black Country 2009, 4.

⁵¹ Natural England 2010.

The statistic for the area of Birmingham and the Black Country is based on a sample size of 560 questionnaires.

Tab. 3.5 Visits to woodland in B&BC derived by distance travelled

	Visits in 2009/2010
Distance travelled <10 miles	65.3%
Distance travelled 11 - 20 miles	17.2%
Distance travelled 21 - 40 miles	17.6%

Source: Natural England data from The national survey on people and the natural environment

These categories do not fit exactly with the categories applied by Scarpa (2003). Conservatively the WTP of £1.80 has been applied for distances travelled between 11 and 40 miles. It is also implied that the number of visits by local residents is a reasonable indication of visits to local woodland sites. However, this might be a conservative assumption because Moorcroft Wood LNR has reasonable visitor counts from foreign countries and even continents because of its prominence as inspiration for *The Lord of the Rings* and *The Hobbit*. For assumptions and calculation see table 3.6 below.

Tab. 3.6 Valuation of recreational benefits provided by Moseley Bog LNR

	Low estimate	Best Guess	High estimate
Distance travelled to woodland within B&BC			
Distance travelled <10 miles	65.3%	65.3%	65.3%
Distance travelled 11 - 40 miles	34.7%	34.7%	34.7%
Visits (2004/05)	45,000	55,000	65,000
Distance travelled <10 miles	29370	35896	42423
Distance travelled 11 - 40 miles	15630	19104	22577
Visitor target after improvements	110,000	137,500	165,000
Distance travelled <10 miles	71792	89740	107688
Distance travelled 11 - 40 miles	38208	47760	57312
Predicted additional visits	65,000	82,500	100,000
Distance travelled <10 miles	42,423	53,844	65,266
Distance travelled 11 - 40 miles	22,577	28,656	34,734
Range for sensitivity analysis	50%		
Value of visits (2004/05)	£29,932	£73,168	£129,706
Annual value of visits after improvements	£73,168	£182,919	£329,254
Annual value of additional visits	£43,235	£109,751	£199,548
Capitalised value of additional visits (2013-2035)	£630,451	£2,059,346	£4,589,605

Source: Own calculations

To recognise uncertainties relating to the sample size, transfer errors and the general scientific uncertainties, a range of 50% has been applied for the sensitivity analysis, which leads to foreseen annual **value between £43,235 and £199,548** (best guess: £109,751) related to the Wildlife Trust activities. The total annual recreational value after improvements will be £182,919, stating the best guess.

The physical improvements to the site will last about 25 years. This is the predicted lifetime of the installed wooden walkways. Assuming the visitor targets will be

reached in 2013 and last until 2035, we gather a capitalised recreational value related to the actual programme of more than £2,000,000.

With an eye toward the health benefits, these figures may still represent an underestimation. On the one hand, many respondents may not be aware or badly informed about the health benefits provided by woodland. Therefore, they may not take this component adequately into account when expressing their WTP. On the other, parts of the negative effects of poor health are mitigated by the social safety net. Therefore a healthy lifestyle may be undervalued by individuals in general.

3.7 Education

Formatting ecological knowledge is a key element of the educational system and children benefit from this knowledge over their whole lifetime. Economically speaking, *“formation of ecological knowledge [...] can be seen as an investment in human capital.”*⁵² A high level of ecological knowledge boosts average lifetime earnings. On the other hand it provides additional non-marketable benefits to human wellbeing. It is arguable that a good ecological education leads to more productive individual use of leisure by ‘enjoying the nature’.⁵³ Referring to the increase in lifetime earnings Mourato et al. (2010) approximate for the UK that

*“...the value of ecological knowledge embodied in this educational attainment at the end of the academic year 2009-10 was just over £2.1 billion.”*⁵⁴

Along with more theoretical environmental education in the classroom, for example by reading books, frequent interaction with the local environment is one key element of acquiring ecological knowledge.⁵⁵

Especially in urbanised areas woodland and greenspace is capable of playing an even more important role in education. Children who have grown up in cities do not have the same relationship with nature as their counterparts living in the countryside. This applies especially for minority ethnic groups in urban contexts.

⁵² Mourato u. a. 2010, 31.

⁵³ Ebd.

⁵⁴ Ebd., 34.

⁵⁵ Ebd., 30.

“In metropolitan areas, per capita greenspace provision has [...] declined, particularly in the most deprived areas, adversely affecting health by reducing childhood development, mental and physical well-being...”⁵⁶

Many activities of the Wildlife Trust for Birmingham and the Black Country aim to provide and improve outdoor education.

Although the value of education has not been formally calculated with the report, it is an important aspect of the project. The project encourages lifelong learning working with school groups to adult volunteers. Over 200 children and adults have benefited from project education so far. School children have undertaken curriculum or project based projects within the reserve, this encourages natural exploration and hopefully inspires the future generation about Moseley Bog Nature Reserve or green spaces in general. Adult education focuses on practical management skills and formal courses such as first aid or moth identification; this increases the individuals' knowledge and practical management skills. Therefore environmental education should be seen as an investment not only for the benefit of green spaces and the student but also for the wider community, as many skills are transferable to the employment market and of economic value on a wider and long term basis. The voluntary activities undertaken at Moseley Bog LNR involving young people is likely to generate benefits to society as well as to the personal futures of the attendees.⁵⁷ Furthermore many parents and teachers are involved in the programme. This in turn is likely to add additional benefits. Unfortunately an economic evaluation and quantification of the educational benefits was not feasible in scope of this case study.

3.8 Summary

As shown above, Moseley Bog LNR provides a wide range of ecosystem services. However, it has to be stressed that only a fragment of it could have been valued in monetary terms within this case study. Also not all ecosystem services have been reviewed. Additional to the services outlined above, Moorcroft Wood LNR mitigates for example storm and flood events or mitigates soil erosion. Therefore the findings can be interpreted as the core of the Total Economic Value (TEV). Table 3.7 below

⁵⁶ UK National Ecosystem Assessment 2011, 34.

⁵⁷ Sustainable Development Commission 2010, 7.

summarises the values for a range of ecosystem services provided by Moseley Bog LNR.

Tab. 3.7 Valued ecosystem services provided by Moseley Bog LNR

Ecosystem Service (price level 2010)		Annual value		
		High	Best Guess	Low
Air Pollution Control		Not quantified		
Local Climate		Not quantified		
Climate Change Mitigation		£851	£466	£182
Habitat for Species		£4,819	£17,411	£31,886
Aesthetic Appreciation		£9,678	£25,808	£58,069
Recreation	General	£29,932	£73,168	£129,706
	Additional (predicted)	£43,235	£109,751	£199,548
Education		Not quantified		
Σ		£87,847	£226,604	£420,060

Source: Own calculations

One can see that the additional predicted recreational value due to the Wildlife Trust actions almost doubles the quantifiable value of the site. Note that the total annual value of £226,604 only applies if the visitor count targets will be achieved. Furthermore the physical improvements have to be kept in good condition and the promotion of the site has to continue.

4. Cost-Benefit Analysis

4.1 *Benefit-Cost Ratio*

The costs of the whole project are estimated to be £567,531. Main funder is the Heritage Lottery Fund. Further funders are for example Birmingham City Council and Natural England.⁵⁸

To proof the profitability of an investment it is reasonable to calculate the Benefit-Cost Ratio (BCR). Most Ecosystem Services are independent or not significantly affected by the programme activities. Educational benefits on the other hand are not quantifiable at this stage of the programme. Main quantifiable improvement is the attraction of more visitors. The assumption has been made that the additional visitor counts will continue until the capital improvements will last; especially the walkways. Following this assumption benefits have been calculated for the time period 2013 until 2035. To maintain the quality of the improvements, updating the webpage etc., annual running costs of £6,000 annually are expected. This results in total running costs from 2013 until 2035 of £112,582 in 2010 prices, stating the best guess. The formula for the Benefit-Cost Ratio is outlined in figure 4.1 below. Every BCR bigger than one means that the investment is rewarding.⁵⁹

⁵⁸ Data provided by the Wildlife Trust for Birmingham and the Black Country

⁵⁹ Note that this is the gross-concept of a benefit-cost ratio. The net benefit-cost ratio (benefits – running costs / investment costs) would produce “extremes” outcomes but would not change the general tendency.

Fig. 4.1 Benefit-cost ratio for Moseley Bog LNR

To calculate the benefit-cost ratio (BCR) the following formula has to be applied:

$$BCR = \frac{\sum \text{Benefits}}{\sum \text{Investment Costs} + \sum \text{Running Costs}}$$

Applying the inflation adjusted/discounted costs and benefits (best guess) gives:

$$BCR = \frac{£2,059,346}{£567,531 + £112,582}$$

$$= 3.03$$

A benefit-cost ratio of 3.03 means that every pound invested in the project generates a net benefit of £2.03

Source: Own calculations

The ratio above shows that the investment in Moseley Bog LNR is rewarding. Note that this calculation is for the capitalised values over 23 years beginning in 2013. Future costs as well as future benefits have been discounted to price level 2010, applying the discount rate of 1.5%. Underlying assumption is that the one-off investment is written off over this time period. Even in the unlikely 'worst-case' scenario with lowest assumptions for additional visitor counts, high discount rate and low estimate for benefits the BCR is almost 1 and therefore the investment would still be viable.

The capitalised net benefits provided by the improvements to Moseley Bog LNR add up to **£1,379,232**; considering all costs and benefits. This is the best guess.

4.2 Payback Period

Another very useful ratio commonly used in investment is the payback period (PBP). It refers to the period of time required for the return of investment. In other words it shows the time that it takes for an investment to pay for itself.

Fig. 4.2 Payback period formula

To calculate the payback period (PBP) the following formula can be applied:

$$PBP = \frac{\sum \text{Investment Costs}}{\sum \text{Benefits} - \sum \text{Running Costs}}$$

Because our calculation includes values in the future as well as values in the past, a dynamic calculation is necessary. Because the present value of future net benefits declines (discount rate) the static formula above leads to a distortion, especially over a longer time period. Table 4.1 below shows the dynamic calculation for the best guess. As noted before the presumption has been made that Moseley Bog LNR will provide its full range and value of benefits from 2013.

Tab. 4.1 Dynamic calculation of the payback period

Year	Discount factor	Running Costs	Additional Benefits	Add. Net benefits	Written-off investment	Remaining value
2012	0.97	£0	£0	£0	£0	£567,531
2013	0.96	£5,738	£104,957	£99,219	£99,219	£468,312
2014	0.94	£5,653	£103,406	£97,753	£196,972	£370,559
2015	0.93	£5,570	£101,878	£96,308	£293,281	£274,250
2016	0.91	£5,487	£100,372	£94,885	£388,166	£179,365
2017	0.90	£5,406	£98,889	£93,483	£481,648	£85,883
2018	0.89	£5,326	£97,428	£92,101	£573,750	-£6,219
2019	0.87	£5,248	£95,988	£90,740	£664,490	-£96,959

Source: Own calculations

As one can see in 2018 the remaining value becomes negative. This means that within 2018 is the payback period where all one-off investment costs are written-off completely. In other words in 2018 the investments in Moseley Bog LNR will turn cost-effective and will have an annual net return on investment what means that the investment is rewarding.

5. Conclusion

As discussed in section 4.1 only in the worst case scenario of high management costs and lowest benefits cost-effectiveness of the investment in Moseley Bog LNR is not reached completely but still almost viable. However, taking into account that increasing visitor counts in 2011 and 2012 have not been taken into account and other benefits such as educational values have not been valued allows the conclusion that the investment in the site will be rewarding in any case. However, general premise is that the visitor targets will be achieved and maintained over the time period. Considering the arguments before, even the best guess for net benefits of the improvements of **£1,379,232** capitalised remain likely to be an underestimation. Especially considering the social value of the site as inspiration for *The Lord of the Rings* or *The Hobbit*.

Comprising the cost-benefit analysis of the improvements at Moseley Bog & Joy's Wood LNR the investment is rewarding and provides high net benefits to human welfare. This indicates that investments in likewise projects are likely to be cost-effective as well.

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