

AECOM

***COST-BENEFIT
ANALYSIS FOR THE
REINTRODUCTION OF
LYNX TO THE UK:***

SITE SELECTION APPENDIX

OCTOBER 2015



PREPARED FOR:



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INTRODUCTION

01

INTRODUCTION

Overview

The EU Habitats Directive requires Member States to assess the potential and desirability of reintroducing species which have been lost. In light of this requirement, the Lynx UK Trust is proposing to undertake a trial reintroduction programme of Eurasian lynx (*Lynx lynx*) in the UK. As part of the preparation for any translocation or reintroduction programme, guidelines prepared by the International Union for Conservation of Nature state that an assessment of the anticipated costs and benefits of a reintroduction should be incorporated into planning for such programmes.¹

On the basis of these guidelines, AECOM were asked by the Lynx UK Trust to undertake an impartial and independent analysis of the potential economic costs and benefits of a proposed scheme to reintroduce lynx into the UK. The initial cost-benefit analysis was focused on two potential sites in the UK: Site 1 in Kielder Forest on the border between north east England and southern Scotland; and Site 2 in Thetford Forest in the east of England. The results of this analysis are available on the Lynx UK Trust website and will hereafter be referred to as the **Main Report**.

In order to support applications to Scottish Natural Heritage and Natural England for a proposed 5 year reintroduction trial, AECOM were asked by the Lynx UK Trust to undertake a further analysis for three additional sites: Site 3 at Kintyre, a peninsula on the west coast of Scotland; Site 4 in Aberdeenshire on the east coast; and Site 5 in Cumbria, England. It is understood that this analysis will inform the decision on the most suitable sites to trial the reintroduction of lynx.

Unless otherwise specified, the analysis in this report uses the same modelling approach and set of assumptions as set out in the **Main Report**. As such, the analysis in this report draws on the guidance for undertaking cost-benefit analysis set out in the Treasury Green Book.² Following this guidance, all costs and benefits are given in 2014 prices and are provided as present values over a 25-year assessment period using a discount rate of 3.5%.

The Green Book also states that in the early stages of identifying and appraising a proposal only summary data is normally required, while in the later stages of an assessment data should be refined to become more specific and accurate. The analysis in this report is therefore proportionate to the resources involved, outcomes at stake, and the time available.

As such, the results should be taken as an initial indicative estimate of the potential costs and benefits of the lynx reintroduction trial. This approach should provide a proportionate ex ante appraisal for the purposes of licensing a trial of the effects of the reintroduction of lynx to the UK. It is recommended that a more in-depth appraisal of the actual economic impacts is undertaken if the trial goes ahead.

Report structure

The report is divided into three sections:

- **Section 2** describes the geographical scope of the analysis.
- **Section 3** describes the results of the analysis for each of the potential costs and benefits.
- **Section 4** provides an overview of the findings of the analysis at the three sites.

¹ IUCN (2013), 'Guidelines for Reintroductions and Other Conservation Translocations'.

² HM Treasury (2013), 'The Green Book: appraisal and evaluation in central government'.

SCOPE

02

SCOPE

Overview

This section provides an overview of the potential sites in Kintyre, Aberdeenshire, and Cumbria.

Site 3: Kintyre

Kintyre is a peninsula in western Scotland, in the southwest of Argyll & Bute. The region stretches from the Mull of Kintyre in the south, to East Loch Tarbert in the north (see Figure 1). The region immediately north of Kintyre is known as Knapdale, the site of the ongoing beaver reintroduction trial. Kintyre is heavily forested with 335 km² of plantation forest. Based on the availability of suitable habitat in Scotland and the density of potential prey species, Hetherington & Gorman (2007)³ estimate that the Scottish Highlands could support a population of 2.63 lynx per 100 km². Using this figure it is estimated that Kintyre peninsula could support a population of around 9 lynx, assuming that the peninsula provides a natural barrier and they are not able to spread beyond it.

Site 4: Aberdeenshire

Aberdeenshire is one of the 32 council areas of Scotland and covers an area of 6,313 km² or 8% of Scotland's overall territory. Aberdeenshire contains a broad mix of habitats, with the southern area containing large tracts of woodland (see Figure 1). According to Hetherington et al. (2008)⁴ the patch of habitats in this southern area contains 769 km² of woodland which could support a population of around 20 lynx, based on the figures provided by Hetherington & Gorman (2007).⁵ Assuming that a reintroduced lynx population is able to spread across the Scottish Highlands habitat network, it is estimated that this population could reach a maximum of 394 lynx.

Site 5: Cumbria

Cumbria is a large, predominantly rural county which contains the entire Lake District and part of the Yorkshire Dales National Parks. Woodland covers around 585 km² of the county although is fragmented, with the largest blocks at Ennerdale and Grizedale. A study of mammal populations in Cumbria estimated a total population of around 257,500 deer giving a density of approximately 38.05 deer per km².⁶ Combining this with the extent of woodland cover and the formula set out in Hetherington & Gorman (2007), it is estimated that Cumbria could support a population of 28 lynx.

By combining the population growth model set out in the **Main Report** with the maximum population size estimates provided above, an outline model of lynx populations at the sites was estimated over a 25 year period. A summary of the model outputs is set out in Table 1.

Table 1. Population model for reintroduced lynx in the UK

Area	Year 1	Year 5	Year 10	Year 15	Year 20	Year 25
Site 3: Kintyre	5	7	9	9	9	9
Site 4: Aberdeenshire	5	7	10	14	20	28
Site 5: Cumbria	5	7	10	14	20	28

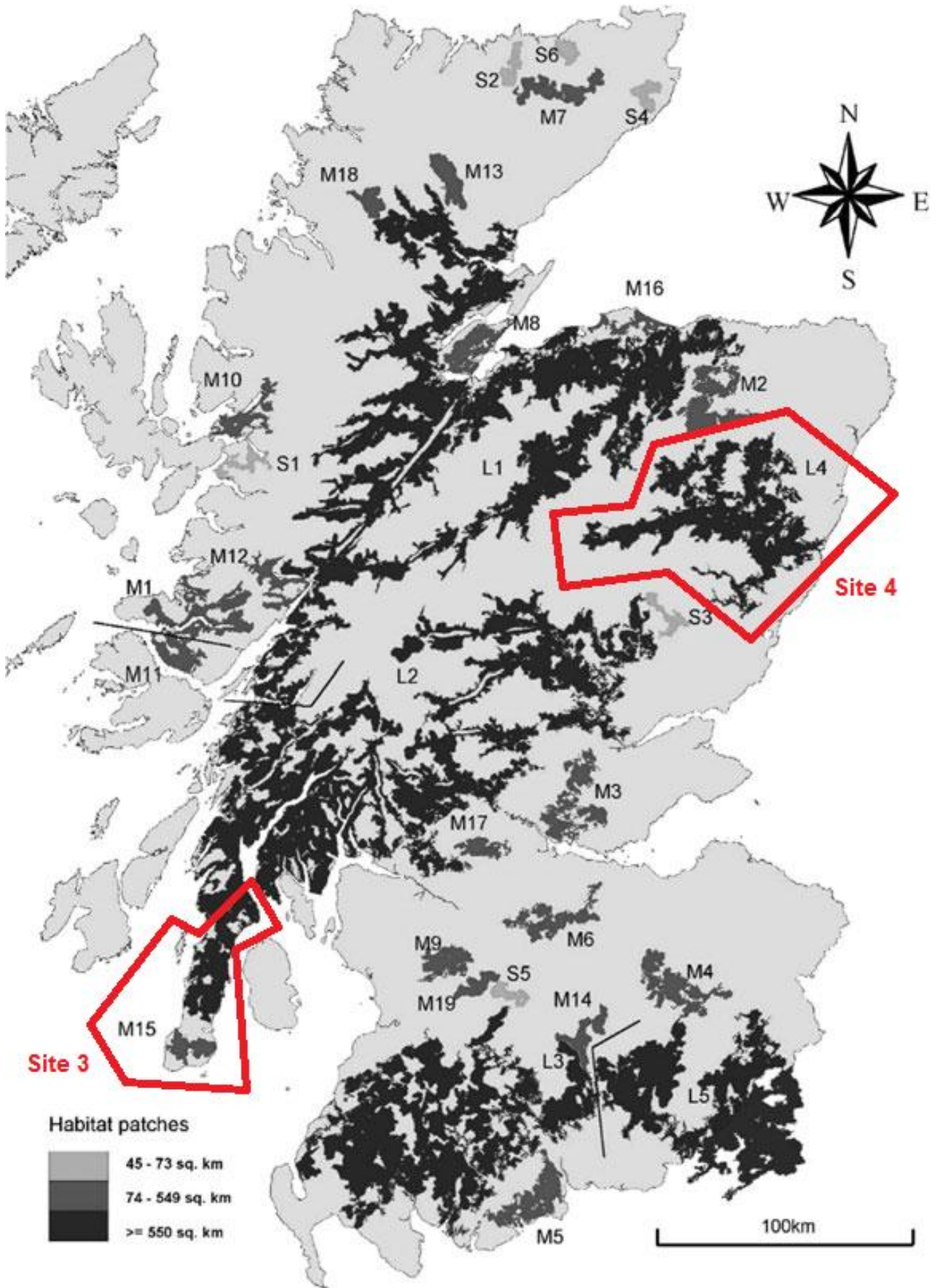
³ Hetherington & Gorman (2007), 'Using prey densities to estimate the potential size of reintroduced populations of Eurasian lynx', Biological Conservation, 137, 37-44.

⁴ Hetherington et al. (2008), 'A potential habitat network for the Eurasian lynx *Lynx lynx* in Scotland', Mammal Rev. 2008, Volume 38, No. 4, 285-303.

⁵ Hetherington & Gorman (2007), 'Using prey densities to estimate the potential size of reintroduced populations of Eurasian lynx', Biological Conservation, 137, 37-44.

⁶ Lurz et al. (2005), 'Mammals in Cumbria: examples of what publicly collected records can tell us about the distribution and ecology of our local species', The Carlisle Naturalist, Volume 13, Number 1.

Figure 1. Habitat patches suitable for lynx in Scotland⁷



⁷ Hetherington et al. (2008), 'A potential habitat network for the Eurasian lynx *Lynx lynx* in Scotland', *Mammal Rev.* 2008, Volume 38, No. 4, 285–303.

ANALYSIS

03

ANALYSIS

Overview

This section sets out the results of the cost-benefit analysis for the sites at Kintyre, Aberdeenshire, and Cumbria. Unless otherwise specified, the approach to quantifying the impacts is the same as set out in the **Main Report**. Due to the significant uncertainty over the estimates for existence value at the two sites analysed in the **Main Report**, these estimates have been excluded from the assessment in Kintyre, Aberdeenshire, and Cumbria.

Impact 1. Predation on livestock and other species

Given the low risk to game and other species (see **Main Report**), and the potential benefits in terms of reduced fox populations, it is assumed that the monetary cost of lynx predation on game and other species is likely to be negligible at the three sites.

With regards to sheep predation, the potential costs were estimated by combining the estimated lynx populations at the three sites each year over a 25 year period with an average predation rate and compensation of £140 per kill (i.e. double the maximum market value).

As set out in the **Main Report**, in countries where predation does occur the rates are typically low. The one outlier is the case of Norway, where an estimated population of 600 lynx killed 18,924 sheep over a 3 year period. According to Wilson (2004),⁸ the high number of livestock taken in Norway is due to the particular sheep farming practices adopted in this area. Unlike in most European countries, sheep in Norway are grazed free range and unshepherded in forest areas which leads to higher predation rates by lynx.

In the rest of Europe (and in the UK), sheep are typically grazed in open pasture and predation is either non-existent or small-scale and localised.⁹ It is therefore assumed that the Norway case is not applicable in the UK context, and the resulting average predation rate across European countries is estimated to be 0.40 sheep per lynx per year.

For the sites at Kintyre and Aberdeenshire, which provide large blocks of continuous forest cover, it is assumed that lynx predation on sheep is likely to equal the European average of 0.40 sheep per lynx per year. In Cumbria, however, the fragmentation of habitats suggests that lynx are likely to move through the landscape to a greater degree. As such, it is estimated that the predation rate on sheep may be closer to the reintroduced lynx population in the Jura mountains in France which saw around 2.84 sheep killed per lynx per year.

The present value was estimated using a 25-year assessment period and a discount rate of 3.5%. The results are set out in Table 2 below.

Table 2. Estimated present value costs of predation by lynx

Site	No. lynx after 25 years	Total sheep kills over 25 years	Present value of compensation
Site 3: Kintyre	9	82	-£7,316
Site 4: Aberdeenshire	28	135	-£11,016
Site 5: Cumbria	28	961	-£78,214

⁸ Wilson, C.J. (2004), 'Could we live with reintroduced large carnivores in the UK?', Mammal Rev. 2004, Volume 34, No. 3, 211–232.

⁹ Hetherington D. (2013), 'Assessing the potential for the restoration of vertebrate species in the Cairngorms National Park: a background review', Cairngorms National Park Authority.

In order to test the sensitivity of the estimates provided in the previous section, a comparison of potential ‘best’ and ‘worst’ case scenarios is presented below.

In the worst case scenario it is assumed that the rate of lynx predation on sheep is equal to the worst case in Europe (excluding Norway) where the predation rate is 2.84 sheep kills per lynx per year across all three sites.

For the sites at Kintyre and Aberdeenshire, the best case scenario assumes the rate of predation is zero. This corresponds to evidence from across Europe which suggests that the most common outcome across European countries is a zero rate of predation (see **Main Report**). While in Cumbria, due to the greater degree of movement across habitat patches, the best case assumes that the predation rate is equal to the European average of 0.4 sheep per lynx. The results are set out in Table 3 below.

Table 3. Estimated present value costs of predation across potential scenarios

Area	Worst case scenario	Central scenario	Best case scenario
Site 3: Kintyre	-£51,943	-£7,316	£0
Site 4: Aberdeenshire	-£78,214	-£11,016	£0
Site 5: Cumbria	-£78,214	-£78,214	-£11,016

Impact 2. Costs of monitoring / maintaining the population

The total costs of the scheme were estimated assuming the introduction of five lynx per site. The present value was estimated assuming a time period of 25 years and a discount rate of 3.5%. The results are set out in Table 4.

Table 4. Estimated present value costs of project administration¹⁰

Factor	Site 3: Kintyre	Site 4: Aberdeenshire	Site 5: Cumbria
Infrastructure e.g. holding enclosures	-£75,000	-£75,000	-£75,000
Capture costs	-£40,000	-£40,000	-£40,000
Monitoring ecologist	-£150,000	-£150,000	-£150,000
Monitoring PHD/research assistant	-£100,000	-£100,000	-£100,000
Local education/consultation	-£185,000	-£185,000	-£185,000
Travel/subsistence	-£16,000	-£16,000	-£16,000
Vet costs	-£21,000	-£21,000	-£21,000
Project management	-£75,000	-£75,000	-£75,000
Exit fund	-£60,000	-£60,000	-£60,000
Longer term monitoring costs	-£100,000	-£100,000	-£100,000
Present Value	-£723,504	-£723,504	-£723,504

In order to account for uncertainty in the cost estimates, a best and worst case scenario was estimated assuming a potential over/under spend of 20%. The results are set out in Table 5.

¹⁰ Provided by the Lynx UK Trust as part of the application to SNH and Natural England.

Table 5. Estimated present value costs of administration across potential scenarios

Area	Worst case scenario	Central scenario	Best case scenario
Site 3: Kintyre	-£868,205	-£723,504	-£578,803
Site 4: Aberdeenshire	-£868,205	-£723,504	-£578,803
Site 5: Cumbria	-£868,205	-£723,504	-£578,803

Impact 3. Risks to human health / disease

Given the extremely low risk of direct harm to human populations or the spread of harmful disease arising from the reintroduction of lynx to the UK, and the potential benefits in terms of reducing the potential for disease spread through other species, the monetary cost is expected to be negligible at all sites (see **Main Report**). Due to the low likelihood of any impact in terms of risks to humans it is assumed that the cost is negligible under all scenarios.

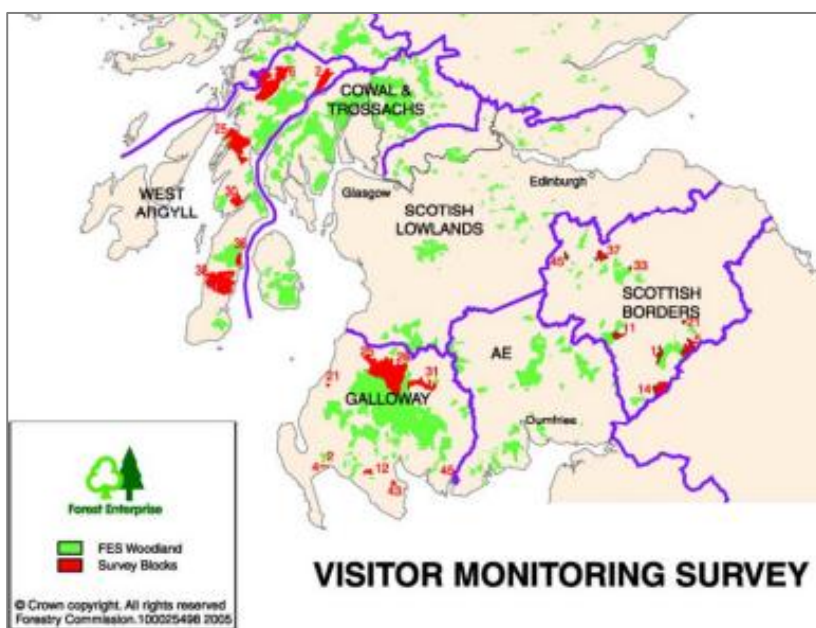
Impact 4. Recreation / tourism benefits

A) Estimating recreational visits during the initial trial period

The proposed site at Kintyre falls within the West Argyll forest district (see Figure 2) which receives around 292,000 visitors a year.¹¹ Surveys of two Forestry Commission owned forests in Kintyre suggest that visitor numbers to Carradale Walks and Lussa Forest (Numbers 36 and 38 in Figure 2) are around 10,000 and 1,000 a year respectively.

Most visitors to the West Argyll forest district are from Argyll & Bute (66%); with the remainder from England (19%), East Dunbartonshire (3%), North Ayrshire (3%), and unknown (9%). It is therefore assumed that the primary visitor catchment area for Kintyre is the population of Argyll & Bute.

Figure 2. Public forest estate in West Argyll¹²



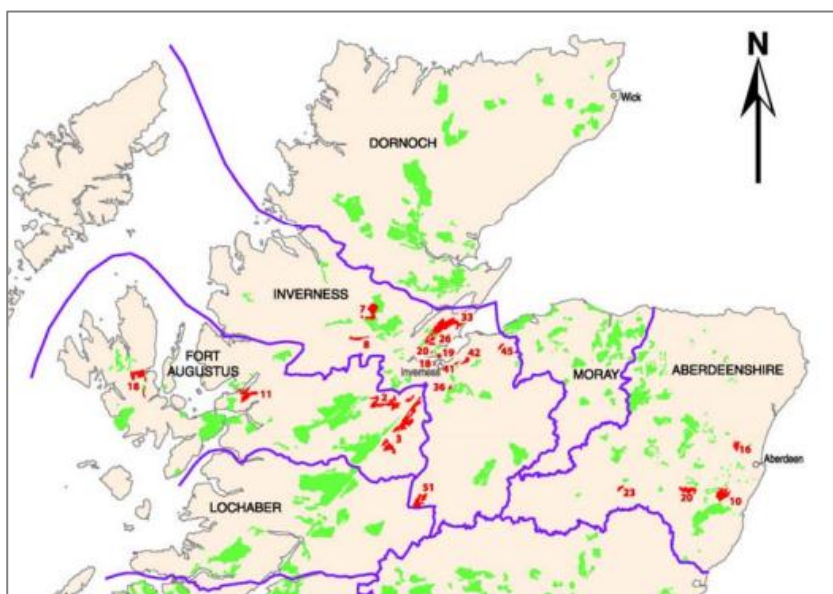
¹¹ Forestry Commission Scotland (2006), 'All Forests Visitor Monitoring Survey of visitors to FCS forests Year 1: June 2004 to May 2005', [http://www.forestry.gov.uk/pdf/AllForestsScotland2004-2005-FinalReport.pdf/\\$FILE/AllForestsScotland2004-2005-FinalReport.pdf](http://www.forestry.gov.uk/pdf/AllForestsScotland2004-2005-FinalReport.pdf/$FILE/AllForestsScotland2004-2005-FinalReport.pdf)

¹² Forestry Commission Scotland (2006), 'All Forests Visitor Monitoring Survey of visitors to FCS forests Year 1: June 2004 to May 2005', [http://www.forestry.gov.uk/pdf/AllForestsScotland2004-2005-FinalReport.pdf/\\$FILE/AllForestsScotland2004-2005-FinalReport.pdf](http://www.forestry.gov.uk/pdf/AllForestsScotland2004-2005-FinalReport.pdf/$FILE/AllForestsScotland2004-2005-FinalReport.pdf)

The proposed site at Aberdeenshire falls within the Kincardine forest district (see Figure 3) which receives around 789,000 visitors a year.¹³ There are four Forestry Commission owned forests within this area, including Durris which receives around 18,000 visits a year, Kirkhill (86,000), Banchory (58,000), and Ballater (3,000).

The majority of visitors to the Kincardine forest district (90%) are from Aberdeenshire and Aberdeen, with the remainder from West Lothian (3%), England (1%), and overseas (1%). It is therefore assumed that the primary visitor catchment area for Aberdeenshire is the population of Aberdeenshire and Aberdeen.

Figure 3. Public forest estate in Kincardine¹⁴



In Cumbria, the large forest block at Grizedale receives around 522,266 visitors each year.¹⁵ The majority of visitors (58%) are from the North West and as such it is assumed that the primary visitor catchment area is the population of the North West.

In order to estimate the potential number of people who are likely to visit the trial sites, a survey of public support for reintroduction of lynx was undertaken by the Lynx UK Trust. The survey asked participants to respond to the statement, *“If lynx were returned to the UK landscape and viewing facilities were available, I would visit the facilities to see the lynx”*. Over 1,000 responses were collected from a representative UK sample using an independent national omnibus polling company. As set out in Table 6, the results suggest that 12.0% of people in the two Scottish catchment areas are likely to visit the lynx trial reintroduction sites, and 24.2% in the North West.

This figure was then combined with the total population of the visitor catchment areas for the three sites, and divided by the number of years of the trial in order to provide an estimate of the potential visitor numbers for each year of the trial period (thereby assuming that 12.0% and 24.2% of people within the relevant visitor catchment areas visit the trial site once during the five year period).

¹³ Forestry Commission Scotland (2008), 'All Forests Visitor Monitoring Survey of visitors to FCS forests Year 3: July 2006 to June 2007', [http://www.forestry.gov.uk/pdf/AFS0607YR3FINALREPORT.pdf/\\$FILE/AFS0607YR3FINALREPORT.pdf](http://www.forestry.gov.uk/pdf/AFS0607YR3FINALREPORT.pdf/$FILE/AFS0607YR3FINALREPORT.pdf)

¹⁴ Forestry Commission Scotland (2008), 'All Forests Visitor Monitoring Survey of visitors to FCS forests Year 3: July 2006 to June 2007', [http://www.forestry.gov.uk/pdf/AFS0607YR3FINALREPORT.pdf/\\$FILE/AFS0607YR3FINALREPORT.pdf](http://www.forestry.gov.uk/pdf/AFS0607YR3FINALREPORT.pdf/$FILE/AFS0607YR3FINALREPORT.pdf)

¹⁵ Forestry Commission England (2004), 'Grizedale visitor monitoring 2003/4', [http://www.forestry.gov.uk/pdf/GrizedaleVisitorMonitoringReport2003-4.pdf/\\$FILE/GrizedaleVisitorMonitoringReport2003-4.pdf](http://www.forestry.gov.uk/pdf/GrizedaleVisitorMonitoringReport2003-4.pdf/$FILE/GrizedaleVisitorMonitoringReport2003-4.pdf)

Table 6. Number of potential visitors to a lynx viewing facility based on response from an independent national survey of a representative UK sample, n(total)=1042

Region	Strongly Agree	Somewhat Agree	Total Agree
North East	21.10%	18.40%	39.50%
North West	24.20%	30.30%	54.50%
Yorkshire & Humberside	22.20%	21.20%	43.40%
East Midlands	18.10%	23.60%	41.70%
West Midlands	14.10%	31.30%	45.50%
East of England	20.90%	31.80%	52.70%
London	19.70%	30.80%	50.40%
South East	16.60%	33.10%	49.70%
South West	14.10%	28.30%	42.40%
Scotland	12.00%	33.00%	45.00%
Wales	22.40%	27.60%	50.00%
UK total	18.67%	28.13%	46.80%

In order to avoid the potential for double counting, it was assumed that people who already visit the three sites for wildlife watching do not count as additional potential visitors as it is likely that they would visit the site even if the lynx were not present. The estimated number of people from each catchment area already visiting the pilot sites for wildlife watching purposes was therefore subtracted from the total existing visitor numbers.

Based on the average number of domestic tourist visits in Scotland which are primarily made for the purposes of wildlife watching, it was assumed that 5.2% of the existing visitors to the two Scottish sites are there for wildlife watching.¹⁶ Assuming total annual visits to the two sites of 11,000 in Kintyre and 165,000 in Aberdeenshire, this equates to 572 and 8,580 wildlife watching visits respectively. This was then multiplied by the percentage of visitors from the two catchment areas (66% and 90%) in order to identify the number of wildlife visitors currently visiting the two sites from Argyll & Bute and Aberdeenshire and Aberdeen.

For the site in Cumbria, it was assumed that 9% of visitors are there for wildlife watching based on statistics provided for the Lake District National Park.¹⁷ Assuming total annual visits to the site of 522,266 this equates to 47,004 existing wildlife watching visits, of which 58% are from the North West.

The average expenditure per trip for visits at the sites was then estimated based on the average spend across Scotland for wildlife attractions of £58.04 per trip (in 2014 prices)¹⁸ and the average expenditure on tourism visits to Cumbria of £22.39 (in 2014 prices).¹⁹ It was also assumed that there is likely to be a visitor entrance fee at the trial sites of £7.

¹⁶ Scottish Government (2010), 'The economic impact of wildlife tourism in Scotland'.

¹⁷ Lake District National Park Partnership (2012), 'State of the Lake District National Park Report' http://www.lakedistrict.gov.uk/_data/assets/pdf_file/0011/229997/State-of-the-Park-2012.pdf

¹⁸ Scottish Government (2010), 'The economic impact of wildlife tourism in Scotland', <http://www.gov.scot/resource/doc/311941/0098485.pdf>

¹⁹ Lake District National Park Partnership (2012), 'State of the Lake District National Park Report' http://www.lakedistrict.gov.uk/_data/assets/pdf_file/0011/229997/State-of-the-Park-2012.pdf

B) Estimating recreational visits over the longer term

With regards to the longer term potential impacts on recreation (i.e. after the trial period has ended) it was assumed that the annual number of visitors to Mull to watch sea eagles is likely to broadly correspond to the annual number of visitors to each of the pilot sites to watch lynx following their reintroduction.

Based on the results of a survey of visitors to Mull it was estimated that around 4,305 people visit the island each year with the primary purpose of viewing sea eagles, and around 73,780 additional visitors identify the presence of eagles as an important reason for their visit.²⁰

Using the number of visitors who travel specifically to see sea eagles, or for whom the presence of sea eagles provides a strong attraction, it was therefore estimated that there are likely to be 4,305 annual visitors to each of the pilot sites whose primary purpose is to view lynx, and a further 73,780 annual visitors for whom the presence of lynx at the sites is an important reason for their visit.

Following the approach adopted by the RSPB for attributing expenditure to wildlife watching²¹ it was assumed that 75% of the expenditure by those who identify lynx as the primary reason for their visit, and 25% of the expenditure of those who identify lynx as an important reason for their visit, could be attributed to the presence of the lynx. The average expenditure per person per day was based on the estimates provided for average expenditure on wildlife attractions across Scotland and general tourist visits in Cumbria (excluding the £7 visitor entrance fee).

With regards to estimating the potential impact on jobs in the local economy, the approach used by Molly et al. (2011)²² was adopted which developed tourism multipliers for recreational visits to RSPB reserves. Using this approach, it is assumed that £48,772 (2014 prices) of local visitor spend supports one full time equivalent (FTE) job.

C) Estimating the total benefits from recreation across the two periods

The potential monetary benefits were estimated by combining the estimated visitor numbers with the average visitor expenditure during both periods. The present value was estimated assuming a time period of 25 years and a discount rate of 3.5%. The results are set out in Table 7 below.

Table 7. Estimated present value benefits from lynx based recreational expenditure

Factor	Site 3: Kintyre	Site 4: Aberdeenshire	Site 5: Cumbria
Trial period			
Population in catchment areas	88,166	475,800	7,052,000
Potential visits from catchments each year	2,116	11,419	341,317
Existing wildlife visits from catchments	378	7,722	27,262
Net increase in visits due to lynx	1,738	3,697	314,055
Expenditure per person per trip	£65.04	£65.04	£29.39
Total expenditure per year	£113,070	£240,466	£9,229,765
Jobs supported	2 FTE	5 FTE	189 FTE

²⁰ Molloy, D. (2011). Wildlife at work. The economic impact of white-tailed eagles on the Isle of Mull. The RSPB, Sandy.

²¹ Molloy, D. et al. (2011). 'RSPB reserves and local economies', RSPB.

²² Molloy, D. et al. (2011). 'RSPB reserves and local economies', RSPB.

Factor	Site 3: Kintyre	Site 4: Aberdeenshire	Site 5: Cumbria
Longer term period			
Visits primarily to see lynx	4,305	4,305	4,305
Attributable expenditure	£187,397	£187,397	£72,292
Visits for which lynx are important	73,780	73,780	73,780
Attributable expenditure	£1,070,548	£1,070,548	£412,984
Total spend per year	£1,257,944	£1,257,944	£485,275
Jobs supported	26 FTE	26 FTE	10 FTE
Total Present Value	£15,563,660	£16,138,861	£47,479,899

It is interesting to note that the potential tourism benefits are higher in the longer term period for the sites in Kintyre and Aberdeenshire, and lower for the sites in Cumbria, Thetford Forest, and Kielder Forest (see **Main Report**). This is due to the assumptions made in the model which assume that the initial five year trial period will generate significant local interest and visits from the surrounding visitor catchment due, in part, to the uniqueness of the project. Following this period, the model assumes that local interest in the trial is replaced by a more mature tourism industry where the site becomes established as a place for lynx related tourism and attracts a steady stream of visitors from across the UK who are strongly interested in visiting lynx areas. Note, the model looks at each site independently and cannot be used to aggregate tourism numbers across all five sites if the trials are adopted at each site.

For the sites in less densely populated areas, such as Kintyre and Aberdeenshire, the local interest in the trial is expected to be much smaller than in the more densely populated areas with more established tourism industries and much larger visitor catchment areas. By contrast, all of the five sites are expected to equal out to similar levels of visits over the longer term period based on the level of interest in lynx tourism across the UK. In the long term period, accessibility is considered to be less of a constraint, as those who are strongly interested in visiting lynx areas are likely to travel, and the expected higher visitor spend in less accessible areas is expected to generate greater expenditure per visitor. As such, the tourism benefits are expected to be higher in the longer term relative to the shorter term for Kintyre and Aberdeenshire which suggests that, although the total value may be lower than the more densely populated sites, the long term contribution to the area may be of greater local significance.

In order to test the sensitivity of these estimates, a potential 'best' and 'worst' case scenario was developed. With regards to visitor numbers during the trial period it was assumed that in the best case scenario the number of visitors equals those who **strongly agreed** and **agreed** that they would be likely to visit the trial site (i.e. 45.0% in Scotland and 54.5% in the North West). For the worst case scenario, the numbers were assumed to be the same as in the central scenario which was based on the most conservative possible interpretation of the survey results.

As set out in the **Main Report**, with regards to the number of visitors over the longer term, in the best case scenario it was assumed that potential visitor numbers are broadly similar to the number of dolphin watching visits in Moray Firth (i.e. 17,000 visitors primarily there to see lynx and 63,000 for which it is an important reason). While in the worst case scenario it was assumed that the longer term number of visitors are similar to the number of visitors to see chough in Cornwall (i.e. 5,400 primary lynx visitors and 18,000 for which it is an important reason).

The results are set out in Table 8 below.

Table 8. Estimated present value tourism benefits across potential scenarios

Area	Worst case scenario	Central scenario	Best case scenario
Site 3: Kintyre			
Annual value trial period	£113,070	£113,070	£491,535
Annual value longer term period	£496,242	£1,257,944	£1,654,140
Total Present Value	£6,448,777	£15,563,660	£22,013,508
Site 4: Aberdeenshire			
Annual value trial period	£240,466	£240,466	£2,282,904
Annual value longer term period	£496,242	£1,257,944	£1,654,140
Total Present Value	£7,023,977	£16,138,861	£30,101,635
Site 5: Cumbria			
Annual value trial period	£9,229,765	£9,229,765	£21,789,212
Annual value longer term period	£191,435	£485,275	£638,115
Total Present Value	£43,963,665	£47,479,899	£106,015,411

Impact 5. Reductions in deer populations

A) Estimating impacts of lynx on deer populations

Each lynx is assumed to consume an average of 2 kg of meat per day.²³ This amounts to a requirement of 730 kg of meat per lynx per year. For the two sites in Scotland it is assumed that this meat is sourced entirely from wild deer populations and the consumption of deer reflects the abundance of each species based on the analysis set out in Hetherington & Gorman (2007).²⁴ Using this approach the total number of deer consumed per lynx at each site is estimated to be 25.6 each year. Details of this estimate are set out in Table 9.

Table 9. Potential consumption of deer species by lynx at Kintyre and Aberdeenshire

Deer species	Relative abundance (%)*	Average weight (kg)	Consumption (kg/yr/lynx)	Consumption (deer/yr/lynx)
Roe deer	61%	20 kg	443	22.1
Sika deer	13%	50 kg	96	1.9
Fallow deer	1%	50 kg	6	0.1
Red deer	25%	130 kg	185	1.4
Total			730 kg	25.6

* Based on population estimates in Hetherington & Gorman (2007)

For the site in Cumbria, the consumption of deer is assumed to reflect the abundance of deer species set out in Lurz et al. (2005).²⁵ Details of this estimate are set out in Table 10.

²³ Wilson, C.J. (2004), 'Could we live with reintroduced large carnivores in the UK?', Mammal Rev. 2004, Volume 34, No. 3, 211–232.

²⁴ Hetherington & Gorman (2007), 'Using prey densities to estimate the potential size of reintroduced populations of Eurasian lynx', Biological Conservation, 137, 37-44.

²⁵ Lurz et al. (2005), 'Mammals in Cumbria: examples of what publicly collected records can tell us about the distribution and ecology of our local species', The Carlisle Naturalist, Volume 13, Number 1.

Table 10. Potential consumption of deer species by lynx at Cumbria

Deer species	Relative abundance (%)*	Average weight (kg)	Consumption (kg/yr/lynx)	Consumption (deer/yr/lynx)
Roe deer	58%	20 kg	425	21.3
Fallow deer	37%	50 kg	269	5.4
Red deer	5%	130 kg	35	0.3
Total			730 kg	26.9

* Based on population estimates in Lurz et al. (2005)

Based on this analysis, it is estimated that a population reaching 9 lynx in Kintyre, 28 lynx in Aberdeenshire, and 28 lynx in Cumbria after 25 years would consume around 445, 721, and 758 deer each year.

B) Estimating the monetary impact of changes in deer populations

The average monetary cost per deer was quantified based on the analysis undertaken by Piran et al. (2002)²⁶ which examined the costs of deer populations in terms of road traffic accidents (RTAs), damage to crops, and costs to forestry operations. It was then assumed that for each deer killed by the reintroduced lynx populations, the total economic costs attributed to deer populations would be reduced by the corresponding cost per deer. A comparison is provided in Table 11.

Table 11. Monetary cost of deer populations

Type of impact	Monetary cost (£/deer/year)
Road traffic accidents (RTAs)	£78.98
Damage to crops	£58.10
Costs to forestry operations	£133.94
<ul style="list-style-type: none"> • <i>Browsing conifers</i> 	£0.32
<ul style="list-style-type: none"> • <i>Bark stripping of conifers</i> 	£22.33
<ul style="list-style-type: none"> • <i>Culling costs</i> 	£111.29
Total	£271.02

C) Estimating the total benefits from reductions in deer populations

The total potential cost savings due to reductions in deer populations was estimated by combining the expected reduction in deer numbers at each site due to predation by lynx each year (accounting for the growth rate of the lynx population), with the total estimated cost per deer in terms of impacts on RTAs, crops, and forestry operations. The present value was estimated assuming a time period of 25 years and a discount rate of 3.5%.

The results are set out in Table 12 below.

²⁶ Piran et al. (2002) 'Economic impacts of wild deer in the east of England'.

Table 12. Estimated present value of cost savings due to reductions in deer populations

Area	Total no. deer killed	Present value of avoided damage			Present value
		RTAs	Crops	Forestry	
Site 3: Kintyre	5,250	£264,158	£194,305	£447,961	£906,423
Site 4: Aberdeenshire	8,660	£397,765	£292,581	£674,533	£1,364,878
Site 5: Cumbria	9,106	£418,282	£307,672	£709,326	£1,435,280

In order to test the sensitivity of the estimates provided, a comparison of potential ‘best’ and ‘worst’ case scenarios is presented below.

In the ‘best’ case scenario it is assumed that the potential cost savings in terms of RTAs, crops, and forestry are equal to the maximum estimates in Piran et al. (2002),²⁷ while the ‘worst’ case scenario cost savings are assumed to be equal to the minimum estimates. Due to the levels of uncertainty over the potential impacts of lynx populations on deer related RTAs, it was further assumed in the ‘worst’ case scenario that any potential reductions in RTAs due to lower deer populations would be fully offset by potential increases due to deer activity and therefore the economic benefits are equal to zero. The results are set out in Table 13 below.

Table 13. Estimated present value of cost savings due to reductions in deer populations across potential scenarios

Area	Worst case scenario	Central scenario	Best case scenario
Site 3: Kintyre	£405,704	£906,423	£1,166,146
Site 4: Aberdeenshire	£610,904	£1,364,878	£1,755,965
Site 5: Cumbria	£642,415	£1,435,280	£1,846,539

²⁷ Piran et al. (2002) ‘Economic impacts of wild deer in the east of England’.

CONCLUSIONS

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Based on the analysis set out in the sections above, the estimated Net Present Value (NPV) of lynx reintroduction over a 25 year period is £15.7 million in Kintyre, £16.8 million in Aberdeenshire, and £48.1 million in Cumbria (Table 14). Note, this model looks at the costs and benefits of each site independently and, as such, the results cannot be aggregated across multiple sites.

Table 14. Results of the cost-benefit analysis for lynx reintroduction

Potential impact	Site 3: Kintyre	Site 4: Aberdeenshire	Site 5: Cumbria
Predation on livestock	-£7,316	-£11,016	-£78,214
Costs of monitoring	-£723,504	-£723,504	-£723,504
Risks to human health	£0	£0	£0
Recreation and tourism	£15,563,660	£16,138,861	£47,479,899
Reductions in deer	£906,423	£1,364,878	£1,435,280
Net Present Value	£15,739,263	£16,769,219	£48,113,461
Benefit:cost ratio	23:1	24:1	61:1

According to the findings of this analysis the economic case for reintroduction appears to be strong for all sites. In order to account for some of the uncertainties in the estimates, a ‘best’ and ‘worst’ case was developed for each site. The results suggest that all scenarios are expected to deliver positive and significant economic returns ranging from £5.9 million under the worst case in Kintyre to £107.3 million under the best case in Cumbria (see Table 15).

Table 15. Net present value for each site under different scenarios

Area	Worst case scenario	Central scenario	Best case scenario
Site 3: Kintyre	£5,934,333	£15,739,263	£22,600,851
Site 4: Aberdeenshire	£6,688,462	£16,769,219	£31,278,797
Site 5: Cumbria	£43,659,660	£48,113,461	£107,272,131

As set out in Figure 4, the results for the two sites at Kintyre and Aberdeenshire are lower than those for the sites at Kielder Forest, Thetford Forest, and Cumbria. This is principally due to the lower population density and lower interest in visiting the trial sites in Scotland.

Figure 4. Comparison of central estimate NPV across four potential sites (‘best’ and ‘worst’ case scenarios presented as error bars)

