

# Economic impacts of the beaver

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# Summary

The European beaver (*Castor fiber*) was once widespread throughout Asia and Europe. It was prized for its fur, the castoreum it produces (for use in medicines and as a base aroma in perfumes) and its meat (which could be eaten by Catholics on Fridays as a fish). Such a useful animal was naturally hunted intensively; the last beaver in Britain is believed to have been relieved of its pelt in the 16<sup>th</sup> century. By the 20<sup>th</sup> century only 8 small populations remained on mainland Europe, holding about 1200 beaver.

**Today through reintroduction schemes and natural range expansion beavers have returned to 23 of the 29 European states from which they had been lost. Britain remains among the 6 nations without beaver.** In Britain reintroduction proposals remain controversial despite no major issues arising from reintroductions in other countries. Among the many potential benefits of a beaver reintroduction, supporters of the scheme cite their potential draw as an attraction for wildlife tourism. In the UK wildlife tourism is a thriving and significant industry [1-5]. For example, visitors to Wales who come specifically for the wildlife spend approximately £13.8 million per annum<sup>1</sup> and in the West of Scotland, the gross tourist income from whale watching alone has been estimated at £7.8 million per annum [6].

This study used questionnaires and economic tools to begin to measure the potential economic impact beavers might have on wildlife tourism in Britain. It was in effect a scoping study and so its predictive powers are limited. Its aim was merely to begin to consider the relative sizes of the costs and benefits.

We found that these benefits could be substantial. **A beaver release site might bring** (tourism multiplier included) **~over £2 million per year into the local economy, whilst a pessimistic estimate could still yield ~£3/4 million.** Focused eco-tourism could further enhance these benefits, for example, just **seven operators in Scotland could inject** (tourism multiplier included) **over £1 million into the local economy adjacent to reintroductions.** Statistical analysis showed that including an enigmatic species, such as the beaver, in a tourism holiday increases its merit by **£63** per person.

In comparison **the potential damages that might be caused by beavers appear small.** Negative economic impacts reported from previous reintroductions varied widely and were not related to area, beaver population size or the amount of time beavers had been in areas. Therefore we were not able to accurately predict likely economic impacts for the UK. However, the order of magnitude of the costs indicated by case studies might be considered low, rarely rising above 10,000 euros/annum/region and in the majority of cases being insubstantial.

The relative sizes of the costs and benefit of a beaver reintroduction: benefits could be around 100 times larger than costs.

Benefits

Costs

<sup>1</sup> Spending figure provided by C. Hughes, Wales Tourist Board.

Analysis of case studies and previous reintroductions indicate that to obtain the greatest benefits from a beaver release the following points should be considered:

- 1) General interest should be raised by involving the public pre-reintroduction
- 2) Local landowners, chambers of commerce and other interested parties should be consulted beforehand on relevant developments
- 3) The use of a well thought out visitor centre should be considered to provide a focus to the reintroduction
- 4) Such ecotourism projects should highlight the wild and natural aspects of the experience and avoid creating a ‘theme park’
- 5) Projects in different locations should differentiate their products to cater to different markets, for example some sites may concentrate on providing more isolated and “natural” experiences whilst others cater for visitors requiring more support
- 6) Ecotourism should generally be practiced at the grassroots level for the benefit of the local community, (but note point 7)
- 7) A cohesive face of ecotourism in England and Wales should be offered to the public through the formation of an umbrella association along the lines of the Wild Scotland initiative
- 8) Thorough discussion and careful planning will be required to minimise the potential imbalance between the recipients of benefits from reintroduction and those that experience conflict with the beaver

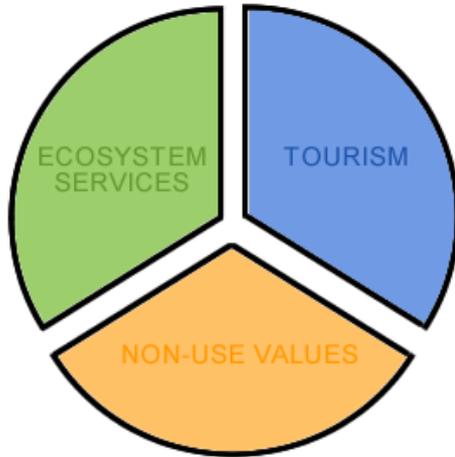
With forethought, prior consultation and planning, a beaver reintroduction should bring significant monetary benefits into the local economy and communities that could greatly outweigh any potential negative impacts. The remaining challenge is the design of frameworks to mitigate and compensate real costs and dispel myths regarding perceived costs.



# Index

<b>Section</b>	<b>Page</b>
<b>Summary</b> .....	<b>i-ii</b>
<b>Index</b> .....	<b>iii</b>
<b>Introduction</b> .....	<b>1-3</b>
Non-market benefits.....	2
<b>Tourism</b> .....	<b>4-9</b>
Experiences from beaver managers and researchers.....	4
Box 1: Tourism multipliers.....	5
Table 1: Profile of visitors to wildlife attractions in the UK.....	5
Table 2: Potential additional site-based revenue.....	6
Table 3: Projected income to a beaver reintroduction site based in the UK.....	6
Experiences and predictions from providers of wildlife holidays.....	7
Table 4: Expected likely revenue in Scotland from some wildlife holiday providers...	8
Hedonic pricing analysis: an independent verification of our results.....	9
Tourism and the beaver overview.....	10
<b>Costs, Perceptions and Mitigation</b> .....	<b>12-16</b>
Fig 1. Reported regional cost ranges of land-use conflict.....	12
Agriculture.....	13
Box 2: Flow devices.....	13
Forestry.....	13
Fisheries.....	14
Domestic gardens.....	14
Other land-use.....	14
Perception.....	14
Mitigation.....	15
Table 5: Mitigation techniques utilised.....	16
Overview of costs, perception and mitigation.....	16
<b>Conclusions and Recommendations</b> .....	<b>17-18</b>
<b>Literature cited</b> .....	<b>19-20</b>
<b>Appendix I: Methods use in this study</b> .....	<b>I-II</b>
<b>Appendix II: Overview of questionnaire respondents</b> .....	<b>III</b>
<b>Appendix III: Wildlife attractions - Visitor expenditure model</b> .....	<b>IV</b>

# Introduction



Due to its foraging and engineering activities, **the European beaver (*Castor fiber*) can be considered a keystone species of significant importance to the maintenance and creation of wetland ecosystems** [7]. Unfortunately these same characteristics may lead to conflict with human land-use. On the other hand beavers are charismatic animals that are appealing to wildlife watchers.

These three factors will all contribute toward the economic impacts of a beaver reintroduction. This small scale study seeks to estimate the relative sizes of these economic impacts through our own original research and with reference to previous work by others. Such quantifications are fraught with

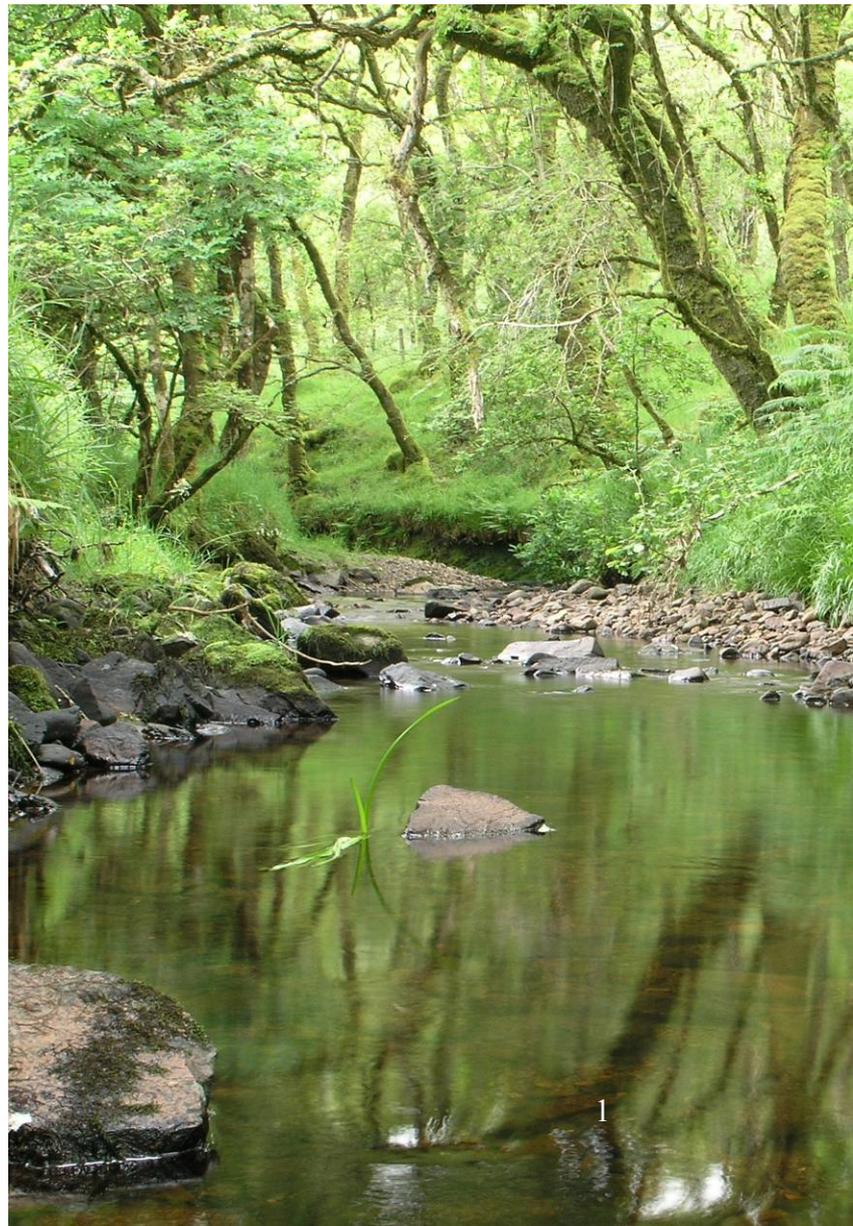
difficulty and we stress that any figures provided should not be taken as exact measures, but as rough illustrations of the potential magnitude of the impact on tourism revenues (blue in figure here).

This report does not present a full cost-benefit analysis of beaver reintroductions as it does not fully account for conservation and environmental issues or the public conscience (orange and green in figure here). However accounting for these benefits should only strengthen the case for reintroduction of the beaver since the relatively slight costs to the economy described later on in this report, are even more fully outweighed by benefits.

The study concentrated on four main aspects:

- 1) A questionnaire survey of experiences of beaver managers and researchers in other European countries
- 2) An analysis of projected visitor expenditure at wildlife attractions in the UK
- 3) A questionnaire survey of the experiences and expectations of wildlife holiday providers
- 4) A hedonic (revealed preference) analysis of actual wildlife package tours.

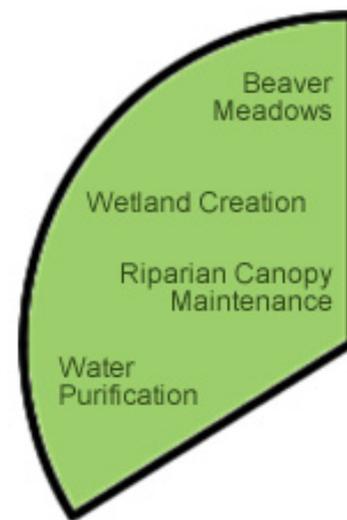
Detailed methodologies are provided the appendices.



## non-market benefits

The environment around us often provides benefits to us that are not immediately apparent or are expensive and difficult to emulate, termed 'ecosystem services'. Wetlands created by beaver activity can deliver a broad range of ecosystem services. Currently wetlands are known to:

1. **reduce erosion**
2. **reduce pollution** by trapping sediments and by trapping excess nutrients and potentially dangerous chemicals in these sediments
3. **regulate peak discharge** on river systems after heavy rain
4. **maintain or raise the water-table** by storing water

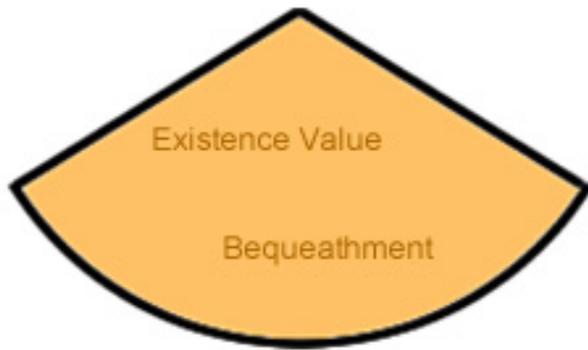


By creating wetlands through their damming behaviour, beavers can greatly assist the provisioning of these ecosystem services. Calculating the value of these services to humanity is difficult and beyond the scope of this report, however the only published attempt (to our knowledge) at valuing beaver created wetlands indicate that the benefits are high: In Latvia in 1982 it was calculated that, based on a population of 100,000 animals, by the year **2000 beavers would have created or conserved 150 km<sup>2</sup> of wetlands valued at £1 billion** as fixed capital [8]. Furthermore, through this, **32 million m<sup>3</sup> of water would be purified annually which would have cost around £120 million to do artificially**. In Tatarstan, beavers are currently being harnessed to reduce the infilling of Lake Raifa from river eroded sediments [9].

The potential for water storing in beaver dams has further application. **Floods** in England and Wales such as those that occurred in the autumn/winter of 2000 have been **estimated to cost the economy around £600 million per annum** [10]. Such flood events are expected to increase in frequency in the future due to climate change [11] and this has encouraged the UK Environment Agency (EA) to reassess its flood management strategies. The EA's River Severn flood management strategy scoping report [10] indicates the need for a more holistic approach to flood management including, for example, preventing peak flow from tributaries coinciding, together with changes in reservoir operating regimes and storage volume to provide flow attenuation.

The dam building behaviour of beavers occurs mainly in smaller tributaries and may provide many of the services outlined in the EA report. It is potentially an extremely useful tool for future holistic flood management systems in many river catchments throughout Britain, including the River Severn. No study has been conducted to examine the economics of **beavers as flood management tools**, but the economic benefits may be considerable.

Other benefits that may be derived from the presence of beavers also revolve around their modification of the local habitats. Beavers do not always create dams however they can add biodiversity value to their local riparian habitat in their actions as ecosystem engineers. By removing trees, shrubs and other shading vegetation they may improve the structural diversity of the local area. This has the potential to benefit birds, invertebrates and other fauna of riparian habitats [7, 12].



Where the public are willing to pay for something even though they may derive no direct benefit or use, then it has 'existence value'.

One estimate of the monetary value of the beaver to the Scottish public suggests that a **beaver reintroduction on top of a large scale forest restoration could be worth as much as £101 per household** [13]. Under that model the forest restoration alone was worth £35 per household, meaning that **the beavers added £66 per household**.

Two other models were produced to estimate the project value per household whilst allowing for a compensation cost to people who view the reintroduction negatively. Accounting for compensation requirements, the better fitting of these two models still indicated the mean value per household for both the forest and the beaver was £67 and for the forest alone £37. This means that **just to have the knowledge that beavers had been reintroduced in Scotland** (not necessarily to experience them) would still be worth £30 to each household. This potentially **amounts to more than £65 million** across Scotland's households.

Even though we might not expect any single person or group of people to directly benefit from ecosystem services or the simple existence of beavers, from this research we can see that the presence of beavers can have considerable value to humans.



## experiences from beaver managers and researchers

We asked people involved in the research and/or management of beaver populations in mainland Europe for their experiences with tourism and the beaver. We did this to attempt to build a picture of the current situation in countries with beaver populations and to see whether anything could be learned. See *Appendix I* for further information on our methods and *Appendix II* for a brief overview of some of our results.

- Two participants gave an estimate of annual visitor numbers to an actual centre of 3000 and 8500 (mean = 5750)
- Two participants gave details of entrance fees for the centres, these being €2.50 and €1.25 / person (£1.66 and £0.83 respectively; mean = £1.25)
- Five respondents said they conducted guided tours.
- Three participants provided further details estimating that the number of people that took the tour ranged from 50 to 5,000 / year (mean = 1,850) at a cost of up to €2.50/person (mean = €1.25 or £0.83).
- In addition, all sites provide free public access to the release sites.
- Four participants gave estimates of the total number of visitors to their sites, these ranged from 500 to 30,000 / year (mean = 11500)

We can estimate the further impact of visitors on the local economy using figures from previous research into tourism. A study [4] by the Royal Society for the Protection of Birds (RSPB) found that **visitors to RSPB reserves in the UK spent an additional £41 each over and above any entrance fees** in 1998. This equates to **£50** at 2006 prices [14]. We can use this to estimate potential expenditure at European beaver reintroduction sites.

For a conservative minimum estimate of income we assume that the site and centre are free with the only people paying anything being those willing to go on a tour. Using the above figures this gives a minimum annual expenditure of **£94,035.50** (1850 tour participants × (£50 additional spend + £0.83 tour fee)). However, if *all* visitors are spending £50 on local goods and services this may increase beyond a potential **£575,000** (11,500 visitors × £50).

If we add Surrey Research Group's regional tourism multiplier of 1.3256 to these figures [15] (see Box 1.), then we arrive at an expenditure range of £124,653.46 - £762,220 indicating that **the benefits to the local economy from one European beaver centre could be around £¾ million per annum when using arguably pessimistic visitor number estimates**.

**Beavers could represent a significant attraction to wildlife tourists in the UK.** Single species wildlife attractions in the UK tend to attract considerably more visitors and may charge a higher entrance fee. For example:

- The Osprey Centre at Loch Garten in Scotland attracted **33,048 visitors in 2005** with an entrance fee of £3 per adult [5] and
- The Red Kite Centre in Wales attracted **33,350 visitors** in 2004 (up 13.9% from the previous year) and charged £2.50 per adult [2].
- If these visitor numbers were comparable to a European beaver site, then **the income to the local economy would be approximately 3 times that of the figure we estimated for a European site (i.e. ~ £2.25 million / year).**

### **Box 1: Tourism multipliers**

The money brought into a region from tourism stimulates further growth as that money circulates through the local economy. This effect is known as the ‘multiplier effect’. There are several different types of multiplier including tourism multipliers, but they all essentially follow the same principles: At the first stage, tourists spend an amount on local products, hospitality, accommodation and goods. This revenue from tourism is then spent on government revenue, business transactions and household income. From these three categories some tourism revenue leaks out of the local economy as it is spent on services or products from outside the local region (import purchases). The remaining revenue gets spent again in local area and again, some leaks out through import purchases. This cycle of spending continues until there is virtually no revenue remaining from the original injection.

The Surrey Research Group’s 1993 multiplier [15] used here was developed for *Highlands and Islands Enterprise, Scottish Enterprise, the Scottish Tourist Board* and the *Scottish Office Industry Department*. Calculation of multipliers is an exhaustive process and highly dependant on local conditions. On the other hand, the cost of producing them precludes the use of constantly updated and regionally specific multipliers. For this reason it is common for multipliers to be used for a longer period of time and in regions beyond those in which they might be considered accurate. For our purposes it is unnecessary to concern ourselves too deeply with this loss of accuracy since we are only trying to illustrate the general size of the impacts expected, but are using the most accurate figures available to us. Nevertheless we would not wish to mislead readers into using these figures as accurate predictions.

A more accurate prediction of the potential revenue that may be created by a beaver reintroduction to the UK can be gained by examining the economic impact of current wildlife attractions. Reviewing the visitor profile and spending at current wildlife attractions gives an indication of income available that may be accrued, for example from admissions.

*Table 1. Data on the profile of visitors to wildlife attractions in the UK [2, 19, 20]. Numbers in brackets denote the sample size of attractions providing information. Please note the different group structures used by the different tourist boards as this will affect visitor statistics (see Appendix III).*

Visitor attraction group	Total no. of visitors	Origin of visitors			Distribution of visitors		Average adult admission /parking charge	
		N	Overseas %	Local %	Other %	Free sites		Paid sites
<b>England (2006)</b> Nature reserves, wetlands, wildlife trips, safari parks, zoos, aquariums, aviaries	13,100,000 (94)		4*	73*	24*	51%** (735)	49%** (1254)	£7.41 (61)
<b>Scotland (2005)</b> Nature reserves, wetlands, wildlife trips	403,309 (20)	(12)	14	35.9	50	71% (12)	29% (8)	£4.49 (5)
<b>Wales (2006)</b> Country parks and visitor centre, forest parks, gardens, nature reserves, wetlands, wildlife trips	3,985,996 (48)	(30)	6.3	63.6	30.1	78% (29)	22% (19)	£3.46 (17)

\* Data from “Origin of visits by category 2006” Factsheet provided by VisitBritain.

\*\*Data from “Sector structure and visits by standard adult entry charge 2006” Factsheet provided by Visit Britain. Data shows visits to all visitor attractions not just the wildlife based attractions.

In addition to admission charges visitor centres and associated retail and food outlets can potentially bring substantial revenue for operators. For example, the National Trust, which has the largest membership of any UK charity, earns **£6.2 million / year** from retail and catering at its visitor centres alone. This is equivalent to £4 / visitor. RSPB, which also has a very large membership, earns around **£10 million / year** from its retail operations, though this includes an online shop. The Wildfowl and Wetlands Trust has nine visitor centres that in 2004, received a total of 788,210 visitors (ranging from 15,501 to 184,466 visitors at each of the centres), netting the trust £1.7 million in admissions and **£489,000 in sales revenue** (a total of £2.78 / visitor). Data from Wales shows that ancillary income at a site may **more than double the income from admission charges** (See Table 2.).

Table 2. Potential additional site-based revenue per person

	Admission	Donation	Catering	Retail	Other	Total
<b>Scotland (N=5)</b>	£4.49	£1.44	£0.24	£0.60	£0.00	<b>£6.77</b>
<b>Wales (N=17)</b>	£3.46	£0.19	£2.77	£1.76	£0.10	<b>£8.28</b>

The England Biodiversity Group recently developed the “Wildlife Attraction: Visitor Expenditure Model” [16]. See *Appendix III* for details of the method used (also see User Guide [17] and Model Assumptions [18]) to estimate the economic contribution an attraction could make to the local community. Combining this model with visitor statistics provided annually by the three tourism boards of England, Scotland and Wales [2, 19-20] (See Table 1) allowed us to hypothesise the impact of a beaver reintroduction in different regions of the UK (See Table 3). This data shows that a beaver site could provide a potential net income in England of **£1.25 million with site-based income such as admission charges increasing this to over £2 million.**

Table 3. Projected income from a beaver reintroduction site based in the UK. Total income was calculated from the net regional income, based on the ‘Wildlife Attraction: Visitor Expenditure Model’ [16], and potential admission income plus additional site income where information was available.

	Mean annual no. of visitors to a wildlife attraction*	Number of visitors used in model*	Net impact in region (£)	Mean admission charge	Potential admission income	Additional site income (from table 2)	Total income
<b>WALES</b>	83,042	82,950	541,252.00	3.46	287,007.00	399,819.00	1,228,078.00
<b>SCOTLAND</b>	20,165	20,180	279,413.00	4.49	90,608.20	46,010.40	416,031.60
<b>ENGLAND**</b>							
East (24)	102,315	102,270	1,090,613.00		757,820.70		1,848,433.70
East Midland (3)	110,502	110,600	1,270,801.00		819,546.00		2,090,347.00
North East (3)	24,028	23,970	260,377.00		177,617.70		437,994.70
North West (7)	203,738	203,740	2,206,766.00		1,509,713.40		3,716,479.40
South East (11)	135,150	135,240	1,595,056.00	7.41	1,002,128.40	Unknown	2,597,184.40
South West (18)	241,132	241,070	2,879,909.00		1,786,328.70		4,666,237.70
West Midlands (5)	41,552	41,475	483,700.00		307,329.75		791,029.75
Yorkshire and Humber (1)	21,036	21,100	4,350.00		156,351.00		380,701.00
<b>MEAN</b>			1,251,446.50		814,604.46		2,066,050.96

\* See Appendix III for explanation of calculations

\*\*Numbers in brackets denote the sample size of attractions providing information on visitor numbers to attractions in that area.

## experiences and predictions from providers of wildlife holidays

We asked companies that provide wildlife based holidays in the UK and mainland Europe to British people, about their operations in general and about their experiences of providing tours that enabled people to view beavers. We also asked the companies if they would be willing to offer tours in the UK that would involve beavers and what they predicted the costs, spending and customer numbers would be. We asked these questions to gain a picture of how wildlife holiday providers currently operate across Europe and to also establish how these same operators would be expected to operate were beavers to be released into the UK. See *Appendix I* for further information on our methods and *Appendix II* for a brief overview of some of our results.

**Providers of wildlife holidays were keen to offer UK based holidays to areas into which beavers are released.** All holiday providers replied that they would offer beaver related holidays if they were released into the countries in which they currently offered tours, except one which specialised in marine and coastal tours.

Furthermore, **some providers would be willing to expand into new geographical regions were beavers reintroduced.** Of those companies not currently operating in the respective countries: 12% would consider adding holidays to England, 10% would consider adding Scotland and 17% would consider adding Wales (an increase in providers of 66%, 10% and 150% respectively in each country).

The economic input to local economies from beaver related holidays could potentially be substantial. If we add up the figures on client numbers, package price, percentage of this price that is spent locally and the extra that clients are likely to spend on accommodation, food, gifts and other products, then we can arrive at a rough estimate of the input into the local economy that these tour companies would have.

We will consider Scotland closely since we received the most responses from there. It also has arguably the most developed wildlife tourism industry with respect to the sort of overnight and longer breaks we are referring to and has a high proportion of overseas visitors (Table 1). Wales and England may benefit more from day trips which make up a large percentage of breaks in the UK (for example, in 2002/3, over 100 million day trips were taken in the English countryside compared with 25-30 million overnight stays [21]).

Seven of the companies that would offer such holidays in Scotland provided enough information to estimate the gross income they might expect. In total the estimate comes to **£800,965 per year from 7 operators** (Table 4). If we **add the regional tourism multiplier** [15] of 1.3256 to these figures (see Box 1), then the benefits to the local economy might rise to **£1,061,759 per year**.

Of the 10 companies that indicated they would or might offer tours in Scotland, we asked whether they would consider offering a tour to Knapdale were beaver to be released there. To our knowledge none of the companies currently offer a tour to the Knapdale area and six companies indicated they would (however one company added the proviso that there shouldn't be a large visitor centre built at the site).

In general, **providers were positive about the knock-on effect the beaver might have for other tourism.** When asked what they thought the impact would be of a beaver release in generating clients for other wildlife and/or non-wildlife holiday packages in the area local to the release, respondents graded the impact on average as 4 out of a maximum of 5.

**Beaver holidays in Europe:** Nine of the 20 tour operators we spoke to already offered holidays in Europe that included the opportunity to view beavers. This figure includes one company which takes tours to the Ham Fen beaver project in Kent, SE England. Therefore **at least one of these nine companies had already begun offering trips to an area directly as a result of a beaver reintroduction.**

Our results, indicate that:

- Wildlife tour operators have the potential to inject considerable income into local economies.
- At both the national and local level, the beaver has the potential to attract wildlife tour operators who have not previously operated in the area.
- In support of this notion; tour operators also believe that the presence of beavers would generate further non-beaver related wildlife tourism for the area local to a release site.

*Table 4: Expected likely revenue in Scotland from wildlife holiday providers.*

These data were obtained from survey results where we asked 10 wildlife tour companies whether they would offer trips to see beavers in Scotland, were they to be released there. We then asked them to estimate the likely pricing, client numbers and local spending in different sectors. We then used these figures to predict the likely revenue for the local economy these companies would create. Not all companies were able to provide all the data necessary for these calculations. Therefore, we extrapolated from those companies that were able to provide all the data to arrive at the bottom line (*Expected total revenue from all interested companies surveyed*).

<b>Variables: Type of beaver holiday offered</b>	<b>No. of companies</b>
No. offer as tour highlight	3
No. offer as tour extra	3
No. offer as both tour highlight and extra	3
No. possibly offer as tour extra	1
<b>Total No. Companies</b>	<b>10</b>
<b>From these companies:</b>	
% providers expecting some non-UK clients	36%
% of clients from outside UK	24.2%
Mean number of clients / year	369.0
Mean group size	9.44
Mean entire package length (days)*	5.33
Mean package price	£477.25
Mean % of price spent locally	87.5%
Mean client extra local spend	£190.00
of which spent on travel	£76.57
of which spent on accommodation	£38.00
of which spent on food	£32.29
of which spent on gifts	£29.50
of which spent on other	£13.64
No. Companies where <i>all</i> the above information supplied	7
Expected revenue from above companies	£800,965.00
Expected mean revenue per company	£114,423.57
<b>Expected total revenue from all interested companies surveyed</b>	<b>£1,144,235.71</b>

\* Tours of more than 1-2 days tend to include more than one species and therefore longer tours may include other species and areas.

The availability of information for Scotland is at least partly a reflection of Scotland's (particularly the Highlands' and the West Coast's) status as the top wildlife destination in the UK. However, it may also be due to the **highly organised nature of Scotland's wildlife tour operators**. For example, tour operators in Scotland present a fairly cohesive face in the form of the *Wild Scotland* website<sup>2</sup>. Five of the 48 tour operators approached during the course of this study were found from this website via *Google*. We could not find an equivalent website for companies operating in England or Wales. Thus, obtaining information on companies operating in Scotland was relatively easy.

The larger population centres in or near England and Wales may provide a large customer base within easy access of a release site in these countries. Indeed, **locals make up the majority of visitors to wildlife attractions (Table 1)**. Additionally, in 1994 **informal day trips to the countryside represented 14% of the total value of tourism to the English economy and generated £9 billion in revenue** [22]. Therefore, we might expect short independent trips to play a larger role and guided trips a smaller role in tourism in England and Wales because of the ease of access.

This suggestion is corroborated by a study on visitor numbers to RSPB reserves in 1998 and 1999 [5]. Of their top 20 (which between them received on average over 800,000 visitors annually between 1998 and 1999) 13 are in England and 4 in Wales compared with just 3 in Scotland (of which two are in central Scotland, and therefore nearer the large population centres).

### **hedonic pricing analysis: an independent verification of our results**

Figures on tourism and beavers obtained from our study could potentially be inaccurate simply due to pessimistic or optimistic responses from our questionnaire. To obtain an independent verification of our results, we conducted an analysis on the pricing structure of actual holidays offered by holiday providers. The assumption is that the price of a product is dependant upon its characteristics. For a car price dependant characteristics might include the safety features, maximum speed and fuel consumption; whilst for eco-tourism we might include accommodation, food and (we would hope) the species you are likely to encounter including beaver.

The analysis took information on 120 holidays from wildlife tour brochures. We then attempted to tease out the degree to which beaver influence the price through statistical techniques as described in *Appendix I*. In order to do this we estimated the increase produced in the price of the holiday when another large charismatic mammal is added to the itinerary. A list of 6 such mammals was created based on whether they had: *a*) been lost to the UK, *b*) weighed over 20 Kg and *c*) were, arguably, charismatic. These were: bear, beaver, bison, elk, lynx and wolves and were called the '*big-6*'. We used this *big-6*, instead of just single species because the low overall numbers recorded for each single species in holiday packages (all less than ¼ of holidays) would not have allowed a robust statistical analysis.

- In accordance with the responses from our questionnaires, beavers are commonly regarded as an attractive species by providers.
- Beaver were mentioned in 20 (17%) of the brochures, wolf in 26 (%), bear in 21 (17.5%), lynx in 19 (16%), elk in 18 (15%) and bison in 11 (9%).
- In total, 43 (36%) of the holidays mentioned one or more of these six species including, 30 (25%) mentioning two or more and one holiday mentioning all six species.

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<sup>2</sup> <http://www.wild-scotland.org.uk>

- The high frequency of reference to the beaver in the brochures may be an indication of one of the advantages this species has to wildlife tourism, rather than simply an indication of the beavers' popularity (according to the tour operators, wolf, bear and lynx tend to attract more queries from potential customers than the beaver does). **The beaver is relatively easy to view** (particularly when compared to the elusive carnivores) and the lack of guaranteed success in viewing European carnivores was frequently highlighted by tour operators in their brochures.

Our model related the destination country, holiday length, the number of meals provided and the number of charismatic mammal species (from the *big-6*) listed in the brochure to the price. This model proved to be fairly accurate in predicting the price of a holiday<sup>3</sup>. It was also realistic in that the price increased with each of the quantifiable variables.

- In this model **the *big-6* mammals contribute significantly to the holiday prices, as the holiday price increased by approximately £63 per person every time one of the *big-6* mammal species was added to the trip itinerary**<sup>4</sup>.
- This estimate of effect on price is likely to be fairly conservative because of the statistical tool used<sup>5</sup>.

The test used will attribute all the variation it can to the destination country first before it attributes any variation to the other (quantifiable) variables. Therefore, if countries with the largest populations of the *big-6* (and therefore the countries most likely to have *big-6* holidays) are also intrinsically more expensive due to higher travel costs (e.g. eastern Europe) or higher living costs (e.g. Scandinavia) than the UK, then an increase in holiday prices are going to be attributed to these factors first and the presence of any of the *big-6* mammals after.

We might expect that some wildlife tour operators would be optimistic in their predictions of tourism in relation to the beaver, particularly if they could benefit from the presence of beavers in the UK and they thought that a positive response in this study might influence any decision to release beavers. However, the hedonic pricing analysis presented here indicates that this is not the case.

- **Based on our analysis, it appears that the *chance* of viewing any of these mammals really does increase the value of a holiday package considerably.**

## tourism and the beaver overview

Our results indicate that the **beaver could bring substantial tourism benefits** to a reintroduction area and present a useful addition to the UK's expanding environmental tourism market. To inject a note of caution here; researchers and managers did not generally grade the economic benefits of beavers very highly. This may be in part due to benefits being spread throughout the community and therefore less obvious or less direct than, for example, a factory or other single large employer in the area. Regional economic benefits of a beaver reintroduction are likely to be smaller scale and more dispersed as they are based on tourism revenue throughout the region. However, we may expect that their presence could provide benefits to local economies that would make **having this species a worthwhile goal even before environmental and biodiversity benefits are taken into consideration.**

<sup>3</sup> This model explained 92% of the variation in holiday price ( $R^2=0.9$ ,  $F_{(32, 87)}= 32.278$ ,  $P<0.001$ )

<sup>4</sup>  $\beta = 62.96 \pm 17.33$  SE,  $P<0.001$

<sup>5</sup> type I GLM



# Costs, Perceptions and Mitigation

We asked experts involved in the research and/or management of beaver populations in mainland Europe for their experiences of land-use conflict, mitigation methods and public perception of the beaver. This was done in order to build a picture of the current situation in countries with beaver populations and to see whether anything could be learned from their experiences. See *Appendix I* for further information on our methods and *Appendix II* for a brief overview of some of our results.

The area covered by each expert ranged from single sites to countrywide population management. It must therefore be noted questionnaire responses varied due to differences in the size of the beaver population being considered (from 20 to >100,000) and the region being influenced.

Based on the questionnaire responses from beaver managers and researchers, **conflict between beaver and human land-use generally appears to be low-level**. For example, though all land-use categories we asked about had experienced some conflict with the beaver in at least one of the respondents areas, when asked to grade the severity of this conflict (where it occurred) from '1' (low) to '5' (high), the mean grade given was 1.5.

We will go through each land-use category and examine the costs, perceptions and mitigation methods used. Overviews of the reported cost ranges are given in Fig. 1 and mitigation methods used are given in Table 5.

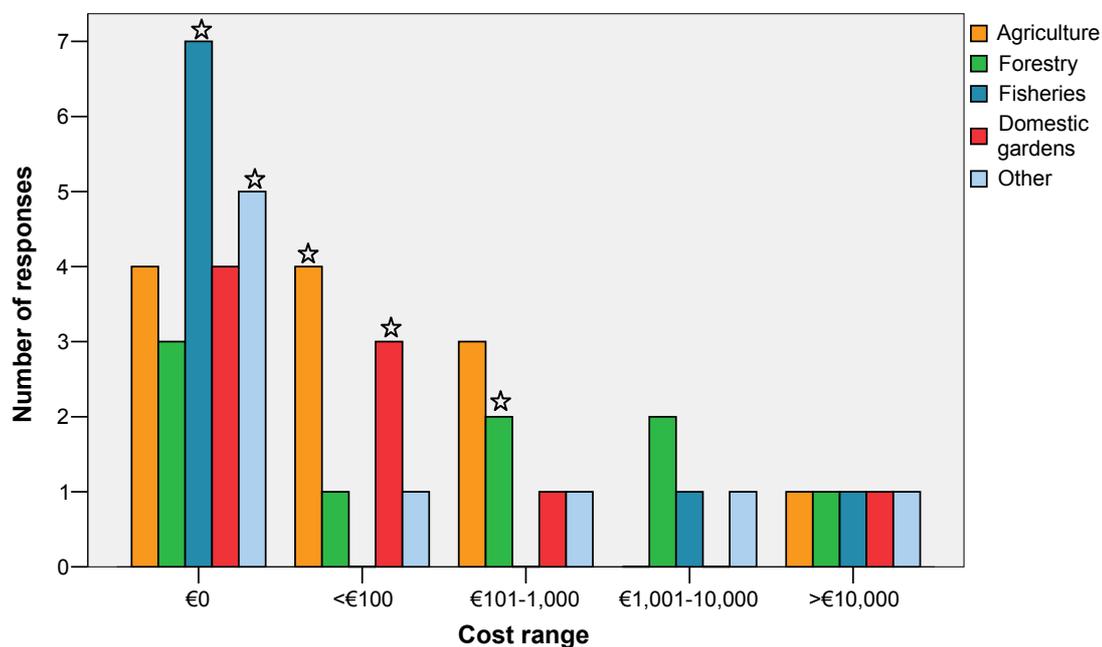


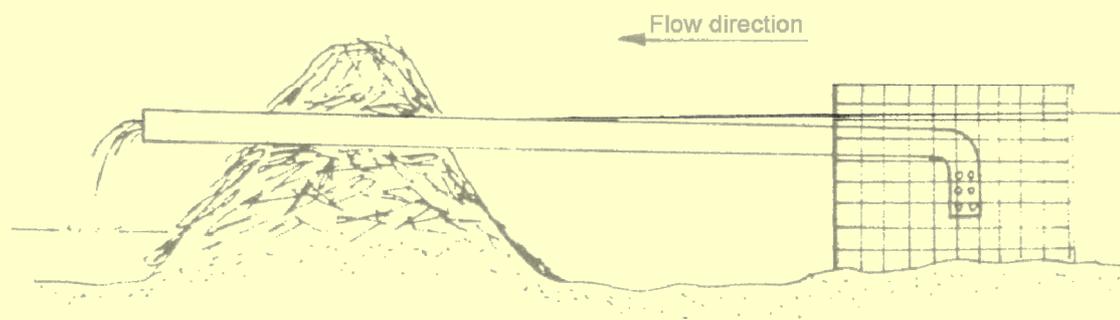
Fig 1. Reported cost per beaver population by land-use category. Stars indicate that the bar represents the median (i.e. typical) cost range for the land-use

## agriculture

- Prior to reintroductions, 37.5% of respondents reported concerns being raised about conflict with agricultural objectives.
- Agricultural conflict appeared to be small scale with a median (i.e. typical)<sup>6</sup> range of €1-100 per annum per beaver population.
- Most conflict appeared to be from beavers foraging on crops (53% of respondents reported that this occurred in their region) or loss of agricultural land due to flooding.
- However, the low costs indicate that such events were localised and small scale.
- In agricultural conflicts the most commonly utilised mitigation methods aimed to reduce flood risk through dam removal and instillation of flow devices (see Box 2).

### **Box 2: Flow devices**

A flow device (otherwise known in North America as a 'beaver deceiver') is a device that is used to drain water from a beaver pond without the beavers being able to work out where the water is escaping and then blocking the flow. The device usually consists of a system of pipes (and sometimes fencing or mesh) that either has an inlet some distance upstream from the dam or that has an inlet that is protected in such a way as to make effective damming of the inlet pipe impossible.



Example of a flow device, from Nitsche [23].

## forestry

- Prior to reintroductions, 37.5% of respondents reported concerns being raised about conflict with forestry objectives.
- With a median cost of €101-1,000 per population, reported costs of conflicts were higher than for all other land-use types, but still relatively low given that the figures represent annual costs.
- Again, most conflict appeared to be due to the foraging activity of beavers (60% of respondents reported some felling of commercial trees) or loss of forestry land and trees due to flooding.
- However, again, conflict generally appears to be localised and small scale, given the low median cost value.
- Except for translocations, all mitigation methods considered were utilised (see Table 5), with dam removal being the most common method applied.

<sup>6</sup> The median value is the measure of the mid-point of a range of numbers and is not the same as the mean or average value. We frequently use medians instead of means in this report because many of the figures we are describing are from questions where respondents were required to indicate the range of values that best described their answer, instead of giving an absolute value. The median is frequently used to indicate an average where data sets may be skewed by high outliers or if analysing ranges of values rather than discrete figures.

## fisheries

- Prior to reintroductions, concerns about conflicts with fisheries were only reported by one respondent.
- Similarly, where beaver populations were established, conflict was among the lowest reported with the majority of respondents reporting no conflict occurring.
- Two respondents reported greater costs, one as a result of a single incident involving a breached fish pond leading to the loss of commercial fish stock.
- Mitigation methods employed were mainly dam removal, but also occasionally the use of flow devices (see Box 2) or the cull or translocation of problem animals.
- Though not mentioned by respondents in this context, fish pond banks can also be protected (see below).

## domestic gardens

- Conflict with domestic gardens was not a concern raised prior to beaver reintroductions.
- Where beaver populations were established, conflict was again limited with a median annual cost of €1-100 per beaver population.
- Most conflict probably arises from the occasional felling of ornamental trees (53% of respondents reported this) and possibly occasional flooding events.
- Resulting mitigation methods employed were predominantly the fencing of gardens, orchards or individual trees and, to a lesser extent, the removal of dams.

## other land-uses

- Conflicts with land-uses other than those mentioned above were low. There were only 4 other instances of different conflicts mentioned.
- The three highest costs specifically concerning three separate incidences in The Netherlands and the Czech Republic of digging of dykes and pond banks resulting in their breaching and the flooding of surrounding land.
- Similar occurrences have been noted in Lithuania [24] and it therefore appears that such incidences are a possibility in low-lying areas and measures should be taken to minimise this risk were beavers to be introduced into such areas.
- However, these incidences still appear to be rare and can be regarded as the extreme end of the economic spectrum of beaver-human conflict.
- Mitigation methods employed involved the strengthening and restructuring of at risk dykes and pond banks using metal mesh, together with other more usual mitigation methods.

## perception

**Public perception of the beavers are predominantly positive** (76% responses, N=17) **and rarely negative** (6%). Current public interest in beavers was generally moderate (53% of responses, N=17). This level of interest varied compared with the public interest during the actual reintroduction period, being higher in 33% (N=12), higher to unchanged in 8%, unchanged in 25% and lower in 33% of responses.

These low levels of conflict are possibly because **beaver behaviour limits human conflict**. The reason for this should be fairly obvious: beavers are an aquatic species that are known as ‘central-place foragers’ [12], that is to say, they use water as a ‘central-place’ for transport and safety and tend to restrict their activity to the vicinity of the water. For example, **95% of beaver cut trees were found within 5m (16ft) of water** in Denmark [25] and two separate Norwegian studies found that mean-maximum foraging distance from water was 40m (130ft) [26] and that **beaver foraging declined exponentially with the distance from water** [27]. Furthermore, their highly developed territorial behaviours help maintain their populations at a low density [28]. Damming, the behaviour that has perhaps greatest potential to create

conflict, only occurs in smaller streams. In North-western Russia, dams were maintained by, at most, 53.6% of Eurasian beaver colonies [29]. When damming occurred, it has resulted in a mean flooded area per beaver colony of around only 0.75 ha (1.85 acres) in Estonia [30] and 1 ha (2.47 acres) in Poland [31]. The same Estonian [30] and Polish [31] studies found that approximately only **10% and 3-4.5%**, respectively, **of colonies were causing conflict between beavers and humans**. This limited conflict may explain why public opinion of the beaver was generally positive.

Openness to the public about a beaver reintroduction may minimise negative public perception. One respondent commented that **lack of transparency during reintroductions had caused problems** because land-users (in this case, fruit tree growers) were unprepared when conflict arose. The respondent went on to say that had these growers been forewarned, they could have taken measures to prevent beaver damage (see below) and furthermore, provisioning growers with materials to protect at risk trees would have created goodwill between land-users and wildlife managers.

## mitigation

**A number of mitigation techniques can successfully reduce conflict between the beaver and human land-use** (Table 5). Overall fencing of property was the most commonly utilised method, followed by dam removal and then application of water flow devices ('beaver-deceivers' [32]; see Box 2). Obviously, fencing larger parcels of land is more expensive and thus for agriculture and forestry, fencing was considerably less popular as a mitigation technique. In general, offensive mitigation techniques such as dam removal (as opposed to defensive techniques such as fencing) were more frequently used. Only one of the nine respondents reported the use of compensation to resolve conflict. Using deterrents, an alternative mitigation technique to protect trees from damage, was not mentioned, probably because it is fairly new concept. This technique involves painting the lower trunks of trees with a clear sand-based paint that herbivores find unpalatable. One example is *Wöbra-biber* made by the German company *Flügel*<sup>7</sup>. A 10kg drum, which could protect approximately 60-70 trees cost for several years, costs € 90.50 (**about £ 0.91 / tree**). This technique may provide a cheap alternative to fencing or netting.

Another method of minimising conflict through mitigation may be the provision of a **beaver advice line** or **website** in the UK that people could call or access to obtain advice on the best methods of mitigation or to report conflict. Sources of advice such as these are frequently used in North America<sup>8</sup> and one has recently been implemented for Wales - the Beaver Information Exchange ([www.beaverinfo.org](http://www.beaverinfo.org)).

Based on this survey, most mitigation techniques employed are non-lethal. This may be largely due to EU laws banning the culling of beavers in many countries. However, non-lethal control would appear to be a very sensible strategy given that, as with many territorial species, culling a problem animal will only provide relief until another almost inevitable fills the resulting gap. A Polish study [31] found that of the 3-4.5% of beaver colonies caused conflict. Most (87%) damage had occurred at the same sites for more than 5 years indicating that problems are specific to certain habitat sites, not transitory depending on beaver behaviour. **Non-lethal mitigation at established conflict sites would therefore be a workable, efficient method to minimise conflict.**

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<sup>7</sup> [www.fluegel-gmbh.de](http://www.fluegel-gmbh.de)

<sup>8</sup> For example, the Ministry for Environment of the Government of British Columbia in Canada offer a 24 hour free-phone number (1-800-663-9453) to which people can report wildlife conflict.

Table 5: Mitigation techniques utilised.

Mitigation techniques applied during conflict with various land-uses according to 14 questionnaire responses. Figures *above the double line* form a matrix that represents the number of responses mentioning the mitigation technique in connection with the particular land-use. Figures *below the double line* (last two rows) represent the number of respondents that mention the mitigation technique and the consequent total percentages of respondents that reported the use of that mitigation technique.

Land-use	Cull	Trans- location	Removal of dams	Flow devices	Fencing	Compen- -sation	Other
Agriculture	3	3	6	4	2	1	0
Forestry	3	0	7	2	3	1	0
Fisheries	1	1	4	1	0	0	0
Gardens	2	0	4	0	9	0	0
Other	2	2	3	1	0	0	2
No. respondents	3	4	7	4	9	1	2
% of respondents using technique	23	31	54	31	69	8	15

## overview of costs, perception and mitigation

As with other wildlife, beavers can come into conflict with human land-use. However, it is also apparent that **the economic cost of such conflict is likely to be low.**

- Estimated annual regional costs (in Euros) of beaver mediated damage varied widely, however, the majority of estimates were clumped toward the lower end of the scale (ranging between €0 and €1,000 per population) and the median (typical) costs were all within this range (Fig. 1).
- Furthermore, one respondent stated that **in Sweden, research into quantifying beaver-mediated damage is not generally considered a worthwhile use of funds because conflict between beavers and land-users is so low.**
- Our figures are not dissimilar to those reported for total (all land-use) compensation claims from beaver conflict in Norway between 1914 and 1925 totalling 32,500 Norwegian kroner (NOK) [33] which is equivalent to NOK 64,000 / annum or c. €8,000 (£5,500) / annum in today's prices.
- There was no correlation between the number of beavers and the annual costs of land-use conflict<sup>9</sup>.
- Similarly, there was no correlation between land area and the annual costs of land-use conflict<sup>10</sup>.
- **Public perception of beavers is predominantly positive.**
- **Several non-lethal mitigation techniques exist, and can be effectively used,** to reduce conflict particularly at sites of persistent damage.

<sup>9</sup> Spearman's rank correlation;  $r_s = 0.49$ ,  $N=10$ ,  $P=0.15$

<sup>10</sup> Spearman's rank correlation;  $r_s = 0.05$ ,  $N=10$ ,  $P=0.89$

# Conclusion and Recommendations

This small investigation merely scoped the relative sizes of the costs and benefits of beaver reintroduction. As such the figures presented are not likely to be accurate, but instead indicate a rough estimate of the likely costs and benefits of a reintroduction. Despite the study's limitations **the balance sheet in terms of the relative sizes of the economic costs and benefits we estimated present a very healthy positive balance in favour of beaver reintroductions.** The economic benefits from tourism alone may factor in the millions of pounds with the establishment of a visitor centre at a release site potentially drawing over a million pounds into the local economy and revenue from commercial tour operators injecting a further six or seven figure sum into the economy. Based on the questionnaire responses, it does appear that the annual cost of a beaver population is likely to remain below thousands of pounds, a small fraction of the potential benefits – and potentially further reduced by the application of appropriate mitigation techniques. Although some of the income would have been spent in the UK by UK citizens anyway, the beaver has the potential to attract visitors from other countries and indeed the beaver may strengthen the UK's position in the international market as a destination for not only culture, but also environmental tourism. Certainly, at the local level, it would appear that beavers have the potential to attract visitors who otherwise may not have visited the locality.

The extent of benefits versus costs will of course depend on how the wildlife tourism is managed. Recommendations for best practice include:

1. **Involve and inform the wider public about the reintroduction.** Their awareness of the project will not only help its smooth running, but also increase utilisation of related tourism ventures.
2. **Inform local land-holders of any reintroduction of animals.** In the Netherlands this was not always done and as a result not only were land-holders unable to prepare any mitigation schemes where required but when any conflict arose land-holders were arguably less tolerant of damage.
3. **Use a well thought-out, eco-friendly visitor centre at a key location.** This may provide a focus for tourism. Many tour operators thought that the Osprey centre at Loch Garten, Scotland provided a good example of such a centre. The centre consists of a hide, shop and environmentally friendly toilets.
4. **Too many tourists can spoil the experience for some and degrade the environment.** Tourism related environmental degradation is a recognised problem. Furthermore, one tour operator we spoke to indicated that their company would not include a beaver reintroduction site in its itinerary where that site had a visitor centre. The reason given is that their clients required a 'wild' experience that a visitor centre could not provide. However, as mentioned above, visitor centres can be a good method of attracting many tourists. We suggest that a suitable balance is sought between catering for those that simply want to see the beavers and those that want to see beavers as part of a wider wildlife experience.
5. **Ecotourism may be best practiced at the grassroots level.** Visitor centres may provide a focus for tourism, but the most efficient method to maximising tourism benefits at the local level would be to involve local tourism stake-holders in the project.

6. **A cohesive face of ecotourism in both England and Wales should be offered** to the public through the formation of an umbrella association. Several Scottish wildlife tour operators cited the formation of Wild Scotland (an association of wildlife tourism operators, see [www.wild-scotland.org.uk](http://www.wild-scotland.org.uk)) as a critical factor in the development of wildlife tourism in Scotland. Furthermore, through its website, it provides an easily accessible interface with the member operators.
7. **Further discussion is needed to evaluate ways of reducing the potential mismatch** between those that benefit from the presence of the beaver (e.g. the local tourism industry) and those that are likely to experience the greatest conflict with the beaver (e.g. local landowners).

Economic Cost-Benefit analyses can be used to help guide policy makers through tough environmental decisions where the right decision is not always easy to see. They will generally attempt to value all of the market based costs and benefits and then add to these non-market benefits. Assessing how the public would like to trade their desires for their environment against other goods, such as clean air against cheap and abundant energy is a difficult business.

The difficulty does not lie in whether or not a beaver reintroduction would pass a cost-benefit analysis or not, it almost certainly would. It is instead that those who would economically benefit from beaver related tourism may not be the same individuals that experience conflict with the beaver. Moreover, whilst the costs might be negligible on a regional scale they would concern the small number of individuals who might shoulder them. This is a common problem with any environmental issue, and there is no easy answer to the problem. However involving local stakeholders from the early stages of a reintroduction project is usually the most important step that could be taken to minimise this imbalance.

We have not presented a thorough cost-benefit analysis. Specifically we have not tried to estimate the non-market benefits such as the sheer joy of knowing that an animal exists, and we do not claim that the figures presented are particularly accurate. On the other hand the relative sizes of the costs and benefits are fairly clear. The results of environmental cost-benefit analyses rarely show such large differences between costs and benefits. So with the public's support it is fairly clear that a reintroduction would improve the welfare of the British people overall.

The remaining challenge is the design of frameworks to mitigate and compensate real costs and dispel myths regarding perceived costs to reassure sections of the population who believe the reintroduced beaver would leave them worse off.



# Cited literature

1. A&M, Review of Wildlife Tourism in Scotland: Main Report. 2002, The Tourism and Development Forum.
2. Martinolli, M., Bereziat, C. and M. Graham, Visits to tourist attractions 2006. Report for Wales Tourist Board. 2007.
3. Dickie, I., J. Hughes, and A. Esteban, Watched like never before; the local economic benefits of spectacular bird species. 2006, RSPB: Sandy.
4. Rayment, M., Spending by Visitors to RSPB Reserves: Results from the Reserves Visitor Survey 1998. 1999, RSPB, Sandy.
5. Shiel, A., M. Rayment, and G. Burton, RSPB Reserves and Local Economies. 2002: RSPB, Sandy.
6. Parsons, E.C.M., et al., The value of conserving whales: the impacts of whale-watching on the economy of rural West Scotland. *Aquatic Conservation*, 2003. 13: p. 397-415.
7. Macdonald, D.W., et al., Reintroducing the European beaver to Britain: Nostalgic meddling or restoring biodiversity? *Mammal Review*, 1995. 25(4): p. 161-200.
8. Balodis, M., Beaver populations of Latvia: history, development and management. *Latvijas Zinatnu Akademijas vestis. Dala B/Proceedings of the Latvian Academy of Sciences. Section B*, 1994. 7/8(564/565): p. 1-127.
9. Gorshkov, D., Is it possible to use beaver building activity to reduce lake sedimentation? *Lutra*, 2003. 46: p. 189-196.
10. EA, River Severn Strategy: A Flood Management Strategy For the River Severn Corridor - Scoping Report. Project Ref. No. 5009. 2002, Environment Agency: West Midlands.
11. EA, The climate is changing - time to get ready. 2005, Environment Agency: Bristol.
12. Rosell, F., et al., Ecological impact of beavers *Castor fiber* and *Castor canadensis* and their ability to modify ecosystems. *Mammal Review*, 2005. 35(3&4): p. 248-276.
13. Macmillan, D.C., E.I. Duff, and D.A. Elston, Modelling the Non-market Environmental Costs and Benefits of Biodiversity Projects Using Contingent Valuation Data. *Environmental and Resource Economics*, 2001. 18(4): p. 391-410.
14. Officer, L.H., Purchasing Power of British Pounds from 1264 to 2005. 2007, [www.MeasuringWorth.com](http://www.MeasuringWorth.com).
15. Scottish Tourism Multiplier Study 1992. Surrey Research Paper No. 31. Surrey Research Group 1993, Scottish Office Industry Department.
16. Wildlife Attraction: Visitor Expenditure Model. 2006. Developed by SQW for England Biodiversity Group, available at [www.ukbap.org.uk/ebg/library.asp](http://www.ukbap.org.uk/ebg/library.asp)
17. Wildlife Attraction: Visitor Expenditure Model. User Guide 2006. Report by SQW for England Biodiversity Group [www.ukbap.org.uk/ebg/library.asp](http://www.ukbap.org.uk/ebg/library.asp)
18. Wildlife Attraction: Visitor Expenditure Model. Model Assumptions 2006. Report by SQW for England Biodiversity Group [www.ukbap.org.uk/ebg/library.asp](http://www.ukbap.org.uk/ebg/library.asp)
19. Visitor Attraction Trends England 2006. published by VisitBritain, 2007
20. Martinolli, M., Bereziat, C. and M. Graham. 2006 The 2005 Visitor Attraction Monitor. Report for Visit Scotland, 2006

21. DEFRA, Sustainable Farming and Food Strategy - indicator data sheet. Environmental outcome: Improved landscape and biodiversity; Core indicator 6.04: Access to the countryside. Updated October 2006. Available at [http://statistics.defra.gov.uk/esg/indicators/d604\\_data.htm](http://statistics.defra.gov.uk/esg/indicators/d604_data.htm)
22. Review of countryside issues in England. Countryside Agency 2004, The Countryside Agency: Cheltenham. p. 68.
23. Nitsche, K., Biber: Schutz und Probleme. 2003, Castor Research Society: Dessau.
24. Mickus, A. The European beaver (*Castor fiber* L.) in Lithuania. in The third Nordic beaver symposium. 1995. Mekrijärvi, Finland.
25. Elmeros, M., A.B. Madsen, and J.P. Berthelsen, Monitoring of reintroduced beavers (*Castor fiber*) in Denmark. *Lutra*, 2003. 46(2): p. 153-162.
26. Parker, H., et al. Landscape use and economic value of Eurasian beaver (*Castor fiber*) on a large forest in southeast Norway. in Proceedings 1st European-American Beaver Congress. 2001. Kazan.
27. Haarberg, O. and F. Rosell, Selective foraging on woody plant species by the Eurasian beaver (*Castor fiber*) in Telemark, Norway. *Journal of Zoology*, 2006. 270(2): p. 201.
28. Campbell, R.D., et al., Territory and group sizes in Eurasian beavers: echoes of settlement and reproduction? *Behavioural Ecology and Sociobiology*, 2005. 58(6): p. 597-607.
29. Danilov, P.I. Canadian and Eurasian beavers in Russian North-west (distribution, number, comparative ecology). in The third Nordic beaver symposium. 1995. Mekrijärvi, Finland: Finnish Game and Fisheries Research Institute.
30. Laanetu, N. The status of European beaver (*Castor fiber* L.) population in Estonia and its influence on habitats. in The third Nordic beaver symposium. 1995. Mekrijärvi, Finland.
31. Czech, A. and S. Lisle, Understanding and Solving the Beaver (*Castor fiber* L.)-Human-Conflict: An Opportunity to Improve the Environment and Economy of Poland, in *Biber: Die Erfolgreiche Rückkehr*, J. Sieber, Editor. 2003, Denisia 9, zugleich Kataloge der OÖ. p. 91-98.
32. Lisle, S., The use and potential of flow devices in beaver management. *Lutra*, 2003. 46(2): p. 211-216.
33. Myrberget, S., The Beaver in Norway. *Acta Theriologica*, 1967. 12: p. 17-26.

# Appendix I: Methods used in this study

Three sub-projects formed the core of this study, these being: two questionnaires, one to professionals working with beaver management or research and one to providers of wildlife tours; and a hedonic (revealed pricing) analysis of wildlife package tours.

## *Questionnaire to beaver managers and researchers*

The questionnaire consisted of two sections. The first section dealt with the history of the beaver and its economic impacts in the respondents' geographical region. In particular, participants were asked about conflict between beavers and five categories of land-use; agriculture, forestry, fisheries, domestic gardens and 'other'. Further details were asked concerning conflict, the mitigation methods employed to reduce conflict and also the benefits noted from the presence of beavers. The final question in this section asked what public concerns had been voiced prior to beavers being translocated into a region. The second section dealt with current public opinion of the beaver and the respondents' experience with ecotourism in relation to the beaver. In particular, participants were asked about visitor numbers to specific beaver sites, perceived economic impacts from tourism and, if the local economy had received little benefit from any tourism, the reasons why this might be the case.

The questionnaire was sent to 57 managers and researchers across Europe. When sending the questionnaires, we simply asked that recipient's completed the questionnaire and return it via post, fax or email. We did not provide stamped return envelopes. Managers and researchers were selected for their contribution to the scientific literature on the beaver and / or their involvement in symposia on research and management of the beaver, such as the International Beaver Symposium.

## *Questionnaire to providers of wildlife holidays*

The questionnaire consisted of three main sections. The first section dealt with the respondents' business, such as company age and size, number of customers and the company's reaction to previous reintroductions of any species. The second with a potential reintroduction of the beaver into the UK and, in particular, asked whether the operator would include a reintroduction program in its itinerary, the number of customers it might expect were it to offer such trips and the money that they would expect clients to spend over and above the price of the holiday. Operators were also asked at what price they would set a UK beaver holiday and the proportion of income from this tour that would be spent locally to the tour location. The third section dealt with the respondents' experiences with the beaver when operating in the rest of Europe. In addition, we asked respondents specific questions concerning the proposed reintroduction of the beaver into Knapdale in Scotland. At the time of data collection, the Knapdale proposal had not yet been refused by the Scottish Executive.

The questionnaire was sent to 42 operators based in the UK and four other based in other parts of Europe. When sending the questionnaire, we told recipients that we would get in touch via telephone within a few days to conduct an interview following the questionnaire. All companies were chosen because they operated in the UK and / or the rest of Europe and targeted customers from the UK. Companies were selected from adverts found in *BBC Wildlife Magazine*, the *Responsible Travel* website ([www.responsibletravel.com](http://www.responsibletravel.com)) and searches conducted in *Google* ([www.google.co.uk](http://www.google.co.uk)).

### *Hedonic pricing index*

Environmental goods are rarely traded directly in markets since they are normally classed as public goods. Public goods are goods such as street lighting, where it is difficult to prevent people from using them and having an extra person using them does not significantly diminish the benefits it imparts on all other users. Public authorities considering the most appropriate amounts of money to spend on these goods have a number of economic tools at their disposal. One of these methods is hedonic pricing.

It is founded on the basic premise that the market price of a good is simply a reflection of the values of its characteristics. If a house is within the catchment area of a particularly good school then we might expect that to be reflected in the price. So by taking the prices of houses in an area and comparing them to their relative characteristics we can tease out the effect of one of these characteristics. For a house this will involve looking at the size, age, proximity to public transport and so forth along with what school catchment it is in.

This method has been used since its conception to consider even less tangible goods such as those pertaining to the natural environment or even the value of a life. In this instance we used eco-tourism holidays and the species mentioned within them to tease out the impact that large charismatic mammals have on the price which holiday providers are able to charge. This is done statistically using some form of multivariate regression analysis, such as a Generalised Linear Model (GLM).

We obtained brochures (either hardcopy or web-based) from 14 of the 46 tour providers mentioned above. From a total of 120 European holidays (including UK holidays) offered by these companies, we recorded holiday offer price, country of destination, length (days), mean daily number of meals provided and whether the brochure mentioned any of the following mammal species: Bear (*Ursus arctos*), beaver, bison (*Bison bonasus*), elk (*Alces alces*), lynx (*Lynx lynx*) and wolf (*Canis lupus*). We choose these six species over others because they were once found in the UK but are now extinct in the wild, they are large (>20kg) and are arguably charismatic. Therefore other large and potentially charismatic mammal species such as the red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*) were excluded as they are currently found living wild in the UK. We called these six species the 'big-6'.

### *Statistical analyses*

All analyses were conducted in SPSS (v.13) or SAS. Analysis of the questionnaire data beyond finding mean values was done using Spearman's rank correlation or linear regression. Where an analysis was done on ranged variables, the median of ranges was used.

Hedonic pricing was analysed using a type 1 general linear model (GLM) with holiday price as the dependent variable, destination country as the fixed factor and all other variables as covariates. The six mammal species were lumped together as a cumulative variable (0-6). This was done because there was significant positive colinearity between these species (Spearman's rank correlations,  $P < 0.01$  for all cases), except between bear and elk and bear and bison. By lumping these species together, we were essentially examining holidays that were specifically targeting customers whom wished to see large charismatic mammals. Additional comparisons of means was conducted using the non-parametric Mann-Whitney  $U$  test.

The two-tailed  $P$  value of 0.05 was used as the cut-off point for significant results in all analyses.

# Appendix II: Overview of questionnaire responses

## *Managers and researchers of beaver populations*

We received 18 replies to the questionnaire, a reasonable response rate of 34%, though not all respondents answered all questions. Respondents' regions of experience ranged from an entire country to a large reserve within a country and came from a total of 14 European countries, these being Belgium, Coatia, the Czech Republic, Denmark, Finland, France, Germany, Norway, Poland, Russia (two participants), Serbia and Montenegro, Sweden (three participants) and the Netherlands (two participants). Reintroductions of beaver from other countries had occurred in eleven of these respondents' regions of experience, seven regions had experienced reintroductions from other parts of the country and in two regions (in Germany and Norway), beavers had never been expatriated. Some regions had experienced combinations of these events, hence the numeric mismatch.

On average, 160 beavers were released over the course of the programs (range from 2 or 3 to 1,500 with a median of 51 animals) and the current beaver population sizes in the respondents regions averaged c. 20,200 animals (range from just 20 to >100,000, median = 2,000 animals). Population growth rates post-release (where known) averaged c.18% (range from 5% to 42). Current population growth rates average c. 16% (range from 0% to 30%).

## *Providers of wildlife holidays*

We obtained 20 responses to this questionnaire, a good response rate of 48%. These responses represent a broad range of tour operations from 'one man' outfits to those employing 600 FT staff (mean 40 FT staff) and from companies offering just one tour option per year to those offering over 100 holidays per year (mean 57 holidays). Likewise, the number of customers taken per year was quite broad, from 40 to 4,000 (mean 980 customers). Most customers came from the UK (mean 81%) with a small proportion coming from other European countries (mean 7%) and non-European countries (mean 12%). The holidays the companies offered encompassed a variety of types but were predominantly 'wildlife only' (72% offered these) followed by 'bespoke', 'wildlife and culture' and 'other' holidays types (44% each). Tour operators' charges were between the ranges of £10-200 to £2,000+ per holiday (the median or typical range was £501-£1,000). Some operators were able to give estimates for the sum they spend on travel, accommodation, food, guides and 'other' spending. Based on the medians of the ranges given for these categories, it appears that the most money gets spent on accommodation (27%) and guides (26% of the total spending in the four categories), followed by travel (24%) food (16%) and 'other' (6%). The tour operators generally appeared to be ethically minded with 72% being members of a non-governmental organisation dealing with conservation and 73% financially contributing towards conservation in some form. However, this figure drops to 65% and 55% respectively if you assume that those that do not contribute to conservation in some form simply ignored the question.

# Appendix III: Wildlife attractions – Visitor expenditure model

The Wildlife Attraction: Visitor Expenditure Model was developed by SQW for the England Biodiversity Group. For this analysis we ran the model for a beaver reintroduction separately for Wales and Scotland, then for separate regions of England as defined in the model, but excluding London.

The reintroduction site was hypothesised to have the following characteristics:

- a remote rural site;
- contain over 3 distinct wildlife habitats (we assumed that at any site at least 3 of the following would be present – dry grassland / wet grassland / marsh, fen, reedbed / lakes / rivers and streams / native broadleaved woodland / native coniferous woodland / lowland bog / upland bog)
- be the best site in the UK for viewing this species

The following assumptions were also made:

- Due to the charisma and appeal of the iconic beaver it was assumed that the site would thereby attracting enthusiasts and general visitors alike.
- It was presumed that the site would be open to visitors all year and assumed that visits during peak season would be approximately 4 times greater than in the low season.
- The “Mean annual no. of visitors to a wildlife attraction” (See table 3) for Scotland and Wales was calculated by dividing the total number of visitors to wildlife attraction by the number of sites providing information (see table 1). Due to the different attractions within each group this does not represent a comparable market. Numbers may also be an overestimate because of the inclusion of zoos in the wildlife attraction definitions. However numbers were accepted as the best available estimate of potential visitor numbers.
- For England the “Visitor Attraction Trends England 2006.” [19] provides information on the number of visits made to a selection of wildlife attractions in each geographical region. The “Mean annual no. of visitors to a wildlife attraction” (See table 3) for each region in England was calculated from this data. As with Scotland and Wales, data is not comparable due to the different group structure and there is potential that this is an overestimate because of the inclusion of zoos in many of the wildlife attraction definitions. However numbers were accepted as the best available estimate of potential visitor numbers.
- The “Number of visitors used in model” (see table 3) shows the final number of visitors used in the Wildlife Attraction model. Instead of inputting the total annual number of visitors the model requires an estimate of weekly visitor numbers for high and low season, stipulating high season as 9 weeks and low season as 43 weeks. And using these figures to calculate the annual visitor number. By manipulating high and low season visitor numbers (keeping a ratio of approximately 4:1) we kept visitor numbers as within 100 of the regions annual mean as calculated from the tourist board data.
- No data was available for spending power of holiday makers versus day-trippers to such a site so the model’s region-based default figures were accepted.