CAIRNGORMS
NATIONAL PARK AUTHORITY
ÙGHDARRAS PÀIRC NÀISEANTA A'
MHONAIDH RUAIDH

Assessing the potential for the restoration of vertebrate species in the Cairngorms National Park: a background review

Internal report

by Dr David Hetherington
Cairngorms National Park Authority Ecology Advisor

February 2013

Executive Summary

To meet biodiversity objectives from the first National Park Plan, the Cairngorms National Park Authority commissioned this review as a systematic approach to identify vertebrate species that previously inhabited the Cairngorms and which could be subject to conservation action to restore them to the National Park.

A review of contemporary and modern literature was carried out to identify which species had occurred in the region in the past, but which are either absent or very localised today because of human activity. The broad scope of the Holocene period – the 10,000 years or so since the end of the Ice Age - when the climate was broadly similar to today, was used to determine nativeness. Experiences from other cultural landscapes in the UK and elsewhere in Europe were called on where relevant to judge the likely potential ecological and socioeconomic impacts of species restoration in the Cairngorms National Park.

For each species an account summarises information on their ecological function; national or international conservation and legal status; historical occurrence; potential socio-economic impacts; and experiences of restoration elsewhere. In order to help pinpoint those species which offered the best nature conservation and socio-economic opportunities for the Cairngorms National Park, each was assessed against five key criteria: conservation status; ecological function; potential land management impacts; potential economic contribution; and recolonisation ability.

The review identified a long-list of 22 native species whose distribution had been severely impacted on by humans, through activities such as habitat modification, over-exploitation, or persecution. The report concludes with a set of ten recommendations, relating to eight species, on how restoration in the Cairngorms National Park could be advanced.

Contents

Introduction

The Cairngorms National Park

In 2003, the Cairngorms became Scotland's second national park, following the creation the year before of the Loch Lomond & Trossachs National Park. The purpose of Scottish national park authorities is to ensure that the National Park aims, as set out in the National Parks (Scotland) Act 2000, are collectively achieved in a co-ordinated way. The aims are:

1. To conserve and enhance the natural and cultural heritage of the area
2. To promote sustainable use of the natural resources of the area
3. To promote understanding and enjoyment (including enjoyment in the form of recreation) of the special qualities of the area by the public
4. To promote sustainable economic and social development of the area's communities

At 4528 km^2, the Cairngorms is not only the largest national park in the UK, but also the largest land park in the European Union. Furthermore, Scottish National Parks differ from many other national parks around the world in that they have a social and economic development aim alongside the aims of nature conservation, and understanding and enjoyment of the countryside. This is an explicit recognition of those who live and work in the cultural landscapes of the Park. Consequently, the park is not pristine wilderness and supports a human population of over 17,000 people, equating to a human population density of 3.8 people per square kilometre. A variety of economic activities, such as farming, forestry, tourism and hunting, continue to shape both landscapes and livelihoods today.

The Cairngorms National Park supports the largest area of Arctic-alpine environment in the UK, as well as the UK's largest remnants of Caledonian pinewood habitats. It is home to 25% of the UK's threatened species. It is an internationally important area for nature conservation with over 50% of its area designated under Natura legislation in recognition of its special habitats and species. However, the area has not been immune to human-induced habitat and biodiversity loss. Several species, some of them ecologically significant and priorities for conservation elsewhere, are thought to have been lost to the region in the past.

In recent decades a wider appreciation of the importance and benefits of conserving biodiversity has developed. Society today largely considers that driving species into extinction is unacceptable and unethical. The restoration of species, either through active translocation or facilitating their recolonisation, is now seen as a way of righting past environmental wrongs, and in doing so reinstating ecological processes and creating economic opportunities.

Background to Species Restoration as a conservation biology tool

The active restoration of native species to areas of Scotland where they had previously occurred is not a new phenomenon. Even before the advent of modern conservation ecology, wildlife populations were being replenished through the translocation of animals from other areas, sometimes for hunting, sometimes for aesthetic reasons. Indeed two highly iconic Cairngorms species, the capercaillie *Tetrao urogallus* and red squirrel *Sciurus vulgaris*, owe their current existence in the National Park to translocations in the nineteenth

century of specimens largely from Scandinavia and England respectively (Ritchie, 1920: Kitchener, 1998).

More recently, other previously native species have been restored to Scotland following their local extinction here. While the goshawk *Accipter gentilis* was restored as a breeding bird following escapes and unofficial releases of captive falconry birds, white-tailed eagles *Haliaeetus albicilla* and red kites *Milvus milvus* have been subject to officially-sanctioned reintroduction programmes. More recently still, a trial reintroduction of an extinct Scottish mammal species, the Eurasian beaver *Castor fiber*, is now underway in Argyll.

Biodiversity loss through human agency, whether by habitat destruction, over-exploitation, or persecution, has been very pronounced over much of Europe over the past few centuries. This trend has been particularly acute in the British Isles, where deforestation, wetland drainage and the systematic persecution of species regarded as harmful to human interests occurred earlier and on a larger scale than most other parts of Europe. Furthermore, geographical isolation from the rest of the European continent means that for many species natural recolonisation is not possible.

Recent decades have seen the growth of environmental awareness and an improved understanding of ecological relationships and processes. The wider ecological impacts of species loss are now better understood and the global wildlife conservation community has begun to employ reintroduction as a means of reversing historical species loss and restoring missing ecological functions and relationships.

Europe has witnessed a general reversal of the trend of the last few centuries for deforestation and species over-exploitation and persecution. Consequently there has been considerable population growth and range recovery by many species, which has seen them restored to regions from which they had previously been extirpated. In several instances, this recovery has been partly assisted by projects that have actively translocated animals, either to reinforce existing but fragile populations, or to reintroduce them to areas from where they had ceased to occur.

Ecological baselines

"Shifting baseline syndrome" was a term first coined in marine fisheries management (Pauly, 1995). It can be described as the failure to identify correctly the "baseline" population size or ecological state for a species or ecosystem, e.g. how abundant or extensive a species or habitat was *before* human-induced changes. Often the ecological baseline is set at a particular point in the past, which is then used as a target state for conservation action. The choice of historic baseline, however, runs the risk of being highly subjective – a form of human error. It can happen at a variety of temporal scales, but it is not uncommon for baselines to be set to the state remembered e.g. from the start of one's career, or from one's grandfather's youth, or to a period with extensive written records. None of these baselines may describe the environment in a state that has not already been considerably modified by human activities. When each generation redefines what is 'natural', the ability to perceive ecological change, such as declines in species or ecosystems, is diminished, running the risk of environmental quality being eroded over time.

In order to reduce the risk of introducing an inadvertently biased baseline this report will, wherever possible, endeavour to consider a variety of different historical evidence across a

broad timeframe, including bones, place names, and contemporary written accounts. The report will also employ a broad spatial context to draw upon knowledge and experience of species ecology and conservation in other countries, particularly in Europe, where the species still occur.

Species restoration terminology

The restoration of species to areas from which they had been removed by human activity can occur through a number of different mechanisms:

Recolonisation – Where the species recovers lost range through natural population expansion, usually after a relaxation in persecution or over-exploitation by humans, or a reversal of habitat loss. This process can be accelerated by humans through concerted conservation action. A Scottish example includes the osprey's *Pandion haliaetus* recovery from the mid 20th century onwards.

Restocking or Reinforcement – Where an existing, but usually small and vulnerable, population of a native species is reinforced through human intervention to improve its viability by more individuals either bred in captivity or translocated from the wild elsewhere.

Reintroduction – Where a species is restored through the translocation, i.e. intentional movement by humans, of individuals from captivity or the wild to a part of its historical range from which is was completely removed by human agency. Scottish examples include the 19th century restoration of the capercaillie and the late 20th and early 21st century restoration of the white-tailed eagle.

N.B. **Introduction** is the translocation by humans of species to areas where they had not naturally occurred. This can often lead to significant ecological and economic problems and is today widely regarded as unethical and undesirable. Scottish examples include the late 19th and mid 20th century translocation of grey squirrel *Sciurus carolinensis* and American mink *Neovison vison* respectively.

Species restoration policy

Bern Convention

Since the Bern Convention of 1979 there has been an obligation under international law for European states, such as the UK, to restore populations of native species. The UK is a signatory state of the Bern Convention and Article 11(2) of the Bern Convention (1979) therefore obliges the UK:

To encourage the reintroduction of native species of wild flora and fauna when this would contribute to the conservation of an endangered species, provided that a study is first made in the light of the experiences of other contracting Parties to establish that such reintroductions would be effective and acceptable.

Rio Convention

By signing the Rio Convention of 1992, the UK is further obliged by Article 9(c) to reintroduce threatened species:

Each Contracting Party shall, as far as possible and as appropriate, and predominantly for the purpose of complementing in-situ measures:
(c) Adopt measures for the recovery and rehabilitation of threatened species and for their reintroduction into their natural habitats under appropriate conditions.

Habitats Directive
As an EU member state, the European Union's Habitats and Species Directive 92/43, obliges the UK to:

"…study the desirability, of re-introducing species in Annex IV that are native to their territory where this might contribute to their conservation, provided that an investigation, also taking into account experience in other Member States or elsewhere, has established that such re-introduction contributes effectively to re-establishing these species at a favourable conservation status and that it takes place only after proper consultation of the public concerned"

Annex IV lists animal (but not birds) and plant species of community interest in need of strict protection.

IUCN Guidelines for Reintroductions
The World Conservation Union (IUCN) developed guidelines for reintroduction projects based on extensive review of case histories and wide consultation across a range of disciplines. The aim was to introduce more rigour into the design and implementation of reintroductions so as to increase the likelihood of project success. Although not legally-binding, these guidelines are widely respected and adopted as a framework within which reintroduction projects are planned and carried out. It is likely that any official reintroduction project in the UK would have to satisfy the IUCN Guidelines wherever possible. According to the Guidelines the aims and objectives of reintroduction are as follows:

Aims
The principle aim of any re-introduction should be to establish a viable, free-ranging population in the wild, of a species that has become extirpated in the wild. It should be reintroduced within the species' former natural habitat and range and should require minimal long-term management.

Objectives
The objectives of a re-introduction may include: to enhance the long-term survival of a species; to re-establish a keystone species (in the ecological or cultural sense) in an ecosystem; to maintain and/or restore natural biodiversity; to provide long-term economic benefits to the local and/or national economy; to promote conservation awareness; or a combination of these.

To read the recommendations of the IUCN Guidelines in greater detail, please see http://www.iucnsscrsg.org/download/English.pdf**.**

The ethics of species restoration determine that species whose population or geographic distributions have been reduced solely through natural processes, e.g. natural climate change, should not be considered for reintroduction. Where such a decline, however, can be attributed to human factors, then reintroduction or aided recolonisation can be considered. The identification and elimination, or reduction to a sufficient level, of these

anthropogenic previous causes of decline should be a pre-requisite for any reintroduction project.

The Cairngorms National Park Plan

The first Cairngorms National Park Plan set out a series of outcomes for the 5-year period 2007-12. It brought together all those involved in the managing of the Park to set out a long-term vision; a framework for management and priorities for action. It set out how all sectors in the Park can work together to collectively achieve its four aims and to create a world class National Park. It was developed and implemented through a wide range of partners.

Under the priority of Conserving and Enhancing Biodiversity and Landscapes, specific actions (3j and 3k) were identified:

From the Local Biodiversity Action Plan identify species that have suffered serious decline or local extinction in the Park and which could be subject to reintroduction or translocations to boost populations.

In the context of national initiatives, identify and address the likely land management and other issues that may arise from the reintroduction of extinct native species that could have broad ecological and economic benefits for the Park.

An external delivery team consisting of representatives from a range of partner organisations including public sector agencies and conservation and land management NGOs, and which the Cairngorms National Park Authority (CNPA) chaired, was charged with coordinating the Biodiversity and Landscapes priority. In order to address actions 3j and 3k, the delivery team agreed on the need for a scoping study to identify and assess potential species restoration candidates. Consequently, the CNPA commissioned this report.

Identifying species for restoration to the Cairngorms National Park

This review aims to identify the vertebrate species formerly native to the Cairngorms National Park (CNP) whose distribution in the area has been severely reduced by human activity. For each identified species an account summarises information on their ecological function; national or international conservation and legal status; historical occurrence; potential socio-economic impacts; and experiences of restoration elsewhere. A 5-point scoring system is used to evaluate each species against five key criteria to help identify which of the species could be subject to further, more detailed, consideration. The report concludes with a set of recommendations on how species restoration in the Cairngorms National Park could be advanced.

Species Accounts

Great-crested newt *Triturus cristatus*

Ecology: The great crested newt spends the bulk of its life on land where it is largely nocturnal and feeds on invertebrates (SNH, 2007). It spends the day in damp places such as under stones and logs. Breeding takes place in small to medium sized freshwater ponds in spring to early summer. Terrestrial life is typically spent within 250 m of these ponds but dispersal of up to 1000 m can occur. A female can lay around 300 eggs, which she attaches singly to vegetation. Larvae usually develop for around 3 months before becoming terrestrial but in cooler climates or nutrient-poor ponds, this can take much longer. They take around three years to reach breeding maturity. The availability of suitable breeding ponds is a key, limiting factor in the species' distribution. The species dislikes low pH water and tends to be found in more productive, lowland environments.

Conservation status: Habitats Directive Annex IV. UK Schedule 5 and European Protected Species. IUCN Least Concern.

Current status in Cairngorms National Park: Thought to occur in just one pond in Strathspey.

Timing of decline: Unclear but probably in the past two centuries.

Reason for extinction: Possible reasons for local extinction include loss of pond habitat, modification of vegetation around pond sites, habitat fragmentation and the stocking of ponds with predatory fish.

Potential for recolonisation: The species is highly unlikely to recolonise historical sites from sites known to be occupied today, as a result of habitat barriers and/or excessive distance.

Evidence for Cairngorms occurrence: Old records suggest the species has undergone a decline and range contraction and is now absent from sites where it used to occur, e.g. at Inverdruie and Abernethy (S. Corcoran, Cairngorms LBAP, *pers. comm*.). Records from the 1970s suggest the species occurred at Dalfaber, near Aviemore but this area is now covered by a golf course and is therefore no longer suitable habitat (S. Scoggins, Scottish Natural Heritage, *pers. comm*.). NBN Gateway records the species as having occurred at 'Abernethy' in 10 km square NH91 during the 19th century. It is not clear if this corresponds to the site of the known current population, also within the same square, or to a lost site within Abernethy Forest. NBN Gateway also lists a 2007 record for a 1 km square near Kincraig, which is away from the known population, but this is considered to be a recording error (S. Corcoran, Cairngorms LBAP, *pers. comm*.).

National or international reintroduction experience: There have been several instances of ponds being created in Scotland specifically for great-crested newts, e.g. Falkirk, West Lothian, Mid Lothian, the Borders and Wigtownshire (SNH, 2009). This work has not

involved reintroduction however. Translocation has been employed on a number of occasions in the UK to remove great crested newts from development sites and re-establish the population elsewhere nearby. Conservation guidance for the species developed by Froglife and funded by a wide range of public agencies and NGOs (Langton *et al*., 2001) recommends, amongst other things, that sites for translocation should:

- Be safe from threat of unfavourable land use change
- Be subject to an agreement for its sympathetic future management
- Have at least four suitable ponds in close proximity
- Have at least one hectare and preferably more, of suitable terrestrial habitat
- lack fish or stocked waterfowl
- Be separated by at least 1 km, or by barriers to dispersal, from other great crested newt ponds, yet capable of being linked up to it by future habitat creation

Land management implications: The species' protected status would presume against the stocking of ponds with fish or waterfowl as both can be harmful to newt populations.

Economic benefits: There is a financial mechanism within the Scottish Rural Development Programme to fund land managers to carry out conservation work for the species.

Scottish feasibility studies: None known

Bittern *Botaurus stellaris*

Ecology: Nests in tall vegetation within standing water and today in England this is chiefly *Phragmites* reedbeds. Nineteenth century Scottish breeding habitat was more varied wetland habitat such as lochs, rivers and mires fringed by *Phragmites*, although mixed fen systems with bulrush *Typha sp*., yellow flag iris *Iris pseudacorus*, rushes and sedges, were also favoured (Gilbert, 2007). The species feeds in areas of open water at the edge of vegetation where they prey on fish (especially eels *Anguilla anguilla*), amphibians, small mammals and large insects.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and UK red list. IUCN Least Concern.

Current status in Cairngorms National Park: Very rare winter migrant from the continent. One bird was observed at the Insh Marshes in early January 2011, the first in the area for almost twenty years (P. Moore, RSPB, *pers. comm*.). One bittern was recorded in a reedbed at the Invertromie marsh in January 1992, during a winter when unusual numbers arrived in Scotland from the continent (Dennis, 1995).

Timing of extinction as breeding bird: Uncertain, possibly in 18th century.

Reason for extinction: Drainage, over-hunting and possibly colder winters seen as reasons for decline.

Potential for recolonisation: Following UK extinction in 1868, the species began to recolonise in 1911 in Norfolk. Now bitterns breed as far north as Lancashire. Elsewhere in Europe, however, bitterns breed as far north as southern Sweden and Finland. The Loch of Strathbeg and the Tay Reedbeds have been suggested as potential recolonisation sites for bitterns due to suitable habitat and the regular occurrence of wintering birds (Gilbert, 2007). However, potential habitat for breeding birds is not considered to be sufficiently extensive within the CNP (I. Francis, RSPB, *pers. comm.*; P. Moore, RSPB, *pers. comm*.).

Evidence for Cairngorms occurrence: According to Gilbert (2007), the bittern is thought to have bred in Scotland as far north as the Great Glen, although Bourne (2007) reports that the bittern or "bewter" was recorded as a plentiful bird of Sutherland in 1630, and was still occurring as far north as Aberdeenshire and Speyside at the times of the Statistical Accounts of the late 18th and early 19th centuries. It bred on the Angus Marshes "many years" before the 1830s (Baxter & Rintoul, 1953). There were records of them having been shot at Banchory and elsewhere in the 19th century (MacGillivray, 1855). The New Statistical Account records that the species occurred (probably as a winter visitor) at Dyke & Moy and Banchory Ternan, but that it was extinct in Kirriemuir. St John (1863)

records the species at Spynie and Lhanbryde in Moray, although these records probably relate to wintering birds.

National or international reintroduction experience: The species' slow UK recovery is due to recolonisation of restored habitat

Land management implications: In order to be suitable for nesting bitterns, existing reedbeds may need to be managed differently. Furthermore, in order to create more habitat, which is likely to be a limiting factor for the species in the CNP, then areas of reedbed could be encouraged on land currently managed for other purposes.

Economic benefits: Breeding bitterns would add to the wildlife tourism resource, and may attract more wildlife tourists to breeding areas, although bitterns are typically very difficult to observe in reed bed habitat.

Scottish feasibility studies: None known.

Corncrake *Crex crex*

Ecology: A ground-nesting summer migrant of unintensively-managed grassland of sufficient sward for concealment, i.e. more than 15 cm high. Grass left ungrazed in summer and either mowed in late summer for silage or hay, or grazed in autumn and winter offers the best conditions. In spring and early summer grass in Scotland is usually too short, so stands of yellow flag iris, stinging nettles *Urtica dioica*, cow parsley *Anthriscus sylvestris*, hogweed *Heracleum sphondylium*, reed canary grass *Phalaris arundinacea* and common reed *Phragmites* are utilised then, and also in late summer (Green, 2007). Feeds on invertebrates from both vegetation and surface of ground. Spends the winter in SE Africa.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and Red List. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct breeder, occasional passage visitor

Timing of decline: Decline occurred in the first half of the twentieth century, with extinction as breeding birds in the Cairngorms by the 1980s.

Reason for extinction: Changes in agricultural practices, such as mechanisation, early cutting of hay, and introduction of silage cutting results in destruction of nests and deaths of birds as well as reduction in available breeding habitat.

Potential for recolonisation: Limited. There was a calling male corncrake in the summer of 2008 at Dinnet which arrived in mid July - the only record for the area in recent years (H. Scott, *pers. comm*.). Elsewhere in Deeside a bird was heard singing in set-aside near Ballater in 2002 (Maggs, 2011). In Strathspey a bird was heard calling in early May 2006 at Insh Marshes (P. Moore, RSPB, *pers. comm*.).

Evidence for Cairngorms occurrence: The species was common and widespread throughout the Cairngorms until the mid twentieth century. The Old Statistical Account records corncrakes at Birse, while the New Statistical Account records them in the parishes of Birse, Lumphanan, Leochel & Cushnie, Strathdon, Knockando, Fortingall, Atholl, Moulin, Kirriemuir, Cortachy & Clova, and Banchory Ternan. The bird was common and widespread in Deeside up to Linn O'Dee (MacGillivary, 1855). The species was reported as being "extremely abundant" around Pitlochry in 1891 (Baxter & Rintoul, 1953). Historically, corncrakes bred in parts of the Highlands up to 400m and were known to have occurred occasionally on moorland (Nethersole-Thompson-Watson, 1981), although grassland habitats are more typical. The species was still a plentiful double-brooder in Deeside in 1903, while in 1905 several were reported killed in a winter snowstorm at Balavil, - an unusual occurrence for a summer migrant (Baxter & Rintoul, 1953). The species was much rarer by 1936, and "very scarce" in Badenoch & Strathspey by 1960 (Dennis, 1995). In 1952

breeding was recorded at Tullochgrue (2 pairs, one producing 11 young), Doune and Corrour, while calling birds were heard at Laggan in 1968; Boat of Garten, Ralia and Dulnain Bridge in 1971; Insh in 1972; Grantown in 1973; Nethy Bridge in 1977, 1980 (probably bred), and 1984, and a dead bird was found at Balavil in 1978 (Dennis, 1995). So while corncrakes used to be regular breeders in meadows in the Strath, there have been no known breeders since 1984.

National or international reintroduction experience: Captive-raised corncrakes have been subject to an ongoing reintroduction project started in 2003 in the Nene Washes in Cambridgeshire. Over 100 birds were released in 2007, with 12 calling males in 2008 (ZSL website, 2008). The project is a partnership between Natural England, RSPB, Zoological Society of London and the Pensthorpe Conservation Trust.

Land management implications: The restoration of viable populations on farmland would probably require changes in agriculture activity including alterations to the timing and pattern of cutting.

Economic benefits: Conservation schemes funded by agri-environmental payments have been instrumental in halting and reversing declines in western Scotland and similar mechanisms could provide financial opportunities to farmers and crofters in the CNP.

Scottish feasibility studies: None known.

Crested tit *Parus cristatus*

Ecology: A sedentary species favouring ancient pinewoods and Scots pine *Pinus sylvestris* plantations for both foraging and nesting (Cook, 2007). Occurs less commonly among other conifer and broadleaved woodlands. Forages mainly along trunks and large branches, especially among lichens. Heather understorey is an important foraging habitat in winter. Nest holes are excavated in dead trees or rotting stumps more than 20 cm in diameter and usually within 3 m of the ground.

Conservation status: UK Schedule 1 and Amber list. IUCN Least Concern. There are six subspecies in Europe, and the one occurring in the UK, *P. c. scoticus*, occurs nowhere else and is the most restricted in range, being confined to a few parts of the Scottish Highlands.

Current status in Cairngorms National Park: The species occurs widely in the Spey catchment (although since 1980 no longer in the Loch Laggan area). The species has been recorded nine times in Deeside during 1968-2004, including a party of 13 birds observed in Glen Quoich in September 1973, but the crested tit is nevertheless absent as a breeding species from the Dee catchment (Cook, 2007).

Timing of decline: It is considered to have been more widely distributed throughout the Highlands when the Caledonian forest was more widespread (Cook, 2007). During the late nineteenth century, it was thought to breed only along a 50 km stretch of Strathspey (Harvie-Brown & Buckley, 1895) but subsequently spread to lowland Moray and Nairnshire and several east-flowing catchments of the west Highlands, taking advantage of new pine plantations. It is not known when the species became absent in Deeside, but it has been absent from the Loch Laggan area since 1980 (Cook, 2007).

Reason for extinction: Historical deforestation reduced suitable habitats to small, scattered pockets. The remnant native pinewoods of Strathspey seem to have provided a large enough nucleus of habitat to allow the species to avoid extinction. The pinewoods of Deeside were reduced to smaller and more scattered remnants than those in Badenoch & Strathspey and may no longer have been extensive enough to support a minimum viable population. Small, scattered populations would have been more vulnerable to extinction through stochastic events such as disease or severe winters. The removal by humans of standing dead timber may also have deprived the species of potential nest sites.

Potential for recolonisation: Currently unlikely for Deeside. Although the species has reached Aberdeenshire in nine years from 1968-2004, mostly during Autumn or Winter, the species has yet to colonise as a breeding bird, despite having had a century of expansion elsewhere (Cook, 2011c). Although one bird was recorded at the Linn of Dee in Spring 1999 (Cook, 2011c), pinewood habitats in the Spey and Dee catchments are currently separated by a treeless expanses of open hill 10-15 km wide, and colonisation from Badenoch & Strathspey is considered unlikely (Cook, 2011c). Plantations of sitka spruce

Picea sitchensis in Donside are seen as a barrier to the colonisation of suitable habitat in Deeside from Speyside via any northern route (Cook, 2011c). Reafforestation of key headwaters would reduce the direct line distance between wooded areas in the two catchments. In particular, the creation of new pinewood habitats in the Feshie-Geldie corridor, the elevation of which is below the altitudinal limit of Scots pine growth in the Cairngorms, could aid colonisation of Deeside by crested tits. The Loch Laggan area is better connected by woodland corridors to currently occupied woods in Badenoch & Strathspey and could well be recolonised in the not too distant future, especially as young, planted pine woodland in the area matures.

Evidence for Cairngorms occurrence: There is no evidence for the historical breeding of crested tits in Deeside. However, any past breeding populations there are likely to have become extinct at a time when pinewood habitats were reduced to small extents. Crested tits may therefore have become extinct in Deeside prior to the late 18th century, with the event likely going unnoticed or unrecorded by people. The occurrence prior to this period of a small passerine, which has no direct impact on human life, is very unlikely to have been recorded in surviving contemporary literature.

National or international reintroduction experience: None known

Land management implications: The creation and retention of decaying pine stumps could be encouraged as nesting habitat.

Economic benefits: Could be employed as a flagship species for initiatives aiming to reafforest the headwaters of the Dee and Spey and thus improve forest habitat networks. These initiatives would bring several economic benefits through delivering ecosystem services such as flood alleviation, soil retention, carbon storage and improvements to salmon fisheries. Crested tits, as an iconic species of the Caledonian pinewood, would add to the wildlife tourism resource of Deeside.

Scottish feasibility studies: None known

Eagle owl *Bubo bubo*

Ecology: The eagle owl is a habitat and food generalist typically found year-round in wooded and/or hilly terrain, where it nests on cliffs and sometimes in trees. It feeds on a wide range of mammals and birds up to the size of a hare or goose. A pair of eagle owls, breeding for several years at a site in North Yorkshire, fed mainly on rabbits *Oryctolagus cuniculus* (Dennis, 2005). The species is not particularly sensitive to climate, occurring as a breeding bird from the Sahara to north of the Artic Circle.

Conservation status: EU Birds Directive Annex 1. IUCN Least Concern.

Current status in Cairngorms National Park: Occasional visitor, probably by way of feral birds, but possibly also continental migrants. There were two observations in December 2005: one from near Dulnain Bridge and one from the rubbish dump north of Aviemore (S. Scoggins, SNH, *pers. comm.*; R. Dennis, Highland Foundation for Wildlife, *pers. comm.*).

Timing of decline: Unknown, but possibly during medieval period.

Reason for extinction: Possibly persecution.

Potential for recolonisation: Limited. Free-flying eagle owls have been reported in northern Scotland on several occasions over the past few years, including the Black Isle, Inverness area, and Strathspey. A pair nested in Moray in 1984 and 1985 (Dennis, 2005; Forrester, 2007b), and after the male was killed on the road, the female continued to lay infertile eggs from 1986-1994 (Francis & Cook, 2011). It has also been argued recently that migrant eagle owls could conceivably reach Britain from continental Europe as long distance movements of up to 600 km within Europe have been recorded (Dennis, 2005). There are several records of eagle owls occurring in the Northern Isles from the 17th-19th centuries (Baxter & Rintoul, 1953), and indeed, eagle owls are known to fly up to 25 km from the Norwegian mainland to offshore skerries to feed on seabird colonies (D. Halley, Norwegian Nature Research Institute, *pers. comm.*) While some consider that the evidence for colonisation of Britain by continental vagrants in the past two centuries is weak (Melling *et al.*, 2008), birds have been photographed on North Sea oil platforms and there have been several records from the Northern Isles (Warburton 2010). The bird is, however, widely kept by falconers and enthusiasts and feral birds do occur in the UK, having been released or escaped from captivity (Melling *et al.*, 2008). In recent years several pairs of eagle owls have nested in northern England. One pair on MOD land in Yorkshire had produced over 20 young since 1996, feeding them mainly on rabbits (Dennis, 2005). Another pair is known to have bred and successfully raised chicks in recent years at the Forest of Bowland in Lancashire (Natural England website, 2010). It seems likely that Scotland and the

rest of the UK offer considerable food resources (particularly rabbits) for eagle owls, especially when compared to other areas of Europe where the species occurs.

Evidence for Cairngorms occurrence: There is no direct evidence for eagle owls having bred historically in the Cairngorms, or indeed anywhere in Scotland. However, given the species' very broad climatic, habitat and prey preferences, records from elsewhere in Holocene Britain would likely be indicative of a wide British distribution in the past. A positively identified eagle owl bone has been recovered from Demen's Dale in the Peak District. The bone was found in layers suggesting the temperate, woodland environment of the Mesolithic. The bone has been measured and found to be of the same large size as Scandinavian eagle owls, suggesting British eagle owls were likely to have been of the nominate subspecies *Bubo bubo bubo* (Stewart, 2007). An unconfirmed record of eagle owl bone was acquired during the excavation of an Iron Age settlement at Meare Lake Village in Somerset (Stewart, 2007). Other bones of genus *Bubo* have been recovered from Chelm's Combe Shelter in Somerset and date to between 11,000 and 10,000 years old, but cannot be confidently differentiated from snowy owl *Bubo scandiacus* (Stewart, 2007). The Demen's Dale record was sufficient for Stewart (2007) to declare the eagle owl a "part of the natural, native British fauna". The excavation of Longstone Edge, an early Bronze Age barrow in the Peak District, revealed several accumulations of small mammal bones, judged to be regular eagle owl pellet deposition sites (Andrews & Fernandez-Jalvo, 2012). It has been suggested that, by the Middle Ages, eagle owls may have been persecuted to extinction in Britain by superstitious societies, fearful of a large, nocturnal, predatory bird (Dennis, 2005).

National or international reintroduction experience: The eagle owl has been reintroduced to several areas of Germany, including Schleswig-Holstein, the Harz, Baden Württemberg, and the Eifel region, as well as in Sweden.

Land management implications: Could potentially prey on gamebirds. Forestry operations would have to avoid disturbing any tree-nesting birds.

Economic benefits: Preys most often on small mammals such as voles but in UK likely to rely heavily on rabbits, which could aid farmers by helping to reduce grazing pressure. As a top predator, it could influence abundance and/or behaviour of corvids and smaller raptors such as buzzards *Buteo buteo*.

Scottish feasibility studies: None known.

Eurasian crane *Grus grus*

Ecology: The species is omnivorous, eating a range of plant and seed matter, as well as invertebrates, amphibians and small mammals. They feed in wetland and grassland habitats, often in agricultural landscapes. They nest in pairs, usually in wetland areas such as bogs and fens with sufficient cover for seclusion. In autumn, large numbers of birds gather and migrate to spend the winter in the Mediterranean region, especially in Spain. In recent years, however, an increasing number of birds has been spending the winter in parts of northern Europe, e.g. France and Germany (Nowald *et al*., 2010).

Conservation status: EU Birds Directive Annex 1. UK Amber List. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct as breeding bird and now rare visitor. There are two recent records from Dinnet: one individual at Ordie in May 2002 (H. Scott *pers. comm*.); and another bird visited for a couple of days during June 2009 (C. Reid, SNH, *pers. comm*.). A crane was recorded at the Insh Marshes in April 2010 (P. Moore, RSPB, *pers. comm*.).

Timing of decline: Uncertain but thought to have become extinct as a breeding bird in Scotland and the rest of the UK in the 16th century

Reason for extinction: Probably over-hunting. The crane was regarded historically as good food. The destruction of wetland habitats may also have contributed.

Potential for recolonisation: Limited. Although individual cranes are reported in Scotland most years, none have as yet remained to breed. A very small resident population occurs in eastern England having originated in 1979 in the Norfolk Broads. The number of breeding pairs rose very slowly since then and in 2010, there were 13-14 breeding pairs, three non-breeding pairs and a wintering population of around 50 birds (Stanbury *et al*., 2011). The majority of the pairs summer in the Broads, with 3 pairs in the East Anglian fens and one pair in South Yorkshire (Stanbury *et al*., 2011). This mirrors an increasing trend within north European populations both for western expansion and also for over-wintering in the region, rather than making the traditional winter migration to Spain. In Scotland, there has been a marked increase in crane occurrence in recent decades, with a peak of over 40 birds observed nationwide in 2002, and April and May being the most common months for their occurrence (Betts & Schofield, 2007). Northern and eastern Scotland report the most cranes occurrences, especially the Northern Isles, Caithness and Aberdeenshire. Cranes are increasingly summering in Aberdeenshire and Moray (Funnell, 2011). Unusually, a flock of 14 cranes was recorded in Caithness in January 2008, before 11 of them then flew to Moray where they spent some weeks on farmland between Elgin and Lossiemouth (D. Hetherington, *personal observation*). No breeding in Scotland has been confirmed but a pair summered in suitable breeding habitat in Caithness in 1997 and breeding was suspected (Betts & Schofield, 2007). A pair summered again in Caithness in 2005 (Forrester, 2007a).

Future breeding in Scotland by naturally recolonising birds is considered a possibility (Betts & Schofield, 2007).

Evidence for Cairngorms occurrence: Loch Insh in Badenoch, now part of a Special Protection Area for wetland birds and a RSPB reserve, may have been known in Pictish times as *Linn Garan*, thought to mean 'Crane Lake' (A. Woolf, University of St. Andrews, *pers. comm*.). This information has survived from the 7th century AD as the site is considered to have been the setting for a significant episode in Scottish history, the Battle of Dun Nechtain when the Picts defeated the invading Northumbrian Saxons (Woolf, 2006). Suitable habitat is likely to have occurred across the area historically. Crane bone (including from juveniles) has been found in Orkney, the Western Isles, the Borders and Edinburgh (Kitchener, 2007). A crane bone was also recovered from a quarried cave at Hopeman in Moray (Groome, 1884). Cranes are known to have been eaten at feasts of James V in the early 16th century, with records showing birds originating from Dumfries, Coldstream, Edinburgh, Fife, and Stirling (Bourne, 2007). Bishop Leslie of Ross reports that cranes were as common as herons in 1578 (Bourne, 2007). Martin saw 60 cranes on Skye in late 17th century, considered as possibly the last Scottish flock (Bourne, 2007). The New Statistical Account records the species at Fortingall, but this is unlikely to refer to breeding birds. An immature bird was shot at the River Dee in Aberdeenshire in May 1851 (Baxter & Rintoul, 1953). Dennis (1995) reports an individual at Nethy Bridge in June and July 1971; one flying over the Insh Marshes in April 1976; an individual at Loch Vaa, April 1978; 2 escaped birds from the Highland Wildlife Park which inhabited the Insh Marshes July 1982 – April 1983; and 2 birds which visited the Insh Marshes in May 1987.

National or international reintroduction experience: Similar species in North America have been subject to reintroduction, with chicks being captive raised and then encouraged to migrate to traditional wintering grounds by following a microlight. However, The Great Crane Project - a recent partnership between the Pensthorpe Conservation Trust, the RSPB and the Wildfowl & Wetlands Trust - aims to re-establish a breeding population of cranes on the Somerset Levels (The Great Crane Project website, 2011). Around 100 eggs will be taken from the wild in Germany and hatched in captivity. Chicks are reared in captivity by human foster parents before being released into fox-proof enclosures. The aim is to have first breeding by 2015 and 20 pairs by 2030. Currently, around 20 immature cranes have fledged with 18 surviving to fend for themselves on and around the Somerset Levels (The Great Crane Project website, 2011). The second batch of 24 eggs was translocated from Germany in Spring 2011.

Land management implications: Cranes can feed on sown crops, especially maize, and in Germany for example, large flocks of non-breeders in late spring can have significant impacts. Maize is not grown in Scotland and in any case large flocks of non-breeders are unlikely to occur here, especially as Scotland does not lie on a major migration route and much unoccupied suitable breeding habitat would likely occur for many years (T. Langgemach, Brandenburg State Bird Conservation Centre, *pers. comm*.).

Economic benefits: The crane is a charismatic species due to its large size, noisy call and spectacular courtship dance. Therefore, there is considerable potential for it to act as a tourism and branding icon.

Scottish feasibility studies: The Great Crane Project assessed the wider British countryside for potential reintroduction sites before settling on the location of the

Somerset Levels. Scottish sites were not chosen as it was felt that birds would need to be taught to migrate south due to harsher winters, which would be prohibitively resource-intensive (K. Morton, RSPB, *pers.comm*.) Roy Dennis carried out a scoping study in the 1990s for crane reintroduction to the Scottish Highlands, focused on Badenoch & Strathspey, and concluded it was viable (R. Dennis, Highland Foundation for Wildlife, *pers. comm*.).

Grey Partridge *Perdix perdix*

Ecology: A ground-nesting species found mostly in lowland agricultural landscapes. It will use less-intensively managed grasslands such as hay meadows and rough pasture. Chicks eat mainly invertebrates, especially plant bugs *Miridae* and sawfly larvae *Symphyta*, while adults feed on range of vegetative matter.

Conservation status: EU Birds Directive Annex 2. UK Schedule 1 and Red List. IUCN Least Concern.

Current status in Cairngorms National Park: Scarce breeder.

Timing of decline: A strong decline in the species began in the 1950s.

Reason for extinction: The GWCT considers that the population of grey partridge in the UK rose considerably during the late 18th and 19th centuries with increases in land enclosure and cultivation, as well as intense predator control (GWCT website). However, the use of pesticides and herbicides affecting food supply for chicks, poor summers and an increase in predation are considered to be major causes of decline in the past few decades (Parish, 2007), while Dennis (1995) considers that in Strathspey the population decrease is due to loss of oat crops and changes in sheep grazing (Dennis, 1995).

Potential for recolonisation: Limited. Regarded as now being very scarce in Deeside, with a pair recorded at over 400m in moorland near Loch Muick in 2004, and breeding probably having occurred in Glen Tanar and near Ballater during the period 2002-6 (Law, 2011). There have been releases of grey partridges by gamekeepers in Badenoch & Strathspey near Newtonmore (P. Moore, RSPB, *pers. comm*.) and at Rothiemurchus but both these reintroductions appear to have failed, the one at Rothiemurchus considered to have been scuppered by wet summers (J. Grant, Rothiemurchus Estate, *pers. comm*.).

Evidence for Cairngorms occurrence: Widely recorded from around the Cairngorms area. In 1618 the species was on the menu in Braemar (Baxter & Rintoul, 1953). In the Old Statistical Account, grey partridges were reported from Aberlour, Duthil, Birse, Glenmuick, Kirkmichael (Tomintoul), Abernethy, and Alford. The New Statistical Account records the species widely in: Birse, Coull, Lumphanan, Glenbuchat, Leochel & Cushnie, Strathdon, Auchindoir & Kearn, Aberlour, Inveraven, Duthil, Rothiemurchus, Laggan, Cromdale, Fortingall, Atholl, Moulin, Kirriemuir, Loch Lee, Cortachy & Clova, Fettercairn, Fetteresso, Strachan, and Banchory Ternan. Partridges occurred far up straths at relatively high altitudes. Harvie-Brown & Buckley (1895) report the species breeding in 'lonely Moray straths', descending in winter. MacGillivary (1855) describes the species as common in Deeside, even above Braemar. Partridges were also nesting at altitude (around 360m) at Tomintoul and also at Dalwhinnie in 1885 (Baxter & Rintoul, 1953). Over a dozen pairs of grey partridges used to breed at Tulloch, but the species has been extinct there since 1984

(Dennis, 1995). Newly hatched chicks were observed at Dulnain Bridge in 1978 and 40 were counted at Kingussie in March 1989 (Dennis, 1995).

National or international reintroduction experience: Unofficial releases to restock or reintroduce populations have probably been widespread and many across UK. Most appear to have failed to re-establish viable grey partridge populations and poor winter survival and low breeding success are considered to be major reasons (Buner & Aebischer, 2008). The GWCT has recently developed techniques for rear and release of grey partridges to areas where they are very scarce or have become extinct, which rely mainly on improving habitat, managing predators and providing feeders (Buner & Aebischer, 2008).

Land management implications: In order to restore viable populations of grey partridge, changes in agricultural practice are required. Well established over-winter and spring cover, as well as nesting, brood-rearing and foraging cover should be provided and should be carried out in conjunction with neighbouring farms in order to support 400 ha of suitable habitat. It is recommended that predators, especially foxes *Vulpes vulpes*, but also feral cats *Felis catus*, stoats *Mustela erminea*, weasels *Mustela nivalis*, rats *Rattus norvegicus*, crows *Corvus corone* and magpies *Pica pica* should also be controlled to reduce predation of adult partridges and nests. One to two feeders per potential pair should be installed and stocked up from release until the end of May (Buner & Aebischer, 2008).

Economic benefits: Habitat improvements for partridges could benefit a range of other species. Having reached viability, populations could be subject to sport shooting, resulting in extra income for estates and farms.

Scottish feasibility studies: None known.

Honey buzzard *Pernis apivorus*

Ecology: A summer migrant that spends winters in West Africa, the honey buzzard is a tree-nesting specialist predator of wasp grubs and frogs during the breeding months. The species in Scotland occurs in both upland and lowland areas, favouring mature woodland, often interspersed with mixed farmland and heath.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and Amber List. IUCN Least Concern.

Current status in Cairngorms National Park: Scarce visitor and a very rare, sporadic, breeder in Badenoch & Strathspey. Satellite-tracked young honey buzzards, fledged from nests in Moray and Inverness-shire, fly across the CNP on their autumn migration with records for one in early September 2008 near Braemar and another recorded from Glenlivet in mid September 2006 (Highland Foundation for Wildlife website, 2008).

Timing of decline: Extinct by late 19th century.

Reason for extinction: Persecution and some habitat loss.

Potential for recolonisation: The species nests most years in very small numbers at sites in northern Scotland, especially Ross-shire, Inverness-shire, Moray & Nairn, and Perthshire, but is a notoriously under-reported species. It is likely that the species is more widespread and abundant than records suggest and may be increasing (Etheridge, 2007), although others consider there has been a recent decline (R. Dennis, Highland Foundation for Wildlife, *pers. comm*.). Its ecological requirements are likely to be met across the CNP.

Evidence for Cairngorms occurrence: The species was recorded nesting at Abergeldy sometime before 1840 and there are no earlier Scottish records than this Deeside nesting (Etheridge, 2007), which may well be due to a lack of contemporary awareness in the difference between honey buzzards and common buzzards. St John (1863) reports a honey buzzard seen eating wasps near the Findhorn River in Moray. Two honey buzzards were shot near Aberdeen (MacGillivray, 1855). One was killed at Carrbridge in May 1855 (Dennis, 1995) and a pair nested at Ballogie in 1867, although both birds were shot (Baxter & Rintoul, 1953). There has been no confirmed breeding in Aberdeenshire since 1867 (Cook, 2011a). Several other records from Strathspey in the later 19th century suggest they had bred in the area (Dennis, 1995). It is considered that persecution and deforestation had probably caused the species' extinction in Scotland until recolonisation during the second half of the twentieth century by Scandinavian birds (Etheridge, 2007).

National or international reintroduction experience: None known.

Land management implications: Forest operations would need to be sensitive to the species' nest sites.

Economic benefits: Although honey buzzards are hard to detect and observe, they would add to the diversity of raptor species within the CNP, which is already an attraction for wildlife tourists.

Scottish feasibility studies: None known.

Marsh harrier *Circus aeruginosus*

Ecology: A summer migrant, which spends the winter in West Africa, the species in Scotland favours wetlands with dense reedy margins for nesting, often close to arable land. In parts of England and in continental Europe the species has shown a recent adaptation to nesting on arable farmland. Marsh harriers feed primarily on small birds and small mammals. The species currently nests in Europe as far north as central-western Finland.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and UK Amber List. IUCN Least Concern.

Current status in Cairngorms National Park: Scarce, non-breeding visitor.

Timing of extinction: Probably prior to 19th century.

Reason for extinction: Probably persecution and wetland habitat destruction

Potential for recolonisation: Marsh harriers have successfully nested at sites in Aberdeenshire, Moray and the Tay Reedbeds in the last few years, following considerable expansion of the UK population since the early 1970s. An adult male was present at Dinnet in April 1992 followed by females in May 1999 and August 2001, while another male was recorded at Dinnet in April 2003 and most recently a female in May 2006 (H. Scott, *pers. comm*.). There are regular summer sightings of marsh harriers at Insh Marshes most years (P. Moore, RSPB, *pers. comm*.). They bred once there in the mid 1980s and there have been the following records since 2003: May-Sept 2003 immature and adult female, with a third bird in late July; May-Sept 2004 adult male and female; Jun-Sep 2005 adult male and female; no records 2006; one individual Aug 2007, May-Jul 2008 and Oct 2008. A female was observed attempting to build a nest during 2010 when she frequented the Marshes from April to August. Habitat at Insh Marshes is considered to be good for marsh harriers and renewed breeding thought only to be a matter of time (P. Moore, RSPB, *pers. comm*.).

Evidence for Cairngorms occurrence: Bell (2007) describes the species as having been a relatively common bird of southern Scotland in the early 1800s, but with no historical breeding records from northern Scotland. Today the marsh harrier occurs in Fenno-Scandia as far north as central western Finland. Historical occurrences for the CNP area relate mainly to the eastern side of the Cairngorms, although past breeding has not been specifically recorded, despite the likely past abundance of suitable habitat. The New Statistical Account records the species in the parishes of Strachan and Banchory Ternan. MacGillivray (1855) also records that the bird was seen in Banchory Tiernan. A male was shot in May 1881 at Dinnet (Baxter & Rintoul, 1953), and a bird was seen in summer at Braeroddoch Loch in 1954 (Nethersole-Thompson & Watson, 1981). Females were present

at Dinnet in 1978 and 1979 and there was an unsuccessful nesting attempt in 1980 but the Dutch-ringed male bird was found poisoned shortly afterwards (Buckland *et al*., 1990).

National or international reintroduction experience: Recent UK range expansion due entirely to natural recolonisation.

Land management implications: Young gamebirds may fall prey to marsh harriers (Bell, 2007).

Economic benefits: Predation on rodents and rabbits in arable fields may reduce grazing pressure on crops. Raptors are charismatic species, and the presence of nesting marsh harriers in the CNP would likely add to the wildlife tourism resource of the area.

Scottish feasibility studies: None known.

Nightjar *Caprimulgus europaeus*

Ecology: Traditionally, nightjars nested on the ground in open woodland with bracken, but in modern Scotland most breeding takes place in restocked conifer plantations on well-drained south facing slopes below 200m, where young trees are less than 10 years old and where there are large amounts of open ground (Shaw, 2007). Feeds on large flying insects. The species spends the winter in sub-Saharan Africa. Today the nightjar breeds across Europe as far north as southern Scandinavia.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and UK Red List. IUCN Least Concern.

Current status in Cairngorms National Park: Rare, non-breeding visitor.

Timing of decline: Decline pronounced during the first half of the twentieth century.

Reason for extinction: The reasons for the nightjar's very marked range contraction in Scotland are unclear, particularly as much apparently suitable habitat still occurs, probably also including the Cairngorms National Park. Historical evidence suggests persecution may have been a factor in some areas (St. John, 1863). The use of pesticides impacting on insect food has been implicated elsewhere in Europe. Changes in local climate to wetter colder summers may have impacted the species at the northern edge of its range (R. Dennis, Highland Foundation for Wildlife, *pers. comm.*)

Potential for recolonisation: Very limited. Today the nightjar is a rare breeding bird in Scotland, with perhaps less than thirty pairs concentrated in Dumfries & Galloway. Birds are occasionally seen in the Cairngorms National Park, and single birds were recorded at two locations in possible breeding habitat in Deeside in 2003 and 2005 (Cook, 2011b).

Evidence for Cairngorms occurrence: A nightjar was seen at Dulnain in 1786 (Thornton, 1786) and the species was recorded as a familiar bird in Badenoch in 1792 (Dennis, 1995). The Old Statistical Account records the species from Perthshire and Inverness-shire, while the New Statistical Account records it from the parishes of Strathdon, Kirriemuir, and Banchory Ternan. Macgillivray (1855) reported that the bird was "often met" in Morayshire, and stated that it was breeding in Lower Birse. St John (1863) recorded the species breeding in Moray and reported an adult and two juveniles at Monaughty in 1853. He added that nightjars were often killed by gamekeepers, simply because of its nickname 'night hawk'. Gray (1871) describes the nightjar in Scotland as a "common bird in almost every county", from Wigtownshire to the north of Caithness. Nightjar eggs were collected in the 1890s from Abernethy (Dennis, 1995), while a bird was shot at Kinveachy in the 1930s (Nethersole-Thompson & Watson, 1981). In 1940 it was reported that the bird was decreasing in Strathspey (Baxter & Rintoul, 1953). A pair nested near Loch Gamhna in 1948 while a cock bird churred close to Coylumbridge in 1951-52

(Nethersole-Thompson & Watson, 1981). Another pair was observed in Inshriach in 1961 (Dennis, 1995). Single birds were seen in Coylumbridge in 1951 and 1952; Inshriach 1971; Loch Garten 1973; Boat of Garten 1976; Tulloch 1980 and 1993; and Loch Garten 1994 (Dennis, 1995). Breeding still occurred in lowland Moray during the period 1968-72, but this was the last confirmed breeding in North-East Scotland (Cook, 2011b).

National or international reintroduction experience: None known

Land management implications: The timing of forest operations in certain circumstances may have to be altered to avoid disturbing nesting birds.

Economic benefits: Would add to the wildlife tourism resource, particularly as nightjars are most active and vocal at dusk, a time when most other bird species are inactive.

Scottish feasibility studies: None known

Red kite *Milvus milvus*

Ecology: A habitat and food generalist, which typically inhabits a mosaic of woodland and agricultural land below 450m. It feeds mainly by scavenging carrion, but will also catch a wide range of live food such as small mammals, birds and invertebrates. The species nests in trees in open woodland, especially Scots pine and oak *Quercus sp*.. Non-migratory in the UK, but tends to roost communally in winter.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and UK Amber List. IUCN Near Threatened.

Current status in Cairngorms National Park: Very rare and recent breeder following long absence.

Timing of extinction as breeding bird: Late nineteenth century.

Reason for extinction: Persecution and over-collection.

Potential for recolonisation: Two reintroduced populations of red kites exist within close proximity to the CNP. To the north-west, the Easter Ross population was reintroduced to the Black Isle in 1989, while to the east a 3 year project released around 75 kites in lowland Aberdeenshire. Red kites are increasingly observed in the CNP, with the RSPB's 'Eye to the Skies' tracking project showing that kites fledged in Easter Ross frequently move south-eastwards and spend time in the area around Moy. Several of these birds have continued to move south and have spent time in Badenoch & Strathspey. Kites from the Aberdeen releases have been observed around Nethy Bridge on more than one occasion. An Easter Ross kite was seen scavenging a roadkill pheasant *Phasianus colchicus* just to the north of the CNP boundary at Advie in 2007; an unspecified kite was noted in May 2009 within the Upper Donside area of the CNP flying west; and another unspecified kite was noted flying north above the River Spey at Grantown in 2009 (D. Hetherington, personal observations). Two kites were also reported from Glen Livet in August 2009 (M. Marshall, *pers. comm*.). The Black Isle population has, in recent years, stopped expanding both in terms of numbers and range. This is thought to be as a result of illegal persecution, mainly arising from poisoning (Orr-Ewing, 2007). A dead kite was found near Cromdale in 2005 while a kite tagged on the Black Isle was found dead near Tomintoul in 2007. Both had been illegally poisoned with the banned pesticide Carbofuran (BBC News website 2005; 2007). The illegal use of poisons in and around the CNP could limit the potential for kites from the two nearby source populations to recolonise the CNP. However, in 2011 a pair of red kites originating from the Aberdeenshire reintroduction successfully nested on the eastern side of the National Park and raised one chick – the first breeding kites in the Cairngorms for around 130 years.

Evidence for Cairngorms occurrence: The OSA reports that kites were residents of the parishes of Birse, Braemar, Crathie, and Kirkmichael (Tomintoul). The NSA records the species at Lumphanan, Strathdon, Fortingall, Moulin, Strachan, Banchory Ternan, Glen Isla

and Clova. The kite was reported as common around Ballindalloch in 1844, but by 1850 was described as being very rare in Moray (St John, 1863). Kites were reported to have nested around Grantown in 1845 and at Glenmore in 1850 (Baxter & Rintoul, 1953). The second half of the 19th century marks the steep decline and disappearance of the species in the Cairngorms area. The species was reported to still be common in Deeside in 1866, but to have been rare east of Glen Muick (Baxter & Rintoul, 1953). Five kites were recorded as having been killed at Crathie in 1867; six were nailed to a door at Ballater in 1865; and one was killed at Balmoral in 1871 (Baxter & Rintoul, 1953). Kites were occasionally observed at Braemar up to 1890 and were probably extinct in Deeside by 1903 (Baxter & Rintoul, 1953). Kites nested near Blair Castle in 1876, while one bird was seen in Glen Clova in 1883 (Baxter & Rintoul, 1953). In Strathspey, Booth was determined to have red kites for his collection and between 1876 and 1878 he shot two females off their nests as well as a male, and took four chicks and three eggs, while woodcutters felled a tree containing a fourth nest in 1878 at Abernethy (Nethersole-Thompson & Watson, 1981). Nesting at Rothiemurchus was recorded in 1878 and birds were still being seen in 1885 but were killed by keepers (Baxter & Rintoul, 1953). Forsyth (1899) wrote that kites before their extinction in Strathspey used to commonly hunt mice and moles *Talpa europaea* in autumn stubble.

National or international reintroduction experience: The red kite has been subject to several reintroduction projects in England (Chilterns, the Midlands, Yorkshire and Tyne & Wear) and Scotland (Black Isle, Stirlingshire, Dumfries & Galloway and Aberdeenshire) since 1989. For the earlier Scottish reintroductions, birds were taken from populations in Southern Sweden and Eastern Germany.

Land management implications: Red kites can prey on young gamebirds, although evidence from around the Black Isle suggests that galliform birds formed only a small proportion of kite diet there (Wildman *et al*., 1998) and this could well have largely been roadkill pheasants. Forestry operations would have to avoid disturbing nesting birds.

Economic benefits: The species offers considerable potential as a wildlife tourism attraction with feeding stations open to the paying public in Stirlingshire, Galloway and Easter Ross. Well-visited feeding stations also exist elsewhere in the UK. Kite diet can also feature significant numbers of animals considered to be damaging to agricultural interests, such as rabbits, corvids, woodpigeons *Columba palumbus*, and rodents (Wildman *et al*., 1998).

Scottish feasibility studies: Feasibility studies were undertaken in advance of the reintroductions which have occurred in several parts of Scotland.

White-tailed eagle *Haliaeetus albicilla*

Ecology: Although the white-tailed eagle in the UK is typically associated with coastal districts, the species can also be found breeding today near inland wetland areas of Europe. The species can feed on a wide range of foodstuffs including fish, seabirds, waterfowl, small mammals and carrion. White-tailed eagles nest on cliffs and in trees.

Conservation status: EU Birds Directive Annex 1. UK Schedule 1 and UK Red List. IUCN Least Concern.

Current status in Cairngorms National Park: Non-breeding visitor.

Timing of decline: Nationally extinct during early twentieth century

Reason for extinction: Persecution.

Potential for recolonisation: The reintroduction of the species to the east coast of Scotland has been underway since 2007 near the Tay Estuary. It was felt that the reintroduced population there would increase and spread more quickly than that on the west coast because of the plentiful, all-year food supply provided by sea bird colonies, wintering wildfowl, rabbits, fish etc. (Marquiss et al., 2005). It is possible that a successful east coast reintroduction would increase the likelihood of the species establishing in the Cairngorms National Park, either by birds following rivers upstream or simply flying cross country. It has been suggested that the Insh Marshes could support several pairs of white-tailed eagles (M. Marquiss, *pers.comm.*). White-tailed eagles, mainly wandering immatures, have been recorded at Insh Marshes several times over the past few years, including Apr 2010, Mar 2008, Apr 2005, Sep 2004, and Oct 2003 (P. Moore, RSPB, *pers. comm.*). A tagged juvenile white-tailed eagle was recorded at the Dinnet lochs early summer 2009 (C. Reid, SNH, *pers. comm.*), while an individual bird was also observed around Tomintoul and in Upper Donside in 2009 (D. Calder, *pers. comm.*).

Evidence for Cairngorms occurrence: There are several place-names in lowland and upland north-east Scotland which employ the Scots word for eagle, "earn". Earn Scar in Glen Quharity; Earn Skelly in Glen Lethnot; Earn Craig in Glen Lee and Earn Stone in Glen Mark, could all place the species in the Angus Glens in and just outside the CNP (A. Watson, *pers. comm.*). However given the upland nature of these sites it is considered probable they refer to golden eagles *Aquila chrysaetos* (R. Evans, RSPB, pers. comm.). Nevertheless, MacGillivray (1836) describes finding the feathers of a white-tailed eagle on a cairn atop Lochnagar in Deeside and reports that the Earl of Fife's forester considered that both white-tailed and golden eagles still inhabited the Braemar district. MacGillivray concludes that "here and there in the Grampian range it occurs in diminished numbers". The Old Statistical accounts records that the white-tailed eagle is "now rare" in the Birse parish. MacGillivray (1855) reported that in Deeside the species had bred on Clachnaben

and 'Glenock', although it is unclear where that it is, and it may be a typo for Glen Esk (A. Watson, *pers. comm*.). He also noted that he'd encountered a 'local' specimen stuffed in an Upper Deeside farmer's collection and speculated that the species used to breed near Braemar. The NSA records the species in the parishes of Glenisla, Cortachy & Clova, Strachan, Banchory Ternan and, by referring to the occurrence of two eagle species in the north-west of the parish, at Strathdon. The species is considered to have bred about Loch Laggan in previous centuries (Baxter & Rintoul, 1953; Dennis, 1995), while one was killed at Carrbridge in June 1854 (Dennis, 1995). Baxter & Rintoul (1953) cite a record of a nest on an island in Loch-na-Baa in Perthshire, which by 1870 had not been used for several years, the birds having been poisoned, and mention other eyries in that district. In 1880 reference was made to a historical nest on an island on Loch Luydon in northern Perthshire, as well as in the Black Wood of Rannoch (Baxter & Rintoul, 1953). The species was reported to once have been common on Rannoch Moor (Baxter & Rintoul, 1953).

National or international reintroduction experience: The species was reintroduced to western coastal districts of Scotland using Norwegian birds in several release phases since 1975. This population has slowly increased and spread through the Hebrides and some areas of the western mainland but the rate of population increase has picked up recently. Over two hundred Scottish-born eaglets have now fledged since the project commenced. One hundred of these fledged in the first 20 years of the project, while the other hundred or so fledged in only the 6 following years. In 2007, 15 juvenile Norwegian birds were released near the Tay Estuary as the first stage of an east coast reintroduction project, scheduled to include five years of similar releases.

Land management implications: White-tailed eagles are capable of killing young lambs. There have been recent concerns amongst the crofting community of the Gairloch peninsula of Wester Ross that white-tailed eagles have killed hundreds of young lambs (BBC News website, 2008). A study commissioned by SNH fitted 58 young lambs in the area with radio transmitters in Spring 2009 in order to monitor mortality from birth to weaning. However, over the course of the 2009 season none of the studied lambs succumbed to predation by white-tailed eagles (Simms et al., 2010). As scavengers, white-tailed eagles are vulnerable to poisoned baits and one bird from the East Coast reintroduction project was found poisoned in the Angus Glens in 2009 (BBC News website, 2010). Forestry operations would have to avoid disturbing tree-nesting birds.

Economic benefits: It is a large and charismatic species, which has acted as a considerable wildlife tourism icon for the island of Mull and other areas of western Scotland. It has been estimated that the species brings in around £1 million in additional income each year to the economy of Mull. The species may also predate on, and disrupt, gaggles of wild geese, which may help to reduce grazing pressure on agricultural land experiencing heavy foraging.

Scottish feasibility studies: The species has been subject to reintroduction projects to both west and east coasts following feasibility studies. The CNP has not been subject to a specific reintroduction feasibility study. The species has also been reintroduced to parts of Spain, France and Israel.

Willow tit *Poecile montanus*

Ecology: In Scotland, it is the *kleinschmidti* subspecies which occurs, as in other parts of the UK, and is typically found year round in wet broadleaved woodland, consisting of willow carr *Salix sp*., birch *Betula sp*., alder *Alnus glutinosa* or hazel *Corylus avellana* (Maxwell, 2007). The species excavates its own nest cavity in decayed wood. It often forages for invertebrates in thick ground cover such as nettles, brambles *Rubus sp*., and rosebay willowherb *Epilobium angustifolium*, as well as amongst tree branches. In winter, feeds on seeds and will come to bird feeders, where it gives way to great tits *Parus major* and blue tits *Parus caeruleus* but not coal tits *Parus ater*.

Conservation status: UK Red List. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct.

Timing of decline: Extinct by the early 1950s.

Reason for extinction: On the continent the willow tit occurs year-round from central Europe northwards through the boreal zone to the Arctic Circle. In Alpine and Boreal regions, however, the lower-ground *kleinschmidti* subspecies gives way to larger, more robust forms with different habitat requirements. Halley (2011b) considers it likely that the boreal subspecies *borealis*, which is today a very common bird of conifer forest and montane willow scrub in Scandinavia, colonised post-Glacial Britain and occurred in Scotland, much like the crested tit, but became extinct in Scotland when humans cleared montane scrub habitats and reduced pinewood habitats to scattered fragments. They may have also lost out in competition with the more dominant crested tit, which was similarly constrained by habitat availability for soft dead stumps in which to excavate nest holes (Halley, 2011b). It has been contended that those willow tits which survived in wet wood habitats in the Cairngorms until the mid 20th century were of the low ground subspecies, which may have always coexisted alongside the Boreal form or colonised from the south subsequent to the Boreal form's extinction (D. Halley, Norwegian Nature Research Institute, *pers. comm*.). Willow scrub clearance and the removal of standing dead timber by humans is considered to have reduced the lowland willow tit to scattered populations which were very vulnerable to major stochastic events such as the severe winter of 1947/8 (Roy Dennis, Highland Foundation for Wildlife, *pers. comm*.). A UK decline has been linked to competition with great and blue tits for nest holes (Mead, 1993).

Potential for recolonisation: Very limited. The species has continued to experience a southwards range contraction during the late twentieth century. The species is sedentary and today found only in southern Scotland, especially in Dumfries & Galloway and, to a lesser extent, in a small area of the Clyde Valley and pockets of Ayrshire.

Evidence for Cairngorms occurrence: Marsh tits *Poecile palustris* and willow tits were thought to be the same species until the early twentieth century, but willow tits occurred commonly in the Cairngorms until the 1950s, especially in Badenoch & Strathspey, while the marsh tit is not known to have occurred. The New Statistical Account records the species occurring at Banchory Ternan, while St John (1863) reports willow tits as being more common in Moray than coal tits. In 1865 breeding by willow tits was known in Perthshire, Aberdeenshire and Inverness-shire (Baxter & Rintoul, 1953). Several were observed at Loch an Eilean in May 1889, while in 1891, the species was considered plentiful in birchwoods at Kingussie, Kinrara, Kincraig & Boat of Garten, with 7-10 seen in a flock (Dennis). In 1893, willow tits were found breeding in stumps from Kingussie to Cromdale, with two nests found near Aviemore (Baxter & Rintoul, 1953). They were recorded as 'numerous' in September 1895 around Kincraig (Dennis, 1995). A willow tit was seen feeding young at Balavil in 1914, while the species was well distributed in 1919, with one bird seen feeding amongst heather at 700 m in the central Cairngorms in September that year (Baxter & Rintoul, 1953). During the years 1937-41, the species was present in Badenoch & Strathspey at Dulnain Bridge, Dorback, Boat of Garten, Rothiemurchus and Kingussie, but had become scarce by 1948 (Dennis, 1995). In Aberdeenshire, a pair fledged young near Turriff in June 1945, while single birds were seen at Ballintober in Glen Muick in April 1944, Balmoral Castle grounds in April 1946, and at Glenmuick House in July 1946 (Watson & Francis, *in press*). It is thought that the Badenoch & Strathspey population had probably crashed because of the severe winters of the late 1940s and early 1950s and then became extinct (Dennis, 1995).

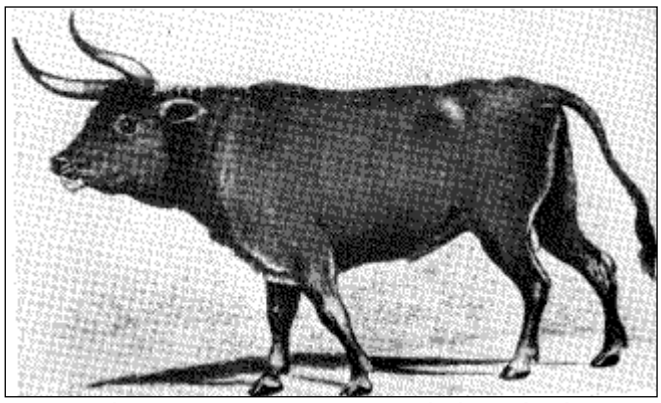
National or international reintroduction experience: None known

Land management implications: The retention of dead and decaying timber in wet woods would likely be encouraged.

Economic benefits: A potential yet modest addition to the wildlife tourism resource of the CNP.

Scottish feasibility studies: None known

Aurochs *Bos primigenius*



Ecology: The aurochs was a large wild bovid which once ranged widely across Europe but became globally extinct in Poland in 1627. However, having been the ancestor of modern domestic cattle *Bos taurus* breeds, many of the species' genes live on in the present day. In semi-natural habitats such as woodlands, grasslands and wetlands, cattle are thought to diversify plant communities, create pathways for young woodland grouse in dense vegetation, and create open areas and disturbed water margins, while their dung provides a rich source of nutrients as well as habitat for many invertebrates (Dennis, 1998). Several birds and mammals are thought to benefit from low intensity cattle rearing, including black grouse *Tetrao tetrix* and capercaillie (Dennis, 1998).

Conservation status: Totally extinct

Current status in Cairngorms National Park: Extinct

Timing of extinction: Uncertain but the Iron Age has been suggested (Kitchener, 1998).

Reason for extinction: Probably over-hunting for food and to prevent conflict and genetic admixture with domestic cattle.

Potential for recolonisation: None, as the species is globally extinct.

Evidence for Cairngorms occurrence: The palaeontological evidence for the aurochs can be difficult to interpret because of morphological similarities to domesticated cattle. However, aurochs bones have been recovered from South and Central Scotland as well Banffshire, Blair Atholl, Pitlochry, near Crieff, Elgin, Aberdeen, Caithness, and Sutherland. Given the distribution of these sites, the aurochs appears to have been widespread in and around the Cairngorms in the past. Only two Scottish aurochs bones have been carbon dated giving dates of 9-11,000 years BP. It is not known what period the many undated Scottish bones derive from. Sixteenth century texts refer to dwindling populations of wild white cattle living in the Caledonian Forest, which were very wary of humans and dangerous to hunt (e.g. Boece, 1526). Robert the Bruce was supposedly charged by a wounded bull during a hunt in the 14th century (Boece, 1526). The original aurochsen were black so these white cattle are likely to have been an ancient breed of domesticated cattle that had gone feral, and are likely to have been similar to the Chillingham white cattle that have been kept at a small number of private parks for several centuries. The aurochs became globally extinct in Poland in 1627, although attempts have since been made to reconstitute the aurochs by the selective breeding of domestic cattle breeds, which have all descended from aurochsen. The best-known result of these attempts, the Heck cattle, is widely used on the European continent for wildland grazing management. The occurrence of both domestic and feral cattle in Scottish forests over the centuries means that the ecological function of large bovids has continued in some areas long beyond the extinction of aurochsen.

National or international reintroduction experience: As the aurochs is totally extinct, and has been for almost 400 years, there have been no reintroduction attempts. However, hardy 'primitive' breeds such as Heck and Highland cattle have been deliberately introduced to areas under conservation management in order to restore the missing ecological functions of large bovids. The most well known examples of this occur on Dutch, Belgian and Danish nature reserves, but it is also showing a growing trend in the UK. FCS have used Highland cattle in some of their forests for conservation management (H. Armstrong, Forest Research, *pers. comm*.), while the RSPB are considering utilising them in Abernethy Forest (J. Roberts, RSPB, *pers. comm*.). Europe's one remaining wild bovid species, the European bison *Bison bonasus*, which is not thought to have occurred in Britain in the Holocene, has been successfully reintroduced to several wild and semi-captive situations in eastern Europe, following complete extinction in the wild. It is possible that the bison may mimic many of the ecological functions of the extinct aurochs.

Land management implications: Reintroduction of the ecological function of the aurochs can be to a large extent achieved through the controlled conditions of domestic cattle grazing, rather than through the reintroduction of wild, free ranging species, so any negative land management implications can be easily managed. Dennis (1998) addressed this issue and recommended greater use of low intensity, traditional cattle grazing.

Economic benefits: Can be incorporated into modern agricultural businesses thus generating income through food production and subsidies as well as agri-environmental payments. There are options for the conservation grazing of cattle under the SRDP.

Brown bear *Ursus arctos*

Ecology: Mainly forest-dwelling and solitary, but can also occur in tundra and on pastures above the treeline. Omnivorous, feeding on berries, grasses, herbs, roots, acorns, mast, honey, invertebrates, fish, carrion, small mammals and can hunt deer. Usually hibernates.

Conservation status: EU Habitats Directive Annex IV. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct

Timing of extinction: Probably during medieval period

Reason for extinction: Probably a combination of deforestation, persecution and over-hunting.

Potential for recolonisation: None, as completely extinct on island of Britain. Elsewhere the species occurs mainly in mountainous or thickly forested areas in parts of Fenno-Scandia, Southern and Eastern Europe.

Evidence for Cairngorms occurrence: A skull and rib were found in a peat bog at Shaws, Dumfriesshire and were radiocarbon dated to 7590 yrs BP, while a canine tooth found at Inchnadamph, Sutherland was dated to 2673 yrs BP (Kitchener, 1998). According to the Roman writer Martial, a 'Caledonian' bear was used to dispatch crucified criminals for entertainment in the opening festivities of the Coliseum in AD 80. Brown bear bone from a North Yorkshire cave has been carbon-dated to the 7th century AD (T. O'Connor, University of York, *pers. comm.*), while a canine tooth found at Keiss, Caithness has not been dated but was considered by Ritchie (1920) to be around 1000 years old. Bears are depicted on Pictish stones dating from the 7th-9th centuries AD from Meigle, Perthshire; Tarbat, Easter Ross; Arbroath, Angus; and Scatness, Shetland (Henderson & Henderson, 2004). There is no direct evidence from within the Cairngorms National Park for the occurrence of bears, but with a confirmed range north and south of the Cairngorms, and with suitable habitat available historically in the area, it is very likely that brown bears occurred in the Cairngorms. The timing of their occurrence in Sutherland suggests their extinction in Britain was driven by human factors such as deforestation and over-hunting, rather than by natural climate change.

National or international reintroduction experience: An attempt to reintroduce brown bears to Bialowieza Forest in Poland during WWII failed (Breitenmoser et al., 2001). However, since the 1990s existing, but very small, populations have been restocked in the French Pyrenees, the Italian Alps and in the Austrian Alps (Breitenmoser et al., 2001). An ongoing reintroduction project also started in 1990 to restore the brown bear to Montana, USA.

Land management implications: Brown bears can kill livestock such as cattle and sheep, which require intensive shepherding, and can be destructive to apiary interests. Attacks on humans in Europe by bears are rare. However, while there were no fatal attacks in Scandinavia between 1906 and 1999 (Swenson *et al*., 1999), the marked increase in the Swedish brown bear population in recent years has led to a rise in the number of attacks, which typically involve hunters and injured bears (Swenson *et al*., 1999; J. Linnell, Norwegian Nature Research Institute, *pers. comm*.). Despite the low incidences of attacks, there may be public safety concerns about a reintroduced population in Scotland. Brown bears can also scavenge from around human settlements, as frequently witnessed in the city of Brasov, Romania. Forestry operations would need to be sensitive to any breeding or hibernation dens.

Economic benefits: A highly charismatic species that would likely be a very significant wildlife tourism draw and branding icon.

Scottish feasibility studies: Wilson (2004) identified a Minimum Viable Population size of 250 for brown bears but felt that the Highlands would support relatively low densities of bears due to insufficient environmental productivity.

Elk *Alces alces*

Ecology: Mainly forest-dwelling, although occurs in nearby montane, farmland and wetland habitats. Elk eat shoots and twigs of trees, especially pine *Pinus sylvestris*, as well as the bark of aspen *Populus tremula*, rowan *Sorbus aucuparia* and willow. Their summer diet is mainly large herbs and leaves, including aquatic plants and cereals such as oats. Adults eat around 10kg per day wet-weight of browse during winter.

Conservation status: Not listed in Habitats Directive Annex IV as it is relatively common and widespread in northern Europe. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct

Timing of extinction: Uncertain, but definitely occurred in Scotland within last 4000 years, and could in theory have survived into medieval times although evidence is currently sparse.

Reason for extinction: Probably deforestation and over-hunting.

Potential for recolonisation: None. The species occurs in large populations in Fenno-Scandia, Russia, the Baltic States and eastern Poland. Low, but increasing, numbers also occur in central Europe such as in Germany, W. Poland, Slovakia, Czech Republic, Austria etc.

Evidence for Cairngorms occurrence: There are around 20 sites in Scotland which have recorded bones of elk (Kitchener, 1998; Yalden, 1999). Several have been reported from southern Scotland where the most recent British radiocarbon date of 3925 years BP stems from (Kitchener & Bonsall, 1997). However, elk bones have also been recovered from Perthshire, Caithness, Sutherland and from near Elgin. A word for elk in Gaelic, *lon*, has been attested, while a Gaelic proverb *Cho luath ris na loin*, is thought to mean "as swift as the elks" (C. O'Boyle, University of Aberdeen, *pers. comm.*). The widespread distribution of elk bones in Scotland, including areas immediately north and south of the Cairngorms, combined with an historical abundance of suitable habitat for elk in the Cairngorms area, suggests it is very likely that the elk is a former native species of the region.

National or international reintroduction experience: In Europe, elk have been reintroduced to the Kampinoski National Park, Poland. Elk were also successfully reintroduced in two phases to the Kamchatka Peninsula in Far Eastern Russia. North American moose (sometimes considered the same species as European elk) have been subject to reintroductions in Michigan. The Alladale Estate in Sutherland released 2 young elk from Scandinavia into a 200 ha forest enclosure in 2007 as part of a wider ecological restoration and wildlife tourism project. This pair produced a female calf in 2011.

Land management implications: Potential for browsing damage to forestry. Also a significant cause of road traffic accidents in Scandinavia.

Economic benefits: An important quarry animal for hunters, particularly in Scandinavia, which provides a good source of game meat. A large, charismatic species, which would add considerably to the wildlife tourism resource.

Scottish feasibility studies: None known.

Eurasian beaver *Castor fiber*

Ecology: Occurs in slow-moving rivers, lakes and wetlands. Will adapt small streams and ditches into broader, deeper watercourses by damming with mud and tree branches. By creating beaver ponds and introducing greater heterogeneity to watercourses, such damming behaviour is beneficial for a range of plants, invertebrates, fish, amphibians, birds, and mammals such as water voles *Arvicola amphibius* (Tumlison *et al*., 1982; Danilov, 1995; Nummi & Pöysä, 1997; Harthun, 1999; Pollock *et al*., 2004; Landesfischereiverband Bayern E.V., 2005; Nummi, 2005; Rosell, *et al*., 2005; Stevens *et al*., 2007; Bartel *et al*., 2010). During the spring and summer months, beavers feed on grasses and the leaves and twigs of herbaceous plants, while in the autumn and winter they concentrate on the twigs and bark of trees and shrubs, especially aspen and willows, although they will consume a range of broadleaved species. This felling of broadleaved riparian trees is thought to be a form of natural coppicing, and populations of aspen in particular are thought to benefit from this (Batty, 2002; Cosgrove *et al*., 2005).

Conservation status: EU Habitats Directive Annex IV species. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct

Timing of extinction: Uncertain, but possibly 16th or 17th century.

Reason for extinction: Over-hunting for very valuable pelts and castoreum

Potential for recolonisation: Limited. A trial reintroduction has seen 11 animals released to a naturally contained site in Argyll, while beavers are kept in large privately-owned enclosures in Inverness-shire and Perthshire. Escapes from captivity, and possibly deliberate releases, have occurred and a feral population now occurs in the Tay catchment (Halley, 2011a). Beavers are now likely to occur widely across watercourses in Perthshire and Angus and individuals may migrate into tributaries of the Tay within CNP boundaries, although these are unlikely to represent optimal beaver habitat and may not favour long-term settlement. Colonisation from the Tay catchment of neighbouring watercourses such as the Spey and Dee, while very unlikely in the short term, is not impossible if the population develops in the years ahead.

Evidence for Cairngorms occurrence: Palaeontological evidence of beavers has been recorded from Moray, Perthshire, Ayrshire, Dumfriesshire, the Borders and Edinburgh (Conroy & Kitchener, 1996). Neill (1821) refers to beaver remains from an unspecified location in West Aberdeenshire but these specimens have been lost. (Conroy & Kitchener, 1996). Beaver-gnawed wood has recently been found on the bed of Loch Tay (Scottish Crannog Centre, 2008). Scottish manuscripts from the 12th and 14th centuries describe how beaver pelts were traded internally and exported (Conroy & Kitchener, 1996). Hector Boece, writing in 1526, described how the beaver was still found in the area of Loch Ness.

Aybes and Yalden (1995) identified an Anglo-Saxon beaver place name in Fife, Beverkae. The Gaelic word for beaver *Losleathan* (meaning broad-tail) was used in the western Highlands until the early 19th century (Ritchie, 1920). There is no direct evidence for beaver having occurred in the Cairngorms, but given that bone evidence has been reported from areas north and south of the Cairngorms, and that much suitable habitat would have existed, especially in the Spey and Dee catchments, it is very likely that beavers would have occurred in the area historically.

National or international reintroduction experience: The Eurasian beaver has been subject to many reintroductions, especially in Europe. Outwith the former Soviet Union (FSU), beavers have been subject to at least 157 reintroductions (Halley & Rosell, 2002). Within the FSU, beavers were also extensively reintroduced, but there are few details available on these schemes. In Europe, beavers have been subject to reintroduction projects in Austria, Belgium, Bosnia, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Latvia, Lithuania, Netherlands, Norway, Poland, Romania, Russia, Serbia, Slovakia, Spain, Sweden, and Switzerland (Halley & Rosell, 2002). Beavers from reintroduced populations in neighbouring countries have colonised Luxembourg and Slovenia. Eurasian beavers occur in large enclosures at sites in Perthshire and Inverness-shire. In England, enclosed beavers are used to manage the habitat at the Ham Fen National Nature Reserve in Kent while another large enclosure exists at a site of an old gravel works in Gloucestershire. Similar projects are planned or underway in Devon and Powys in North Wales (D. Gow, *pers. comm*.). The beaver was included in 2007 on SNH's Species Framework as a species that ought to be further considered for reintroduction. The Environment Minister granted a licence in 2008 for a trial reintroduction on Forestry Commission Scotland land in Knapdale in Argyll. The first 11 beavers of around 20 imported from Norway, were released in May 2009 into the Knapdale lochs, and will be closely monitored for 5 years.

Land management implications: Beaver dams can result in the inundation of land adjacent to watercourses that can affect farmland, forestry, paths etc. Dams can also, under certain circumstances, restrict the movement of migrating fish, and there has been vocal opposition to beaver reintroduction in Scotland from some fisheries interests concerned about the potential for beaver dams to impact negatively on the breeding and migration of salmonids. Evidence from Norway where significant populations of both Atlantic salmon *Salmo salar* and Eurasian beavers coexist in several catchments suggests that there are no significant negative impacts on salmonid populations (Halley & Lamberg, 2001; Parker & Rønning, 2007). SNH commissioned independent fisheries biologists to critically review the effects of beavers upon fish and fish stocks (Kemp *et al*., 2010). This review of the international scientific literature indicated that the main positive impacts of beaver activity on fish cited were increased habitat heterogeneity, greater area for rearing and over-wintering, higher invertebrate production, and the provision of refuge from both high and low flows. The main negative impacts of beaver activity cited were barriers to fish movement due to the construction of dams, loss of spawning habitat due to siltation, and reductions in oxygen levels in beaver ponds leading to fish kills. Overall, positive impacts were cited more frequently than negative impacts. The results of an expert opinion survey revealed that the majority of fisheries scientists and managers suggested that the impact of beaver dams on the movement of aquatic organisms in tributary streams, including upstream and downstream migrating salmonids, and on the availability of suitable salmonid spawning habitat was generally considered to be negative (Kemp *et al*., 2010). However, the overall impact of beavers on fish populations was generally considered to be positive and the impact

of beavers on the abundance and productivity of migratory salmonids was also considered to be positive. Experience from Europe shows that problem dams can be removed or breached to resolve flooding issues. In Norway, for example, beaver dams are not legally protected and can be removed at the landowner's discretion (D. Halley, Norwegian Nature Research Institute, *pers. comm*.). Beavers can fell or damage broadleaved trees valued for amenity, landscape, fruit etc., although trees can be protected from felling by fencing off areas with stock fencing or by using wire mesh around the trunk of valued single trees (D. Halley, Norwegian Nature Research Institute, *pers. comm*.). Burrowing in certain circumstances may undermine banks where a vehicle track or road passes above.

Economic benefits: Beavers have been shown from other European countries to contribute to the wildlife tourism and environmental education resource and in some countries, e.g. France and Denmark, have become site-based tourism attractions (E. Holder, Bretagne Vivante, *pers. comm*.; S. Asbirk, Danish Forest and Nature Agency, *pers. comm*.). Being territorial and site specific, it is feasible to build a viewing facility for visitors to observe beavers and their activities. Their increased activity in the early morning and in the evening means that visitors coming from areas further afield will likely require local accommodation. In several European countries beavers are hunted and eaten, and in Norway, for example, riparian owners are paid by hunters for the shooting rights (D. Halley, Norwegian Nature Research Institute, *pers. comm*.). Beavers can also provide ecosystem services that are hard to quantify in monetary terms, e.g. improving water quality, storing water in the landscape during dry periods, and improving conditions for sport fish such as brown trout *Salmo trutta* (Coles, 2006; Müller-Schwarze & Sun, 2003; Bräuer & Marggraf, 2004).

Scottish feasibility studies: The feasibility of beaver reintroduction to Scotland has been subject to several assessments. One population viability and habitat analysis concluded that a beaver reintroduction in Scotland had a good chance of leading to an established population (South *et al*., 2000). Another assessment by visiting Norwegian beaver managers concluded that beaver reintroduction in Scotland would result in viable populations and of the several sites visited, they identified the Insh Marshes in the Spey Catchment as one of the best quality sites for beaver reintroduction (Parker *et al*., 2000). A GIS analysis of potential beaver habitat across Scotland identified the Spey, Dee and Don catchments, and in particular their areas within the CNP, as being among the river systems having the most suitable beaver habitat. The Insh Marshes and Dinnet lochs emerged as the top two sites in northern Scotland for their suitability for beaver reintroduction (Macdonald *et al*., 2000) while the Dee catchment as a whole has been identified as having sufficient suitable habitat to enable the development of a viable, long term beaver population (Jones, 1995). The section of the River Dee between Ballater and Dinnet was considered to support sufficient quantities of suitable woody food as well as offering riverbanks well suited to settlement (Gurnell, 1997).

SNH carried out a public consultation exercise to gauge public support for the reintroduction of beavers to Scotland in 1998 (Scott Porter Research & Marketing Ltd, 1998). Overall, of the 1944 responses received, 86% were in favour, with 14% against. Of the 59 responses from the Knapdale Community area, where a trial reintroduction was planned, 64% were for, 24% were against and 12% were neutral about the re-introduction proposal. Of the 40 responses from people living in the vicinity of the proposed trial site, 65% were in favour, 27.5% were against and 7.5% did not express a clear view about reintroducing beavers to their local area. A survey was also conducted of the passive public,

i.e. members of the public in Scotland who had not submitted a response to the consultation. Of the 2141 people interviewed, 63% were in favour, 25% were unsure and 12% were against. Another survey noted among the public a strong willingness to pay for beaver reintroduction compared to other conservation projects (Philip & Macmillan, 2003).

Eurasian lynx *Lynx lynx*

Ecology: The Eurasian lynx is mainly forest-dwelling although has been known to forage amongst rocks and scrub above the treeline. It is a solitary, ambush predator of small to medium-sized woodland ungulates, typically feeding on one per week. Reintroduced lynx in Switzerland were effective at reducing locally high densities of roe and chamois *Rupicapra rupicapra* and breaking up concentrations in the landscape (Haller, 1992; Breitenmoser & Haller, 1993). In Scotland they would likely prey on roe and sika *Cervus nippon* adults as well as red deer calves, and the occasional hind (Hetherington, 2008). Foxes and lagomorphs also feature regularly in lynx diet across Europe (e.g. Hell & Slamecka 1996; Sunde *et al.* 1999; Jobin et al., 2000; Valdmann *et al.* 2005; Helldin *et al.* 2006). Capercaillies are only a very rare occurrence in lynx diet in western and Central Europe where deer densities are high compared to boreal regions (e.g. Jobin *et al*., 2000).

Conservation status: EU Habitats Directive Annex IV. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct

Timing of extinction: Probably during late medieval period.

Reason for extinction: Probably a combination of deforestation, prey decline and persecution.

Potential for recolonisation: None, as species is completely extinct on island of Britain. It occurs in large populations in mountainous and/or thickly wooded parts of Scandinavia and Eastern Europe. Smaller populations, stemming from reintroductions, occur in well-wooded upland parts of Central and Western Europe.

Evidence for Cairngorms occurrence: Discoveries of lynx bones in Britain are today strongly associated with limestone cave sites as result of favourable bone preservation conditions. Bones from two specimens have been found in neighbouring caves near Inchnadamph, Sutherland. One of the specimens was dated to 1770 years BP (Kitchener & Bonsall, 1997). Undated lynx bones have also been found at coastal limestone cave sites near Oban, Argyll and Durness, Sutherland. Lynx bones have been reported from several cave sites in England and Wales. One recently dated specimen from North Yorkshire gave a date of 1550 years BP (Hetherington *et al*., 2006). A Cumbric literature reference describes the hunting of lynx in the Lake District in the early 7th century AD, while the Old Gaelic word for lynx was used in the Highlands of Scotland up until the 13th century (Hetherington *et al*., 2006). Bones have not been found in the Cairngorms as a result of the absence of limestone caves. Given lynx occurred elsewhere in the Highlands, as well as further south in Britain, and that suitable habitat and prey would have been widespread in the Cairngorms

area, the lynx is very likely to have been a native species of the Cairngorms region. It is thought that the lynx became extinct in Britain in the Late Middle Ages and that the Cairngorms region may have been the species' last stronghold because of its relatively late deforestation (Hetherington, 2006).

National or international reintroduction experience: Eurasian lynx have been subject to several reintroduction projects in Europe. With the exception of East Prussia during WWII, all reintroductions have taken place since the early 1970s (Breitenmoser *et al*., 2001). Some official projects, such as in Bavaria, the Italian Alps, and Austrian Alps, failed, as did clandestine reintroductions in the Black Forest and Italian Appenines. However, other projects using wild lynx, as opposed to zoo stock, such as in the Swiss Jura, Swiss Alps, Bohemian Forest, Vosges Mountains, and in the Dinaric Alps of Slovenia, have been more successful. A healthy lynx population now exists in both the French and Swiss Jura, while the Swiss Alpine lynx population has spread to the French and Italian Alps. The release in the Bohemian Forest has resulted in lynx living on both the Czech and Bavarian side of the border today. The Slovenian reintroduction saw lynx spread into neighbouring Croatia. More recently, reintroductions involving zoo-born animals have occurred in the Kampinoski National Park in Central Poland and in the Harz National Park in Central Germany and appear to have been successful so far.

Land management implications: Sheep, especially lambs, are sometimes killed. In Norway, where sheep are grazed free range and unshepherded in forest, depredation by lynx is widespread. However, in the rest of Europe, where sheep are grazed largely in open pasture, depredation is small-scale, localised and manageable (Angst *et al*. 2000; 2002; Stahl *et al*. 2001). Typically the annual total of lynx-killed sheep for the whole of Switzerland varies between 15 and 40 (KORA website, 2010). Deer populations exposed to lynx predation can change their distribution within the landscape to attempt to avoid predation and so human hunters may have to adapt to these changes in deer behaviour. Elsewhere in Europe any undesirable impacts are counter-balanced by a variety of methods, including: the deployment of preventative measures such as fencing or livestock guarding animals; the translocation of individual lynx from high density populations to unoccupied areas; the licensed shooting of problem individuals; or quota hunting of the population. Forestry operations would need to be sensitive to any breeding dens.

Economic benefits: Preying on woodland deer and breaking up their concentrations, they could reduce grazing and browsing pressure on forestry and reduce the costs of deer control and fencing. Regular predation on foxes, which is considered to be additive to other mortality factors, might also contribute to conservation of small game and ground-nesting birds such as woodland grouse, as fox predation on such species is considered to be more significant than lynx predation (Helldin *et al*., 2006; Elmhagen & Rushton, 2007; Elmhagen *et al*., 2010). It is a charismatic species that would likely be a very significant wildlife tourism draw and branding icon, despite its elusiveness, as demonstrated in several national parks, especially in Germany. Like the other large carnivores of northern and eastern Europe, the quota hunting of lynx contributes to the local rural culture and economy.

Scottish feasibility studies: Wilson (2004) identified a MVP size of 200-250 for Eurasian lynx and concluded that human population density and development was low enough and that there was sufficient space and prey for a viable population in the Highlands, including the Cairngorms. He also concluded that, taking into consideration potential impacts on livestock, threat to human safety, and likely public support, the lynx was the most realistic

candidate of the three large carnivore species (lynx, wolf, bear) for reintroduction to Scotland, the feasibility of which merited further assessment. A more detailed assessment of habitat availability & connectivity, prey availability, and population viability for reintroduced lynx in Scotland has since been carried out (Hetherington, 2005; Hetherington & Gorman, 2007; Hetherington et al., 2008). These studies concluded that Scotland could support two lynx habitat networks: one north of the Central Belt; and one centred on the Southern Uplands and including Kielder Forest. The amount of habitat in the two networks as well as prey densities within them, meant that the southern population could likely support around 50 lynx, while the more northern one (which included wooded landscapes in the CNP such as Badenoch & Strathspey, Deeside, Donside, Perthshire and the Angus Glens) could support around 400. The smaller population would probably not, in isolation, support a MVP in the long term, but the northern one could comfortably accommodate a viable lynx population. A review of evidence from elsewhere in Europe reported that depredation on sheep grazed in open pasture was small-scale, localised and controllable, while the presence of lynx could enhance visitor perceptions of an area's 'wildness' and thus contribute positively to nature-based tourism (Hetherington, 2008).

Reindeer *Rangifer tarandus*

Ecology: Occurs in subarctic coniferous and birch forest, montane heath, and tundra. Reindeer eat lichen, sedges, heather, grasses, moss, leaves, shoots and fungi.

Conservation status: Not listed in Habitats Directive Annex IV. The wild reindeer occurs in the EU only in Finland where it is a game animal. It is listed on Annex II and so SACs are designated for the species. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct as wild species but occurs locally as free-ranging semi-domestic.

Timing of extinction: Uncertain

Reason for extinction: Natural climate change, over-hunting by humans, or a combination of the two.

Potential for recolonisation: As a wild species, none. Small wild populations in Europe are today confined to Norway, Finland and Russia. Semi-domestic reindeer are more widespread across Fenno-scandia and Russia.

Evidence for Cairngorms occurrence: Palaeontological evidence for reindeer in Scotland has been recovered from Sutherland, Perthshire, Fife, the Borders, Dumfriesshire and several sites in Central Scotland (Kitchener, 1998). The bone caves near Inchnadamph in Sutherland have yielded many reindeer bones and the youngest radiocarbon date for Britain, 8300 years BP, comes from this area (Clutton-Brock, 1991). This date proves that reindeer lingered on in Scotland for some time after the end of the last Ice Age and could survive in the more temperate climate of Mesolithic Scotland. The shape of antler fragments suggests these reindeer were the tundra form *R. t. tarandus.* Some Scandinavian semi-domestic reindeer, which are considered to be descended from wild tundra reindeer (Røed *et al*., 2008), were brought to the Cairngorms in 1952, and there has been a free-ranging presence ever since.

National or international reintroduction experience: Reindeer are not known to have been successfully reintroduced in Europe, although there have been introductions to new areas such as Iceland. There were, however, failed reintroductions at Atholl and Mar in the 18th and 19th centuries (Nethersole-Thompson & Watson, 1981). Caribou (same species as reindeer) have been reintroduced in North America in parts of Alaska and Maine while reintroductions are being discussed for elsewhere. The establishment of free-ranging semi-domestic reindeer in the Cairngorms since the 1950s is frequently and mistakenly referred to as a reintroduction. The two extant herds are owned by The Reindeer Company and as well as receiving some veterinary care (e.g. vaccinations against tick-borne

encephalitis, and external tick treatments prior to grazing on open hill), they receive supplementary feeding as a management tool to discourage distant dispersal (T. Smith, The Reindeer Company, *pers. comm*.). Some of these animals are a tourist attraction and can be hand fed. A herd of around 80 is grazed free-range in the Arctic-Alpine environments of the Cairngorms massif year round and can, at times, range widely e.g. a female recently wandered over to Glenfeshie and gave birth to a calf (T. MacDonell, Glenfeshie Estate, *pers. comm*.). Another 50 or so animals are grazed free-range in winter on the Cromdale Hills. These herds can subsist on the native vegetation of the Cairngorms.

Land management implications: There is a possibility of increased grazing and browsing pressure as well as tick burden in upland areas. Reintroduced wild reindeer could interbreed and hybridise with the extant semi-domestic reindeer.

Economic benefits: Wild reindeer would likely add to the wildlife tourism resource, while surplus animals could be hunted, and the meat sold, as they are today in Norway.

Scottish feasibility studies: None known other than the site selection process undertaken in the early 1950s by Sami reindeer herdsman, Mikkel Utsi, which identified the Cairngorms as having the most similar climate and vegetation in Scotland to reindeer habitat in Swedish Lappland, and was thus the most suitable place for a semi-domestic herd.

Western polecat *Mustela putorius*

Ecology: Occurs in a wide range of wooded and open habitats, with dens often located in rabbit burrows. In Britain their diet includes shrews, voles, mice, rats *Rattus norvegicus*, rabbits, hares *Lepus europaeus*, hedgehogs *Erinaceus europaeus*, small birds, poultry, young game birds, birds' eggs, amphibians, reptiles, invertebrates, carrion, fruit and honey (Birks & Kitchener, 1999). Where rabbits are abundant, they are likely to be a very significant component of their diet as evidenced by the stomach contents of roadkill polecats from across the English midlands (Birks & Kitchener, 1999).

Conservation status: Wildlife & Countryside Act Schedule 6 species. The species can be legally shot but it is illegal to trap the species without a licence. IUCN Least Concern.

Current status in Cairngorms National Park: Probably still extinct.

Timing of extinction: late 19th century

Reason for extinction: Persecution for protection of gamebirds.

Potential for recolonisation: Escaped or feral ferrets *Mustela furo*, which are genetically very similar to polecats (having been domesticated from them) and can therefore interbreed and produce fertile hybrids, may sporadically occur in the CNP but there is little evidence to show there is a self-sustaining population. However, a population of polecats seems to have become established in central Perthshire following unofficial releases before or during the early 1990s (Birks, 2008). Certainly carcases of polecat-type animals have been recorded widely from Perthshire and Angus in recent years, and so the south of the National Park could begin to be colonised in the next few years.

Evidence for Cairngorms occurrence: According to the Old Statistical Account of Scotland (OSA), whose parish accounts were compiled during 1791-1799, 57 polecats were killed in 5 parishes on Upper Deeside as part of a bounty scheme to reduce predators during 1776-1786. They were also recorded at this time in the parishes of Birse, Glenmuick, and Alford. Polecats were clearly still widespread across the region in the first half of the nineteenth century as the NSA records them in the late 1830s/early 1840s in the following parishes: Birse, Coull, Leochel & Cushnie, Auchindoir & Kearn, Inveraven, Kirkmichael, Knockando, Moy & Dalrossie, Laggan, Cromdale, Fortingall, Atholl, Moulin, Kirriemuir, Cortachy & Clova, Strachan, and Banchory & Ternan. Several parish accounts refer to weasels *Mustela nivalis* and polecats being common, but stoats *Mustela erminea* rare, suggesting polecats may once have suppressed stoat populations through competition and/or aggression. According to MacGillivary (1855) the species was widespread and not uncommon among woods, rocks and moors in Deeside in the 1850s. The last polecat from

Strathspey was considered to have lasted until 1860 (Forsyth, 1899). During 1863-64, one keeper killed 30 on the Littlewood Estate on Upper Donside (Ritchie, 1920). The last Deeside record is from Ballochbuie in 1890 (Nethersole-Thompson & Watson, 1981). Collating references to vermin bags and observations of the species in the literature, Langley & Yalden (1977) concluded that polecats became extinct in the Cairngorms counties thus: Angus (c. 1860); Perthshire (1904); Aberdeenshire (1890); Banffshire (1867); Morayshire (1870-1880) and Inverness-shire (1900-15).

National or international reintroduction experience: Polecats have been subject to unofficial reintroductions in several parts of the UK (Birks, 2008). Based on dead animals recovered from roads, it appears that polecats have been unofficially released in Argyll, Caithness, Sutherland and Perthshire (Craik & Brown, 1997; Birks, 2008). Such clandestine reintroductions could see the return of polecats to the Cairngorms, either directly through local releases or indirectly through recolonisation from neighbouring areas such as Perthshire. While the polecat phenotype has been recorded from Perthshire (Birks, 2008), photographs of some specimens from the area are considered to show animals with a phenotype consistent with hybridisation with ferrets, e.g. paler facial ring (J. Birks, *pers. comm*.). This seems to be typical for the colonising front of polecat populations as male polecats move into new areas without females and interbreed with female feral ferrets (Kitchener *et al*., 1999). Polecats seem to have a competitive advantage over ferrets, probably due to domestication having selected for docility and tameness, and hybrid offspring often maintain the polecat phenotype. In time, the polecat phenotype often seems to become dominant over the ferret phenotype at the population level (Kitchener *et al*., 1999).

Land management implications: Polecats can occasionally prey on the eggs and young of ground-nesting birds such as grouse and pheasant, and can also kill poultry. In a survey of land managers' attitudes towards polecats in England and Wales, 28% of farmers regarded the species as a threat to poultry, 11% had experienced polecat predation on poultry, 39% felt that polecats controlled rodents on the farm and 53% believed polecats control rabbits (Packer & Birks, 1999). Most gamekeepers (68%) had experienced polecat predation of penned game and regarded the polecat as a minor pest, but ranked it as a less serious threat to game than the fox *Vulpes vulpes*, feral cat *Felis catus*, stoat, mink and corvids.

Economic benefits: May increase predation pressure on rabbits, (especially as polecats can enter their burrows), thus alleviating negative economic impacts on farming and forestry etc. Polecats may also help to control mice and rats around farm buildings. By completing the set of extant British carnivores, the polecat is also likely to add value to the wildlife tourism resource of the CNP.

Scottish feasibility studies: None known

Wild boar *Sus scrofa*

Ecology: This species occurs mainly in deciduous and mixed woodland, but will forage in nearby wetlands and grassland, including agricultural land where its foraging can cause damage. Wild boar have a broad diet and are omnivorous. Typically, plant material accounts for 90% of their diet and animal matter the remaining 10%: plant matter consists of roots, bulbs, tubers, fruit and berries, while animal matter can consist of small mammals, birds' eggs, reptiles, invertebrates, and carrion (Goulding, 2003). The diet changes to accommodate seasonally available items, and acorns and beech mast can be particularly important in the autumn (Goulding, 2003). Their rooting around in the soil for food, breaks up ground vegetation and loosens soil, and thus creates opportunities for some tree species and other woodland flora (Goulding, 2003).

Conservation status: Not listed in Habitats Directive Annex IV as it occurs widely in human-modified landscapes throughout Europe south of Scandinavia. IUCN Least Concern.

Current status in Cairngorms National Park: Probably extinct.

Timing of extinction: 16th century?

Reason for extinction: Probably deforestation and over-hunting.

Potential for recolonisation: Low. Officially extinct in Scotland, but captive populations in rural areas of Scotland are widespread and boar are notoriously good at escaping from enclosures. Free-ranging and self-sustaining populations, currently found in several areas of southern England, stemmed from boar escaping from captivity. There is potential for the same situation to develop in northern Scotland, perhaps leading to the formation of free-ranging populations in the Cairngorms National Park. A wild boar was observed by two police officers between Newtonmore and Laggan in 2002 but its origins are unknown (BBC News website, 2002). Furthermore, free-ranging boar and probable hybrids with domestic pigs have been reported from several parts of Scotland in recent years, although whether these relate to established populations on the scale of those in England remains to be seen. According to the recent Atlas of Highland Land Mammals, wild boar foraging signs have been recorded from five adjacent 10 km squares in the West Highlands since 2000, although these could relate to boar x domestic pig hybrids (Scott, 2011).

Evidence for Cairngorms occurrence: There are difficulties with palaeontological evidence because of the similarity of domestic pig bones and those of wild boar. As a result, there are remarkably few bones from Britain that have been positively identified as wild boar. However, wild boar bones have been identified from sites in Caithness, Sutherland, Skye, and from Angus, including the Loch of Forfar (Ritchie, 1920; Kitchener, 1998). Boars and boar hunting were widely depicted in Pictish standing stones such as those found at

Knocknagael, Inverness; Dores, Inverness-shire; Shandwick, Ross-shire; Tarbat, Ross-shire; St. Vigean's; Angus; Dunadd, Argyll; and Dupplin, Perthshire. Gaelic place name evidence gives reference to pigs in the Cairngorms with Glen Muick in Deeside and Muckerach and Muckrach in Strathspey, thought to refer to the animals, while other place names refer to pigs in order to convey the 'hog's back' shape of a hill or mountain (Wallace, 1899; Aybes & Yalden, 1995). Lynturk, a Pictish or Gaelic place name south of Alford, is likely to refer more specifically to wild boar, rather than the more general 'muck' for pigs. Boece (1527) refers to wild boar being an inhabitant of the Caledonian Forest. Given the palaeontological and cultural evidence north and south of the Cairngorms, as well as the likely historical abundance of suitable habitat in the Cairngorms area until recent centuries, it is highly likely that the wild boar inhabited the Cairngorms in the past.

National or international reintroduction experience: Wild boar are likely to have been subject to several unrecorded translocations around Europe for the purposes of hunting. The existence of feral boar populations in England and Sweden, as well as non-native populations in the USA and Australia, shows the ease with which boar can thrive in new or former areas. The Alladale Estate in Sutherland released around 20 wild boar into a 200 ha forest enclosure as part of a wider ecological restoration and wildlife tourism project. Another experiment, The Guisachan Wild Boar Project, which involved several boar being released into a large woodland enclosure, was conducted on Forestry Commission land in Glen Affric and concluded in 2008. In November 2009, wild boar from the Highland Wildlife Park were taken to Trees for Life's Dundreggan estate in the West Highlands where they are being used in semi-natural woodland enclosures to help break up thick, ground-covering vegetation and suppress bracken *Pteridium aquilinum*.

Land management implications: Agricultural crops may be raided, particularly fields of maize, turnips and potatoes, but grassland, including playing fields, golf courses etc. can also experience damage. Nests of ground-nesting birds may also be at risk of predation, while young lambs may occasionally also fall prey.

Economic benefits: Where boar occur they are usually a much sought-after quarry species which hunters pay to shoot, and which yields a gourmet meat. Their scarifying activity on the forest floor can encourage woodland regeneration and has been utilised by the Forestry Commission in woodland enclosures (M. Wield, Forestry Commission Scotland, *pers. comm.*). A recently concluded project in Glen Affric, where boar were kept for 2 years in large woodland enclosures, concluded that wild boar can control invasive bracken through trampling and eating rhizomes, thus aiding the establishment and growth of tree seedlings in a Caledonian woodland habitat (Balharry, 2008). Boar would also likely be a significant addition to the wildlife tourism resource.

Scottish feasibility studies: Two studies have been published on the feasibility of boar reintroduction to Scotland but reached different conclusions (Howells & Edwards-Jones, 1997; Leaper et al., 1999). Howell & Edward-Jones (1997) concluded that none of the three largest woodlands in Scotland with a semi-natural component, (all found in the CNP: Glenmore/Rothiemurchus, Abernethy and Glen Tanar), were by themselves sufficiently large to support a Minimum Viable Population of 300 individuals. They then concluded that reintroducing wild boar in Scotland would not be possible in the short-term. However, it is very unlikely that wild populations would be restricted to just one woodland. Leaper et al (1999) concluded that reintroduction *was* biologically feasible. They identified a series of habitat patches across Scotland, especially in the Highlands, centred on broadleaved

woodland but also including suitable non-wooded habitats, which were collectively capable of supporting several thousand boar. Patches large enough to support 150-250 boar were identified in the CNP in the Badenoch & Strathspey, Deeside and Glenesk areas.

Wolf *Canis lupus*

Ecology: The wolf is a social species, which inhabits wooded and open habitats alike. Its Scottish extinction was not driven by deforestation, as its favoured prey, red deer, continued to exist in open moorland environments and wolves, as a cursorial predator, do not require cover when hunting. Other deer species such as roe are also taken, while wild boar, elk and beavers can be important in wolf diet in some areas. Evidence from the US Rockies, where wolves were reintroduced in 1995, shows that wolves can release vegetation, e.g. riparian woodland, from heavy grazing and browsing pressure by dispersing high concentrations of deer away from valley floors during winter (Ripple & Beschta, 2004; 2007). After wolf reintroduction, densities of mesocarnivores such as coyotes were also considerably reduced (Crabtree & Sheldon, 1999). Wolf-killed carcases are a source of food for avian scavengers, especially ravens, as well as other mammals and invertebrates, while it has been shown that locations predisposed to repeated wolf predation events, e.g. for topographical reasons, over time experience soil enrichment and a consequent vegetational response through the regular decomposition of ungulate carcases and thus nutrients (Bump *et al*., 2009).

Conservation status: EU Habitats Directive Annex IV species. IUCN Least Concern.

Current status in Cairngorms National Park: Extinct since early 18th century

Reason for extinction: Persecution, driven by bounties and penalties, as it was seen as a threat to human and livestock safety.

Potential for recolonisation: None. There are no source populations on the island of Britain. Elsewhere, the wolf is recolonising lost range by expanding into western and central Europe, e.g. France, Switzerland, and Germany.

Evidence for Cairngorms occurrence: A wolf is depicted on a Pictish standing stone from Ardross, Ross-shire. Wolf place names are widespread in the Cairngorms e.g. in Glen Lui, Crathie, Glen Banchor, Glen Gairn, Glen Dee, Glen Tromie, Glen Clunie, Tulloch, Glen Muick, Glen Clova (Aybes & Yalden, 1995). There are several references in contemporary literature to wolves, which have been compiled by later writers (e.g. Ritchie, 1920). King James V and Queen Mary hunted wolves in the Forest of Atholl in 1529 and 1563 respectively. Wolves were mentioned in the "Brea of Marr" in 1618. The last wolf in north east Scotland was killed in the Banffshire parish of Kirkmichael (which now includes Glenlivet and Tomintoul) in 1644. A wolf was reportedly killed at Killiecrankie in 1680, while another was killed in Forfarshire in the same year. The last British wolf is traditionally thought to have been killed in the Findhorn valley in 1743 (Lauder, 1830), although the veracity of this and other last wolf stories has recently been called into question (Crumley, 2010). The New Statistical Account of Scotland (NSA), whose parish accounts were compiled during the period 1834-1845, refers to old wolf traps in the parishes of Duthil and

in Moy & Dalrossie, as well as a place name in Birse. The remains of wolf cots, used to protect livestock from wolf predation, can still be found to the south of Abernethy Forest in Strathspey (M. Dennis, *pers. comm.*).

National or international reintroduction experience: In Europe, wolves have been reintroduced only in Georgia in the Caucasus Mountains during the 1970s. In North America there have been successful gray wolf reintroductions in Minnesota during the 1970s and the Northern Rockies during 1995/96, while a project has been reintroducing the Mexican subspecies to the Southern Rockies of Arizona since 1998. The wolf's recent reappearance in Switzerland, France and Germany has been due to recolonisation from neighbouring countries such as Italy and Poland.

Land management implications: Livestock, particularly free-ranging sheep, but potentially cattle too, are at risk of predation by wolves. Wolves and viable livestock husbandry are not incompatible but more intensive shepherding is usually required to safeguard sheep etc. There is a small risk to human safety and concerns about this could well be exaggerated and, if not allayed, could impact on tourism. Forestry operations would need to be sensitive to any breeding dens.

Economic benefits: Predation on deer, and the avoidance by deer of areas with a higher predation risk, could contribute to the reduction of grazing and browsing pressure and may reduce costs for forestry and woodland conservation. This highly charismatic species is likely to be a very significant wildlife tourism draw and branding icon.

Scottish feasibility studies: Wilson (2004) regarded wolf reintroduction as biologically feasible but likely to generate considerable socio-economic problems. He identified a Minimum Viable Population (MVP) size of 200-250 for wolves and concluded that human population density and development was low enough and that there was sufficient space and prey for a viable population in the Highlands, including the Cairngorms. Gorman (2008) concluded that predation by reintroduced wolves in Scotland would not have a significant impact on red deer population size, but Nilsen et al. (2007) concluded the opposite. Manning et al. (2009) advised that the non-lethal effects of wolves on deer populations, i.e. moving deer away from areas through the fear of predation, can be significant and should also be assessed for Scotland. They recommended that experimental wolf reintroduction in Scotland should occur on an offshore island or large enclosed area. Sandom *et al.* (2012) designed a protocol for identifying the extent of a fenced reserve in the North West Highlands which could adequately support a wolf population that would naturally predate on wild red deer but not negatively impact on human activities. Nilsen et al. (2007) also assessed opinions of different sectors within Scottish society towards wolf reintroduction and found greater support in urban areas than in rural areas, but that rural opinion was nonetheless, on the whole, positive. However, they also found that organisations representing rural interests were more negative about wolf reintroduction than the rural population as a whole.

Discussion

Compiling the Species long-list

The list of species considered here has been compiled following a comprehensive literature review. These sources provided evidence for historical species occurrence based on a variety of different evidence types, including excavated bones; contemporary accounts; and cultural evidence such as place names and references in art.

The survival of bone evidence over long periods of time is very dependent on the existence on the correct conditions for bone preservation, which in Scotland often relies on the occurrence of either limestone caves or peat marls. Unfortunately neither of these situations is typical of the Cairngorms National Park and consequently very few historical wild animal bones have been excavated in the region. The historical occurrence of many bird species in Scotland is less well known than those of mammals. The light, fragile bones of birds tend not to survive well over time and in many cases are difficult to identify to the species level.

For some species cultural evidence and contemporary written accounts can fill in the gaps left by the scarce bone evidence. However, even here the picture is likely to be incomplete, with both written Gaelic, as well as a scientific approach to recording nature in English, only having widely developed since the 18th century. It is likely that many bird species in particular were not distinctive or significant enough to past societies to have warranted depiction or documentation in any cultural media. Consequently, several species could already have become extinct before people began writing things down for future generations to read about. It has recently been hypothesised, for example, that several small passerine species, such as bluethroat *Luscinia svecica*, brambling *Fringilla montifringilla*, Lapland bunting *Calcarius lapponicus*, and willow tit, may have become extinct or much restricted in Scotland following the almost complete destruction of montane scrub habitats through human activities (Halley, 2011b).

There are gaps then in our understanding of when and why certain species may have become extinct in Scotland. Scotland is likely to have been the last stronghold in the UK for several now extinct species, particularly the larger mammals. However, both bone and cultural evidence is lacking for the late survival of several. As well as further radio-carbon dating of bones already excavated, a research project to investigate Gaelic, Pictish, Scots and Norse cultural sources such as place names, early texts, poems, artwork etc. could be particularly useful for casting more light on the timing of the occurrence and extinction in Scotland of species such as elk, bear, lynx, beaver, boar, crane, and eagle owl, as well as their relationships with people. Rediscovering historical cultural links with locally extinct species reconnects the animal with both people and place and may help to increase local acceptability of species prior to their restoration, which could otherwise be perceived as foreign and unfamiliar.

While evidence for historical occurrence directly from the Cairngorms area may be lacking, for several species bone or cultural evidence has been recovered from other areas both to the north and to the south of the Cairngorms National Park. Many of the species considered are large, mobile, habitat generalists, which are not particularly sensitive to climatic variation, especially the relatively slight differences found across Scotland. These

species are often still widely found across Europe today and it is likely they ranged across Britain historically, so that an absence of evidence from within the Cairngorms National Park is very unlikely to represent evidence of absence.

The water vole is a species that has been suggested for translocation within the Cairngorms National Park (Cairngorms National Park Plan 2007-12). However, and despite large reductions in population size and range brought about by predation by introduced American mink, the water vole remains relatively widespread across the Park. Although the species has been subject to several reintroduction projects across the UK, including in the Loch Lomond and Trossachs National Park, it is considered that the species will recover unaided following large-scale mink control across north-east Scotland (X. Lambin, University of Aberdeen, *pers. comm*.). This has been underway since 2005 and has been successful in removing mink from large areas. Consequently the species was not subject to further consideration in this report.

This report has focused on vertebrate species only. As it happens, all but one species considered in detail was either a mammal or bird, reflecting perhaps their greater susceptibility at the population level to human pressures than other classes such as amphibians, reptiles and fish. The native species diversity in Scotland of these other classes is low compared to mammals and birds, and consequently the number of extinctions is also likely to be correspondingly low. As far as can be ascertained, no reptile species has been lost to the region, while, with the exception of the great-crested newt, all other amphibian species remain well distributed. Scotland is thought to have 15 native freshwater fish species and none of these has become nationally extinct (Locker, 2010). The only evidence encountered for possible range contraction of a fish species in the Cairngorms National Park relates to a record from the Old Statistical Account of 'char' being found in Loch an Eilean in the Rothiemurchus parish. Arctic charr *Salvelinus alpinus* are not known to occur there today, and because of its relatively shallow profile the loch is considered to be rather unlikely habitat (D. Pretswell, *pers. comm*.). However, it may be that the loch still supports a population of Arctic charr that awaits rediscovery. On the other hand, perhaps the record from the 1790s is mistaken or refers to another salmonid species.

Selection criteria

Selection of species for restoration should not be purely an ecological consideration. The benefits of reintroduction, whether these relate to the conservation status of the species itself, its contribution to functioning ecosystems and wider biodiversity, or any potentially positive financial impacts, must be weighed against any potential, negative impacts, such as the financial costs of project implementation or of impacts on existing economic activities in the countryside. Species restoration projects tend to be relatively expensive and will thus likely compete for funding with other conservation initiatives considered to be of high priority. The flip side is that they, when focused on iconic or charismatic species, often have popular appeal and a high media profile. They therefore have the potential to attract funds from private sources, such as corporate sponsorship or private donations, which may not otherwise be available to nature conservation.

Nevertheless, a species restoration project should strive to offer good value for money. The need for a species' reintroduction should be considered alongside its potential for recolonisation. Given that conservation resources are limited, the reintroduction of a

species which could otherwise recolonise the Cairngorms from nearby might not be the best use of resources, unless it can be shown that reintroduction is highly desirable for conservation reasons and can be carried out using relatively few resources. Ideally a species subject to a restoration project should subsequently be able to improve significantly its conservation status, make a positive contribution to the wider ecosystem, and inflict few costs on human livelihoods. Furthermore, if a species has been previously subject to restoration projects elsewhere, either nationally or internationally, then by tapping into existing expertise both the effectiveness and financial efficiency of the project can be maximised.

Five factors were judged to be the most significant for assessing the suitability of a species for reintroduction in the Cairngorms National Park: their conservation status; their ecological significance; their potential negative impacts on land management activities; their potential positive economic contribution; and their potential for natural recolonisation. The candidate species were assessed for each of the five factors and given a score of 1 to 5.

Conservation status
A species was given a score of 1 if it does not have the top legal protection schedule in the UK and the population is stable or increasing; a 2 if not given the top legal protection schedule in the UK, but if the population had experienced a significant decline in recent years; a 3 if listed on the highest UK legal schedule without being listed on the highest annex in the EU Habitats (11 or IV) or Birds (1) Directives; a 4 if the species was listed on the highest EU Annexes, but had a relatively low IUCN red list category; and a 5 if the species was listed on the highest EU annexes and had a high IUCN red list category relative to other candidate species.

Ecological significance
Scores for ecological significance were assigned based on a judgment of the significance and uniqueness of a species' interaction with habitats and other species, with a 5 signifying a strong, unreplicated ecological function.

Land management impacts
Drawing from experiences in other regions, scores were assigned based on a judgement of a species' potential to inflict negative impacts on land management activities e.g. farming, forestry, gamekeeping, tourism. A species judged to have a negligible land management impact was given a 5.

Economic contribution
Scores for a species' potential positive economic contribution were assigned based on a judgement of the potential positive impacts of a species, drawn from experiences in other regions, on the rural economy e.g. on tourism, forestry or hunting. A species judged to have a high potential economic contribution was given a 5.

Recolonisation potential
A species' ability to recolonise the Cairngorms National Park without further human intervention, thus reducing or negating the need for reintroduction, was assessed based on proximity of populations and the scope for expansion. A species judged very unlikely to recolonise the National Park unaided was given a 5.

The aurochs was not subject to scoring on the basis that the wild species is globally extinct, and that its descendants are domestic animals. For evaluation of the reindeer, only the wild form was subject to scoring, as opposed to the semi-domestic form. Crested tit recolonisation potential was assessed for the Deeside part of the National Park, rather than for the whole National Park, because it already occurs in the west of the Park.

For each category, species are listed and colour-coded according to scores (Tables 1 - 5). Within the same score band, species are listed alphabetically.

Scoring results

- *Conservation status*

Western polecat, wild boar and elk each received a score of 1 based on their relatively low legal status within EU and/or UK law and their generally expanding populations (Table 1). Willow tit, although not listed on Wildlife & Countryside Act Schedule 1 or on the Birds Directive Annex 1, is on the UK's Birds of Conservation Concern red list having declined significantly, and therefore receives a 2. Grey partridge and crested tit are not listed on Birds Directive Annex 1, but are on Schedule 1 of UK legislation and so received a score of 3. All other species, with the exception of red kite, received a 4, on the basis of their listing on either Annex 1 of the Birds Directive or Annex II or IV of the Habitats Directive and being listed on the IUCN red list as 'Least Concern'. Red kite is listed on Annex 1 of the Birds Directive but has a higher IUCN category of 'Near Threatened' and so received a 5.

Table 1. Evaluation of species based on conservation status

Species	Conservation status
Red kite	5
Bittern	4
Brown bear	4
Corncrake	4
Eagle owl	4
Eurasian beaver	4
Eurasian crane	4
Eurasian lynx	4
Great crested newt	4
Honey buzzard	4
Marsh harrier	4
Nightjar	4
Reindeer	4
White-tailed eagle	4
Wolf	4
Crested tit	3
Grey partridge	3
Willow tit	2
Elk	1
Western Polecat	1
Wild boar	1

- *Ecological significance*

Twelve of the candidate species received a score of 1 as they were judged to have an ecological function that was relatively insignificant or was replicated by other extant species (Table 2). The beaver is widely seen as the archetypal keystone species and there is much evidence for its ability to create wetland habitats to the benefit of a wide range of species so that it was the sole recipient of a score of 5. For their regular, year-round predation of large herbivores, as well as smaller carnivores, both lynx and wolf received a score of 4. The wild boar's scarifying and trampling activity also resulted in a 4, while eagle owls with their ability to predate on smaller predatory birds saw them also receive a 4. Elk received a 3 for their browsing, aquatic grazing, and trampling behaviour, while the same score was given to white-tailed eagles for their ability to disperse and predate large wildfowl such as geese. Brown bear received a 3, a lower score than the other large carnivores because it is not a regular, year-round predator of large herbivores but it can nevertheless predate deer now and then and can be a significant scarifier and seed disperser. Reindeer received a 2 as it is a large grazing and browsing species well adapted to high altitudes, but much of its feeding behaviour on high ground in the Scottish Highlands is replicated by the red deer.

Table 2. Evaluation of species based on ecological significance

Species	Ecological significance
Eurasian beaver	5
Eagle owl	4
Eurasian lynx	4
Wild boar	4
Wolf	4
Brown bear	3
Elk	3
White-tailed eagle	3
Reindeer	2
Bittern	1
Corncrake	1
Crested tit	1
Eurasian crane	1
Great crested newt	1
Grey partridge	1
Honey buzzard	1
Marsh harrier	1
Nightjar	1
Red kite	1
Willow tit	1
Western Polecat	1

- *Land management*

Nine of the species received a score of 5 for their very limited negative impacts on land management interests (Table 3). There was considerable overlap between these species and

those that had received a 1 for ecological significance. Two species, wolf and bear, received the lowest score because of their considerable potential for livestock depredation and being perceived as threats to human safety. Beaver, elk and wild boar scored 2 because of their potential for flooding, tree-felling, browsing or crop-raiding. Lynx scored higher (3) than wolf or bear because it is rarely perceived as a threat to human safety and because the scale of livestock losses is typically smaller and more controllable. Wild reindeer scored a 3 because of potential grazing and browsing impacts, as well as the scope for hybridisation with extant semi-domesticated reindeer. The polecat received a 3 because of their potential to predate on gamebirds and poultry. Two large predatory birds, eagle owl and white-tailed eagle, also scored 3 because of the scope for them to predate on gamebirds or young livestock. Red kite scored 4 as they may occasionally take young gamebirds, while crane also received a 4 in recognition of their potential to feed on crop seeds.

Table 3. Evaluation of species based on potential negative impacts on land management

Species	Land management
Bittern	5
Corncrake	5
Crested tit	5
Great crested newt	5
Grey partridge	5
Honey buzzard	5
Marsh harrier	5
Nightjar	5
Willow tit	5
Eurasian crane	4
Red kite	4
Eagle owl	3
Eurasian lynx	3
Reindeer	3
Western Polecat	3
White-tailed eagle	3
Elk	2
Eurasian beaver	2
Wild boar	2
Brown bear	1
Wolf	1

- *Economic contribution*

Four species achieved a full score of 5 for economic contribution (Table 4). The three large carnivore species are widely regarded as being highly charismatic megafauna, with considerable opportunities for branding and tourism. There may also be scope, as in some other parts of Europe, for quota hunting. Wild boar also attained full marks partly on the basis of being a marketable wildlife tourism icon, but even more so as a sought-after quarry animal. At the opposite end of the scale two small species were seen as offering a much

more limited economic contribution because they are neither quarry animals nor are significant wildlife tourism draws, being either difficult to observe (great-crested newt) or being relatively common in parts of the UK where many of the CNP's wildlife tourists come from (willow tit). Other large, charismatic species, some of which are part of the hunting culture in other areas of Europe (e.g. elk and reindeer), and/or are marketable wildlife tourism draws (e.g. beaver, white-tailed eagle, crane, reindeer) were given a 4. The four raptors were given 3s on the basis of their wildlife tourism potential, as was the grey partridge through its potential to be a game species. Bittern, corncrake, nightjar, crested tit, and polecat were given 2s as none of them are likely to be quarry animals and have only limited potential for wildlife tourism, being either difficult to observe or occurring elsewhere in the UK with a wildlife tourism industry.

Table 4. Evaluation of species based on potential economic opportunity

Species	Economic opportunity
Brown bear	5
Eurasian lynx	5
Wild boar	5
Wolf	5
Elk	4
Eurasian beaver	4
Eurasian crane	4
Reindeer	4
White-tailed eagle	4
Eagle owl	3
Grey partridge	3
Honey buzzard	3
Marsh harrier	3
Red kite	3
Bittern	2
Corncrake	2
Crested tit	2
Nightjar	2
Western Polecat	2
Great crested newt	1
Willow tit	1

- *Recolonisation potential*

Scores of 5 were given to species whose restoration to the Cairngorms National Park is very unlikely to occur without human intervention i.e. mammals which don't occur in the wild in the UK or, in the case of the willow tit, occur far from the region and are highly sedentary and declining (Table 5). Great crested newt does occur in the CNP but given its ecology and limited dispersal ability it is unlikely to colonise new habitat and so received a 4. Most of the species scoring 3 were birds which are relatively mobile and which have some capability to colonise new areas of the CNP. Also attaining a 3 were the beaver and boar which have good dispersal capabilities and occur ferally near to the CNP and which could colonise if human management allows. White tailed eagles and polecats are expanding their

populations close to the CNP and so received a 2. Grey partridges also received a 2 despite occurring in the CNP, but are rare and declining and so are unlikely to colonise the rest of the region unaided. Red kite, marsh harrier, and honey buzzard all received a score of 1 because breeding may already occur in the CNP or is soon likely to as part of a national population expansion.

Table 5. Evaluation of species based on recolonisation potential

Species	Recolonisation potential
Brown bear	5
Elk	5
Eurasian lynx	5
Reindeer	5
Willow tit	5
Wolf	5
Great crested newt	4
Bittern	3
Corncrake	3
Crested tit	3
Eagle owl	3
Eurasian beaver	3
Eurasian crane	3
Nightjar	3
Wild boar	3
Grey partridge	2
Western Polecat	2
White-tailed eagle	2
Honey buzzard	1
Marsh harrier	1
Red kite	1

Species Assessment

The three large carnivore species, **wolf**, **bear** and **lynx**, scored highly across most of the five criteria, reflecting their high conservation status, significant ecological function, and potential for wildlife tourism and/or hunting. Furthermore there is no scope for them to recolonise unaided by humans.

Evidence for all three having occurred in the Scottish Highlands in the past is incontrovertible. However, the ecological function of a non-human predator of deer has been largely missing from Scotland for over three centuries since the wolf was finally extirpated. There is now a growing appreciation of the 'trickle down' function of top predators, such as wolves and large felids, and the impacts on ecosystems of removing them. Bears are largely herbivorous and so their predation on deer is likely to occur at levels that would be ecologically insignificant. Predation of deer by wolves and lynx on the other hand has been shown to be significant and can differ spatially from that of humans.

Large carnivores are often very contentious species because of their predatory behaviour on humans, livestock or large game. Of the three species, wolves and bears are often perceived as dangerous and do have the potential to harm humans, although the risk is small. In regions of Europe where all three species occur, the lynx is seen as the least damaging to livestock interests and is generally not perceived as a threat to human safety. Indeed unprovoked attacks on humans have not been recorded while predation on livestock has been shown to be controllable. Eurasian lynx, a Habitats Directive Annex IV species, have been restored to several well-forested, yet human-modified landscapes in Europe, including in several national parks. Consequently, there is considerably more lynx reintroduction expertise and experience to call upon from elsewhere in Europe than for wolves and bears. Like the wolf and bear, the lynx is highly charismatic and would likely create marketing opportunities for businesses and communities in the National Park and add considerably to the wildlife tourism resource, despite being rarely seen. Furthermore, the successful reintroduction of the Eurasian lynx to the UK would improve the conservation status in the EU of a species of European community concern.

For large, mobile species, with high spatial requirements, such as large carnivores, any restored population would need, for its long-term viability, to extend across an area much wider than the confines of the Cairngorms National Park. Consequently the availability of suitable habitat and food across a wider area must be considered.

The **polecat** was the last mammal to have become extinct in the Cairngorms National Park, having disappeared just over a century ago. Despite this, the species received a low reintroduction suitability score for most criteria, having a low conservation status and the potential to recolonise. It never became extinct in the UK, as a relict population clung on in Wales. Since a relaxation in persecution in recent decades, this population has expanded considerably, helped along the way by a series of unofficial translocations. Perthshire has also witnessed the unofficial release of polecats in recent years and it is a distinct possibility that this population may grow and expand to recolonise the southern part of the National Park, where suitable habitat and prey still occur. Reintroduction may not therefore be necessary in the longer term and may not represent good value for money in the shorter term. The potential for recolonisation of the National Park could be facilitated by raising awareness of the species' nativeness and legally protected status, which does it allow it be shot, but not trapped.

The **wild boar** scored poorly for its low conservation status and high potential for land management impacts. There is also some potential for recolonisation. It was, until recently, extinct in the UK as a wild species, but escapes and releases of captive animals have resulted in feral populations becoming established in several parts of the UK, including very recently in the Scottish Highlands (Scott, 2011). In England, DEFRA considered three main possible policy approaches to the management of feral wild boar; 1) no management, 2) a proactive, government-led, national eradication and 3) regional management to address local concerns. Following public consultation and risk assessments of feral boar in the countryside, DEFRA chose not to attempt a government-led eradication programme but rather considered regional management to be the most appropriate approach to address local concerns (DEFRA, 2008). Government policy in England therefore is that primary responsibility for feral wild boar management lies with local communities and individual landowners. The species is very widespread and common in continental Europe, and not inconsistent with intensively settled environments, including farmland and towns. Consequently wild boar are

not endangered and are not listed on Annex IV of the Habitats Directive as a species whose reintroduction must be considered by EU member states. However, the species has a distinctive ecological role within woodland ecosystems as a scarifier of compacted or heavily vegetated soils to the benefit of trees and other plant species, as well as some small bird species. While wild boar can, at times, have undoubted impacts on land management activities such as farming, these are managed elsewhere in Europe through sustainable culling which is an integral part of the hunting culture and generates both income and a valued game meat. Given the apparent ease with which wild boar escape from captivity and the speed with which they can then multiply and become established in the wild, it is possible that feral populations could, in the years ahead, expand to, or indeed originate within, the Cairngorms National Park as they have elsewhere in the UK. Allowing wild boar to escape into the wild without a licence is an offence and no policy has as yet been drawn up for feral boar in Scotland. Depending on the government's response, an official reintroduction project may prove to be unnecessary for the species' restoration, particularly if, as elsewhere in the UK, it is decided that it is impractical or undesirable to eradicate feral populations.

The timing of **elk** extinction in Scotland is unclear. The most recent radiocarbon date on elk bone from Scotland is around 4000 years old, and it could be argued that, as this period coincides with natural climate change, the species died out through largely natural factors. Although it is likely that the climate of modern Scotland would be suitable for elk (Kitchener, 2010), a convincing case for the species' later survival has yet to be made. The species also has a low conservation status, being rather abundant where it occurs across large areas of northern Europe. Furthermore, with the browsing of trees and shrubs by extant deer species seen as a contentious ecological and socio-economic matter, discussions of the potential restoration of another heavy browser to the landscape may be seen as unwelcome by many at the current time, despite the elk's obvious potential as a game animal.

The evidence for the timing, and thus causes, of **reindeer** extinction in Scotland is perhaps even less clear. It is very possible that this cold-adapted species died out largely because of natural climate change and therefore its reintroduction could be unethical. The reindeer scored relatively highly overall, and in the event that it could be shown that the species survived until more recently, thus implicating humans in their extinction, then consideration of reintroduction could be justified on ethical grounds. However, with the occurrence today of free-ranging, semi-domestic reindeer in suitable habitat in the Cairngorms National Park, it could be argued that the species' ecological function was restored to the region 60 years ago. The semi-domestic nature of the free-ranging Cairngorms herd means that its grazing impacts can be largely controlled, and its potential as a tourism attraction more effectively exploited.

The **aurochs** has been globally extinct since the 17th century and cannot therefore be reintroduced. However, the genes and ecological function of the aurochs largely live on in modern domestic cattle breeds that have formed a close cultural bond with people in the Scottish Highlands. Nevertheless, in recent decades there has been a contraction in the area of cattle-grazed land in the Highlands. While not strictly speaking a reintroduction, the more widespread, low intensity grazing of cattle, especially hardy local breeds, in semi-natural habitats such as woodlands, moorlands, grasslands and wetlands, could restore the ecological function and processes of the ancestral aurochs, thus bringing many benefits to biodiversity, while being relatively simply integrated into modern agricultural practices. As

well as ecological benefits, there could be economic and cultural advantages to restoring cattle more widely in the landscape.

The Eurasian **beaver,** another Habitats Directive Annex IV species, has been much discussed as a reintroduction candidate for Scotland over the past two decades and indeed a licensed 5-year trial reintroduction of free-ranging beavers is currently underway at a site in Argyll and is due to be completed in 2014. The species scored highly for several criteria in the reintroduction suitability assessment but there have been concerns, particularly from farming and salmon fishery organisations, about potential beaver impacts and these will remain largely unanswered by the current trial due to the nature of the landscape in that area. A feral population of beavers has recently been discovered living in the Tay catchment, a farmed landscape with a very significant salmon fishery interest. The part of the Tay catchment lying within the CNP offers only a modest amount of suitable beaver habitat. Should the trial in Argyll be judged a success and wider reintroduction desirable, then it is likely that a salmon river in a farmed landscape will be considered as a reintroduction site, either for full reintroduction or as another trial. The rivers Spey, Dee and Don are considered to offer suitable beaver habitat within the Cairngorms National Park, and unlikely to be colonised from the Tay in the short- to medium-term as a result of significant natural barriers. The ecological contribution of beavers is likely to be considerable and their potential as a site-based wildlife tourism resource also significant. Their reintroduction to the UK would improve the conservation status of a species of European community concern, albeit an increasingly widespread one.

Two large wetland birds likely became extinct as breeding birds in the region – the **bittern** and **Eurasian crane**. Both appear to have been highly sought after as food while the later extinction of the bittern in northern Scotland suggests it may also have been affected by wetland habitat destruction driven by land improvement initiatives from the 18th century onwards. Both birds have some rather limited potential for recolonisation but the crane has the greater potential to act as a wildlife tourism attraction. Bitterns do still winter in Scotland and two east coast sites that regularly attract wintering birds have been suggested as potential breeding sites for recolonising birds. There does not appear to be enough suitable habitat for bitterns in the Cairngorms National Park today, although recolonisation of *Phragmites* beds at Dinnet in the east of the Park might be a possibility in the future.

Although it can be secretive around nest sites, the Eurasian crane is otherwise a large, noisy and spectacular bird which may have been relatively easy to locate and hunt, leading to its extinction as a breeding bird before the age of modern science. These same characteristics, however, could make the species a charismatic restoration candidate, which could act as a high-profile flagship species for the restoration of wetland habitats, including woodland bogs.

Since the late 1970s a growing crane population has formed in East Anglia which stemmed from two or three non-migratory birds, but which attracted wandering migrants from the continent that then stayed to breed. Isolated breeding has also been reported from further north in Yorkshire, while a reintroduction project employing rear and release techniques is underway in south-west England. There has been a fast-growing trend for non-breeding cranes to visit Scotland over the past few decades, following population increase and range expansion facilitated by legal protection and habitat conservation on the continent. Pairs have summered in northern Scotland on more than one occasion in recent years, but breeding has yet to be confirmed. There is some potential therefore for recolonisation of the Cairngorms National Park, as suitable breeding habitat would appear to exist. However,

it may well not happen in the short to medium term and it could be that recolonisation by birds from the continent or elsewhere in the UK could be facilitated and speeded up through practical conservation action. For example, this could involve the use of flightless adult birds in a large, fox-proof enclosure to attract over-flying wild birds and encourage them to settle in the area, similar to the origins of the East Anglian population. This would likely be significantly cheaper than reintroduction. It would also help to improve the conservation status of an EU Birds Directive Annex I species.

Several raptor species were removed from the National Park area following intense and sustained persecution running from the late 18th to mid 20th centuries. While the osprey recolonised naturally, and the goshawk was restored following unofficial releases and escapes from captivity in the 1960s and 70s, several species remain extinct as breeding birds. In recent decades both the **red kite** and **white-tailed eagle** have been subject to reintroductions elsewhere in northern Scotland and may recolonise the National Park in due course. The white-tailed eagle scored slightly higher than the kite for its potentially greater ecological function, which could include being a predator of larger birds such as geese. Non-breeding birds of both species are increasingly seen each year in the National Park and in 2011 a pair of kites bred in the area for the first time in over 130 years. If left unmolested by human activities, both species could take advantage of suitable breeding habitat in the years ahead so that reintroductions within the National Park may not be necessary.

Like the osprey, the **marsh harrier** has undergone considerable recolonisation of lost range in the UK in the past few decades. There is an increasing trend for observations of the species in suitable breeding habitat in both the Spey and Dee catchments and it seems only a matter of time before the species stays to breed. The evidence therefore suggests that reintroduction is unlikely to be necessary for the species' restoration to the Cairngorms National Park. The **honey buzzard** is known to have bred historically in the Cairngorms National Park area before its extinction as a Scottish breeding bird in the nineteenth century. Following recolonisation from Scandinavia a small population now occurs in Scotland and may well breed on occasion in suitable habitat in the National Park. The species is notoriously under-reported and under-recorded and so its status in the National Park is unclear. Conservation efforts could usefully focus on monitoring the current population and assessing the potential for further recolonisation rather than on reintroduction.

Three species of ground-nesting bird became very scarce or extinct in the Cairngorms over the course of the twentieth century. The **corncrake** and **nightjar** declined rapidly over the first half of the century, while the **grey partridge** declined sharply in the latter half. Unfavourable trends in weather, predator abundance and land management practice have all been implicated in these declines. The nightjar's decline is the most unclear as it appears that potentially suitable habitat still occurs in the region. It may be, however, that the species is too close to the edge of its range and may have been affected by poor summer weather in recent decades. Changes in agricultural practice seem to have been the principal factor in the corncrake's decline, resulting in reduced habitat as well as the destruction of nests and birds through changes in crop harvesting time. The intense predator control of the nineteenth and early twentieth centuries probably benefitted all three ground-nesting species. The subsequent recovery of populations of small and medium-sized carnivores over the twentieth century may well have been a contributing factor in the decline of species already stressed by wholesale changes to their environment.

Compared to the other two species, the partridge's lower conservation status was compensated for by its potential to be a game species and thus contribute economically. Recolonisation by nightjars seems unlikely, as the closest source population is much further south in Dumfries & Galloway. Sources of corncrakes and grey partridges are closer at hand but recolonisation would require significant changes to land management practice, particularly in farming. The corncrake is unlikely ever to be the common and widespread bird of agricultural landscapes as it was in the past. However, with population increases elsewhere in the UK there is perhaps potential for this migratory species to recolonise areas of more natural tall vegetation found at wetland sites, particularly in Badenoch & Strathspey and Deeside, where calling birds have been heard in recent years. Guidelines have been drawn up for the successful reintroduction and conservation of grey partridge populations on areas of over 400 ha, but these require intensive management, including providing the correct quantity, height and type of vegetation at the right time of year, controlling several predator species, and installing feeders in the landscape. Perhaps these measures would be better suited to the larger, more productive lowland farming environments outside the National Park.

The **eagle owl** scored highly for its high conservation status under the Birds Directive, as well as its potential to contribute both ecologically and economically by being a charismatic top predator. It was not listed as one of the raptor species killed in large numbers as vermin in recent centuries. Indeed, historical breeding of the species in Scotland has never been proven leading some to believe the species is not a former native of Scotland, or indeed the British Isles. This issue has become contentious in recent years following the localised breeding of eagle owls in several parts of the UK countryside. Opinion is divided as to whether these birds all stem from escapes or releases from captivity, or whether some may be migrants from nearby populations on the European continent. The acceptance of feral birds of the European subspecies as legitimate 'native' British birds is likely to depend on evidence of their historical occurrence as a breeding bird or proof of current colonisation by continental birds. Given their very wide geographical distribution in Europe and their generalist habitat and prey preferences, it seems likely that eagle owls were once a native British bird which succumbed to the same relatively early deforestation and persecution which saw the demise of the bear and lynx as native British species. The Scottish Highlands may well have been the last refuge of the species in Britain and a reappraisal of both potential bone and cultural evidence could be very useful in informing the current debate. Given its uncertain history, and what appears to be a trend for colonisation from continental stock and/or escapes from captivity, which has resulted in recent records of the species from in and around the National Park, reintroduction would not currently be a priority.

The **willow tit** population of Badenoch & Strathspey is thought to have died out following particularly hard winters of the late 1940s and early 1950s. However, the species occurs today year-round in the far north of Scandinavia where such harsh conditions are commonplace. It may be that land management practices, such as willow scrub clearance, reduced the population to such a level that a major stochastic event such as a short series of long, harsh winters, resulting in high mortality, pushed the species into extinction in the region. The species has low potential for land management impacts and also has low potential for recolonisation as it has retreated to southern Scotland where it is sedentary. However, competition with other tit species for nest sites and at feeding stations suggests that the willow tit's missing ecological niche may have since been occupied, at least away

from montane willow scrub, thus reducing the wider ecological value, and likely success, of its reintroduction. However, if large tracts of montane willow scrub can be restored to parts of the National Park in the years ahead, thus creating potential habitat where it would have a competitive advantage over other tit species, then perhaps reintroduction using Scandinavian birds would be viable in the future.

The **crested tit** is widespread in Badenoch & Strathspey but oddly absent from apparently suitable habitat in other areas of the National Park. In assessing its suitability for reintroduction, the species received modest scores for its relatively low conservation status in Europe (although the Scottish subspecies is the most restricted), and some potential for recolonisation of currently unoccupied range. It is considered to have become extinct historically in the eastern part of the National Park perhaps through deforestation reducing its habitat to small remnant patches of insufficient size for long-term population survival. Since then, there has been considerable expansion of pinewood habitats in Deeside and the crested tit could be a potential beneficiary of any future initiatives to improve the connectivity of pinewood habitat between the Spey and Dee catchments, thus facilitating the species' recolonisation of the eastern side of the National Park. As an iconic Caledonian pinewood bird, the crested tit could be employed both as a useful flagship species for restoring landscape-scale pinewood habitat networks, and then as an ecological indicator of the success of such initiatives.

The **great crested newt** has a high conservation status, is unlikely to impact significantly on land management practices, and currently has very limited potential for recolonising former range. It seems to be highly site-specific but its full historical distribution within the National Park is not well understood. It may have gone extinct from several areas in the past through habitat loss and the introduction of predatory fish without anyone ever having noticed. There is also a lack of robust local populations that could act as sources for reintroduction, as recommended by conservation guidelines. Perhaps conservation efforts for this species in the short-term should focus firstly on confirming the extent of its distribution within the National Park, and then ensuring that those populations meet the minimum standards recommended by guidance. This may mean the provision of new breeding ponds within suitable terrestrial habitat and dispersal distance of extant populations.

It is noteworthy that several of the species with high scores for ecological significance also have high scores for potential economic contribution, but generally low scores for potentially negative land management impacts. So in order to secure the potential ecological and economic benefits of these species, the challenge is whether and how the negative impacts can be controlled to acceptable levels.

There are examples from across Europe, including the UK, where attempts to restore species following local extinction have led to conflict with those people who live and work in the countryside. The ability of the potential restoration candidates identified in this report to fit into the socio-economic landscape is likely to be the key limiting factor in their successful restoration. It is essential that people from a wide spectrum of both local and national interests are included within the decision-making process and are given the opportunity to shape the design and implementation of conservation measures. There is a great deal of experience and expertise available from other European countries on how to manage any undesirable behaviour of many of the species discussed in this report, whether through regulated hunting, licensed control of problem individuals, or implementation of

proactive prevention measures. Practitioners here are likely to be in the advantageous position of being able to choose the most appropriate method for our landscapes, without having to undergo many of the associated burdens of trial and error that other countries have experienced.

A need to manage undesirable impacts through culling or prevention measures is not something unique to species which are currently absent and which are potential candidates for restoration. Several extant native species, e.g. roe and red deer, require management in order to reduce negative impacts on farming and forestry, but in so doing bring economic opportunities, while their presence enriches the ecosystem. Despite some negative land management impacts, roe deer and red deer are nevertheless regarded as species which belong here and which are important parts of our ecology and socio-economic scene. However, for many parts of Scotland, these two species have had to recolonise naturally or be reintroduced from remnant populations in the Highlands following their local extinction in previous centuries.

When animals that have been missing for a long time return to an area, either by themselves, or through human intervention, people may have difficulty accepting the 'new' and unfamiliar species. It is however worth noting that some of the Cairngorms National Park's most cherished and emblematic species, such as the red squirrel, capercaillie and osprey, had become extinct in the area but were restored following either reintroduction or recolonisation involving intensive conservation action. Each now contributes considerably to the identity and economy of the region. Might the lynx, beaver and crane be just as valuable to the Cairngorms National Park in the years to come?

Conclusions

The Cairngorms National Park is an area of high nature conservation value which hosts a very significant number of priority species as well as a large area of land and water protected by international designations. Indeed some 49% of the Park's 4500km^2 area has been designated under the EU's Natura legislation. The environment of the Cairngorms National Park has historically experienced a lighter human footprint than other parts of the UK thanks to, amongst other things, less intensive agricultural activity and the survival and maintenance of considerable tracts of native woodland. The area is rightly celebrated for its rich biodiversity which contributes considerably to the rural economy through nature-based tourism, including field sports.

Despite this, it is clear from an examination of its historical vertebrate fauna that the biodiversity of the region has been significantly altered and depleted by human activity over the centuries. The National Park, and Scotland as a whole, are therefore far from hosting the full complement of their native wildlife. At least twenty two native vertebrate species have experienced either extinction or severe range contraction within the Cairngorms National Park. Compared to other northern European countries with similar boreal ecosystems, such as the Fenno-Scandian and Baltic nations, Scotland has experienced much greater species loss, particularly with regard to large mammals. For example, Scotland supports just two of its native large mammal species, the roe and red deer, out of a previous complement of ten, representing an 80% species loss. By comparison, none of the Fenno-Scandian and Baltic nations have lost more than two, or 20%, of their large mammal

species. Several of Scotland's missing species are ecologically significant i.e. so-called 'keystone' species whose removal likely has led to wider, and at times profound, impacts on habitats and other species. Furthermore, several are also potentially economically significant, either for hunting, or by being charismatic and iconic enough that people want to come to see them, or merely experience a landscape which, in their minds, is wild and beautiful enough to host them.

Taking into consideration the likelihood of recolonisation, ecological benefit, conservation status and potential socio-economic impact, species whose potential for restoration in the Cairngorms National Park could be subject to a further round of closer consideration, could include the Eurasian crane, Eurasian beaver and Eurasian lynx, all of which scored highly when assessed against key criteria. The beaver and lynx have been reintroduced many times in Europe, and much expertise has been gained on how to cope best with the management issues that can arise, while the Eurasian crane is currently subject to a reintroduction project elsewhere in the UK. By being charismatic, and therefore marketable, these species are likely to contribute considerably to wildlife tourism, and, in the case of the crane, could be a flagship for wetland habitat conservation and restoration in and around the Cairngorms National Park. Furthermore, scientific feasibility studies have shown that the wider Scottish environment could support viable populations of beaver and lynx. Reintroduction projects for these species would be ambitious, ground-breaking and high profile and would undoubtedly require broad partnership approaches to bring them to fruition.

Recommendations

1. **A similar approach to assessing potential restoration candidates could be taken for invertebrates, plants, lichens and fungi.** This could also usefully identify which biodiversity elements of a typical Caledonian woodland ecosystem are under-represented in newly created native woodlands sites due to difficulties in colonisation, but which are ecologically significant and could be translocated to help kick-start and complement new woodland biomes. Potential partners could include SNH, Buglife Scotland, Plantlife Scotland, the British Mycological Society, and the British Lichen Society.

2. **Research should be carried out to further our understanding of the reasons for, and timing of, the decline and/or extinction of several native vertebrate species in the Scottish Highlands.** A research project involving a range of partners e.g. CNPA, National Museums of Scotland, and cultural and linguistic experts, could collate information from the fossil record and combine it with a systematic examination of Scotland's cultural record for references to extinct and native species.

3. **Within the context of agri-environmental support mechanisms, explore the feasibility of expanding domestic cattle grazing in the National Park, and maximising its ecological value, particularly in semi-natural habitats.** Advice and experiences should be gathered from land managers, government bodies, and conservation NGOs on how best to manage cattle profitably for conservation benefits in the Cairngorms National Park. If feasible, this could then become a habitat priority under the Cairngorms LBAP and promoted to land managers via the CNPA's Land Management Training Project.

4. **The current status of the great crested newt within the National Park should be assessed and the feasibility explored of creating new breeding habitat within dispersal distance of extant populations.** A survey could be commissioned of potential breeding ponds in the vicinity of recorded sites. If populations could be strengthened by pond creation, then the relevant landowners could be encouraged to carry out habitat improvements for SRDP funding.

5. **The crested tit should be employed as a flagship species for developing a forest habitat network linking pinewoods in the Spey and Dee catchments.** When communicating to the public, private estates and other organisations the need to strengthen forest habitat networks in the Cairngorms, particularly through the Feshie-Geldie corridor, the crested tit should be highlighted as both a potential beneficiary and indicator of success.

6. **The public should be made aware of the polecat's nativeness and legal status and be encouraged to help monitor its distribution and recolonisation of the National Park.** Awareness could be raised via the web, social media, ranger services and a leaflet about the need to report sightings and collect carcases. The implications for predator control activities of the polecat's legal status should be communicated to local gamekeepers and other land managers through CNPA's Land Management Training Project.

7. **Should a significant feral boar population develop in the National Park amid a tolerant national policy context, they should be accepted as an ecologically significant native species that should be subject to regulated hunting.** A national policy on feral boar would likely be developed by Scottish government and SNH. Training could be delivered to land managers on the practicalities and economics of boar management to ensure that negative impacts are controlled but that economic and ecological opportunities are maximised.

8. **The potential for facilitating the recolonisation of the National Park by Eurasian cranes should be further investigated.** The crane should become a research priority under the Cairngorms LBAP. Interested organisations, should then commission a feasibility study, which identifies potential habitat in and around the National Park and assesses if facilitated recolonisation could lead to the formation of a viable crane population in the area. If shown to be feasible, a partnership of relevant organisations and landowners could be pulled together to implement a crane restoration project in the context of wider wetland habitat conservation.

9. **The potential for river catchments in the Cairngorms National Park to host either a trial or full reintroduction of Eurasian beavers should be further explored.** The Knapdale trial will conclude in 2014, while valuable beaver management experience is also very likely to have been gained by then in the Tay catchment. Consequently, national discussions on the direction of beaver restoration in Scotland will likely occur during the 5-year implementation period (2012-17) of the next Cairngorms LBAP and National Park Partnership Plan. Furthermore, given their previously identified suitability for beavers, Cairngorms catchments such as the Spey and Dee are likely to figure prominently in any discussions about further releases.

10. **The potential for the Cairngorms National Park to contribute to a national lynx reintroduction project should be further explored.** Given the very large spatial requirements of a lynx population, reintroduction would occur across a much broader area than the National Park. Should discussions of lynx reintroduction in northern Scotland develop and a partnership project take shape, even if it is focused on landscapes outside the National Park, the CNPA and others connected to the Cairngorms National Park should be closely involved from the early stages. There is growing interest in the subject of lynx reintroduction in Scotland, particularly amongst the conservation sector. However, any lynx reintroduction project must be advanced as a broad partnership including local communities, land management bodies, government agencies, and conservation NGOs, so as to limit the capacity for conflict.

Acknowledgements

Many thanks to N. Benvie, P. Cairns and M. Hamblin for the use of photos. Thanks also to W. Boyd-Wallis, S. Corcoran, R. Dennis, I. Francis, D. Halley, J. Prigmore and J. Willet who provided valuable comments on earlier drafts of the report.

References

Andrews, P. & Fernandez-Jalvo, Y. (2012) Bronze Age barrows at Longstone Edge: taphonomy and site formation. *Quaternary International. 275: 43-54.*

Angst, C., Olsson, P., & Breitenmoser, U (2000) *Übergriffe von Luchsen auf Kleinvieh und Gehegetiere in der Schweiz – Teil I: Entwicklung und Verteilung der Schäden. Bericht 5.* KORA, Muri

Angst, C., Hagen, S., & Breitenmoser, U. (2002) *Übergriffe von Luchsen auf Kleinvieh und Gehegetiere in der Schweiz – Teil II: Massnahmen zum Schutz von Nutztieren. Bericht 10.* KORA, Muri

Aybes, C. & Yalden, D.W. (1995) Place name evidence for the former distribution and status of wolves and beavers in Britain. *Mammal Review*, **25**, 201-227.

Balharry, L. (2008) Results from the Guisachan Wild Boar Project. http://www.treesforlife.org.uk/forest/missing/guisachan200805.html. Accessed 21/9/10

Bartel, R. A., Haddad, N.M. & Wright, J.P. (2010) Ecosystem engineers maintain a rare species of butterfly and increase plant diversity. *Oikos* 119: 883–890.

Batty, D. (2002) Beavers: aspen heaven or hell? In: Cosgrove, P. & Amphlett, A. (eds) *The biodiversity and management of aspen woodlands: proceedings of a one-day conference held at Kingussie, Scotland, on 25th May 2001*. The Cairngorms Local Biodiversity Action Plan, Grantown on Spey.

Baxter, E.V. & Rintoul, L. (1953) The Birds of Scotland. Oliver & Boyd, Edinburgh.

BBC News website (2002). *Wild boar evades police capture.* news.bbc.co.uk/1/hi/scotland/2528255.stm. Accessed 10/1/11.

BBC News website (2008). *Sea eagles blamed for lamb deaths.* news.bbc.co.uk/2/hi/uk_news/7630655.stm. Accessed 10/1/11.

BBC News website (2005). *Protected birds of prey poisoned.* news.bbc.co.uk/2/hi/uk_news/Scotland/4184133.stm. Accessed 10/1/11.

BBC News website (2007). *Police probe rare bird poisoning*. news.bbc.co.uk/2/hi/uk_news/Scotland/north_east/6755775.stm. Accessed 11/1/11.

BBC News website (2010) *Police probe into sea eagle poisoning.* news.bbc.co.uk/1/hi/scotland/glasgow_and_west/8468733.stm. Accessed 20/1/11.

Bell, H. (2007) Eurasian marsh harrier. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Betts, M. & Schofield, R.A. (2007) Common crane. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Birks, J.D.S. (2008) *The Polecat Survey Of Britain 2004-2006*. Vincent Wildlife Trust, Ledbury.

Birks, J.D.S. & Kitchener, A.C. (1999) *The Distribution and status of the Polecat* Mustela putorius *in Britain in the 1990s*. Vincent Wildlife Trust, London.

Boece, H. (1526) *Scotorum historiae a prima gentis origine.* Paris.

Bourne, W. R. P. (2007) The early history of Scotland's birds. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Bräuer, I. & Marggraf, R. (2004) *Valuation of ecosystem services provided by biodiversity conservation: an integrated hydrological and economic model to value the enhanced nitrogen retention in renaturated streams*. The Fondazione Eni Enrico Mattei.

Breitenmoser, U. & Haller, H. (1993). Patterns of predation by reintroduced European lynx in the Swiss Alps. *Journal of Wildlife Management*, 57, 135-144.

Breitenmoser, U., Breitenmoser-Wursten, C., Carbyn, L.N., & Funk, S.M. (2001). Assessment of carnivore reintroductions. In *Carnivore conservation* (eds J.L. Gittleman, S.M. Funk, D. Macdonald & R.K. Wayne), pp. 241-281. Cambridge University Press, Cambridge.

Buckland, S.T., Bell, M.V. & Picozzi, N. (1990) *The Birds of North-East Scotland*. North-East Scotland Bird Club, Aberdeen.

Bump, J.K., Peterson, R.O., & Vucetich, J.A. (2009) Wolves modulate soil nutrient heterogeneity and foliar nitrogen by configuring the distribution of ungulate carcasses *Ecology* 90: 3159-3167

Buner, F. & Aebischer, N.J. (2008) *Guidelines for Re-establishing Grey Partridges through Releasing*. Game & Wildlife Conservation Trust, Fordingbridge, Hampshire.

Clutton-Brock, J. (1991) Extinct species. In *The Handbook of British Mammals* 3rd Edition, (Ed. by G.B. Corbet & S. Harris), pp. 571-575. Blackwell Science, Oxford.

Coles, B. (2006) *Beavers in Britain's past*. Oxbow Books & WARP, Oxford.

Cook, M. (2007) Crested tit. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Cook, M. (2011a) Honey buzzard. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Cook, M. (2011b) Nightjar. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Cook, M. (2011c) Crested tit. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Conroy, J.W.H. & Kitchener, A.C. 1996. The European beaver (*Castor fiber*) in Scotland: a review of the literature and historical evidence. *Scottish Natural Heritage Review No 49.*

Cosgrove, P., Amphlett, A. Elliott, A., Ellis, C., Emmett, E., Prescott, T. & Watson Featherstone, A. (2005) Aspen: Britain's missing link with the boreal forest. *British Wildlife* 17: 107-115

Crabtree, R.L. & Sheldon, J.W. (1999) Coyotes and canid coexistence. In *Carnivores in ecosystems: the Yellowstone experience* (Ed. by T.W. Clark, A.P. Curlee, S.C. Minta & P.M. Kareiva), pp. 127-163. Yale University Press, New Haven.

Craik, J.C.A. & Brown, D. (1997) Polecats in the West of Scotland. *Glasgow Naturalist* 23 (2): 50-53.

Crumley, J. (2010) *The Last Wolf*. Birlinn, Edinburgh.

Danilov, P.I. (1995) Canadian and European beavers in Russian northwest (distribution, number, comparative ecology). In: *Proceedings of the Third Nordic Beaver Symposium* (Ed. By A. Ermala & S. Lahti), pp10-16. Iiomats, Finland, 15-17 September 1992. Finnish Game and Fisheries Research Institute, Helsinki.

DEFRA (2008) *Feral wild boar in England: an action plan*. DEFRA, London.

Dennis, R. (1995) *The Birds of Badenoch & Strathspey*. Colin Baxter Publishing, Grantown on Spey.

Dennis, R. (1998) *The importance of traditional cattle for woodland biodiversity in the Scottish Highlands - a personal view*. Unpublished report.

Dennis, R. (2005). The eagle owl has landed. *BBC Wildlife* 23 (13): 24-29.

Elmhagen, B. & Rushton, S.P. (2007) Trophic control of mesopredators in terrestrial ecosystems: top-down or bottom-up? *Ecology Letters* 10: 197–206.

Elmhagen, B., Ludwig, G., Rushton, S.P., Helle, P. and Lindén, H. (2010) Top predators, mesopredators and their prey: interference ecosystems along bioclimatic productivity gradients. *Journal of Animal Ecology* 79: 785–794.

Etheridge, B. (2007) European Honey-buzzard. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Forrester, R.W. (2007a) Scottish list – Category E. In: Forrester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds) 2007. *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Forrester, R.W. (2007b) Supplementary data for 2005 and 2006. In: Forrester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds) 2007. *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Forrester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds) 2007. *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Forsyth, W. (1899) In the Shadow of Cairngorm (Chronicles of the United Parishes of Abernethy and Kincardine).

Francis, I. & Cook, M. (2011) *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Funnell, D. (2011) Crane. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Gilbert, G. (2007) Great bittern. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Gorman, M. L. (2007) Restoring ecological balance to the British mammal fauna. Mammal Review 37: 316 – 325.

Goulding, M. (2003) *Wild Boar in Britain*. Whittet Books, Stowmarket.

Gray, R. (1871) *Birds of the West of Scotland including the Outer Hebrides.* T. Murray & Son, Glasgow.

Groome, F. (1884) Covesea. *Ordnance Gazetteer of Scotland*.

Green, R.E. (2007) Corn crake. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Gurnell, A.M. (1997) *Analysis of the effects of beaver dam-building activities on local hydrology*. Scottish Natural Heritage Review No. 85
GWCT website. www.gwct.org.uk/research_surveys/species_research/birds/grey _partridge_bap-species/default.asp. Accessed 10/1/11.

Haller, H. (1992) Zur ökologie des Luchses (Lynx lynx) im Verlauf seiner Wiederansiedlung in den Walliser Alpen. *Mammalia depicta*, 15, 1-62.

Halley. D.J & Lamberg. A (2001): Populations of Juvenile salmon and trout in relation to beaver damming of a spawning steam. pp 122 – 127 in Czech, A & Schwab, G (eds). The European Beaver in a New Millennium. Proceedings of the 2nd European Beaver Symposium, Bialowieza, Poland. Carpathian Heritage Society, Krakow.

Halley, D.J. & Rosell, F. (2002) The beaver's reconquest of Eurasia: status, population development and management of a conservation success. *Mammal Review* 32: 153–178.

Halley, D.J. (2011a) Sourcing Eurasian beaver *Castor fiber* stock for reintroductions in Great Britain and Western Europe. *Mammal Review* 41: 40-53.

Halley, D. (2011b) Common birds of montane scrub and their potential to recolonise restored habitat in Scotland. *Scrubbers' Bulletin* 9: 22-34.

Harthun, M. (1999) Influence of the European beaver (castor fiber albicus) on the biodiversity (odonata, Mollusca, Trichoptera, Ephemeroptera, Diptera) of brooks in Hesse (Germany). *Limnologica*, 29, 449-464.

Harvie-Brown, J.A. & Buckley, T.E. (1895) *A vertebrate fauna of the Moray basin*. David Douglas, Edinburgh.

Hell, P, & Slamecka, J 1996 Current status of the lynx (*Lynx lynx*) in Slovakia. *Acta Scientiarum Naturalium Academiae Scientiarum Bohemicae Brno* 30 (3): 64-78

Helldin, J.O., Liberg, O., & Glöersen, G. (2006) Lynx (*Lynx lynx*) killing red foxes (*Vulpes vulpes*) in boreal Sweden – frequency and population effects. *Journal of Zoology* 270: 657-663

Henderson, G. & Henderson, I. (2004) *The art of the Picts: sculpture and metalwork in early medieval Scotland.* Thames & Hudson, New York.

Hetherington, D.A. & Gorman, M.L. (2007) Using prey densities to estimate the potential size of reintroduced populations of Eurasian lynx. *Biological Conservation*, 137: 37–44.

Hetherington, D.A, Lord, T.C., & Jacobi, R.M. (2006) New evidence for the occurrence of Eurasian lynx (Lynx lynx) in medieval Britain. Journal of Quaternary Science. 21: 3-8.

Hetherington, D.A., Miller, D.R., Macleod, C.D. & Gorman, M.L. (2008) A potential habitat network for the Eurasian lynx *Lynx lynx* in Scotland. *Mammal Review.* 38, 285–303

Hetherington, D. (2006) The lynx in Britain's past, present and future. *ECOS* 27: 66-74

Hetherington, D. (2008) The history of the Eurasian lynx in Britain and the potential for its reintroduction. *British Wildlife* 20 (2): 77-86

Highland Foundation for Wildlife website (2008). www.roydennis.org/honey-buzzard/. Accessed 8/6/10.

Howells, O. & Edwards-Jones, G. (1997) A feasibility study of reintroducing wild boar *Sus scrofa* to Scotland: are existing woodlands large enough to support minimum viable populations? *Biological Conservation* 81: 77-89.

IUCN (1998) *Guidelines for Re-introductions*. Prepared by the IUCN/SSC Re-introduction Specialist Group. IUCN, Gland, Switzerland and Cambridge, UK.

Jobin, A., Molinari, P. & Breitenmoser, U. (2000). Prey spectrum, prey preference and consumption rates of Eurasian lynx in the Swiss Jura Mountains. *Acta Theriologica* 45: 243-252

Jones, I.K. (1995) The reintroduction of beaver (Castor fiber) into Scotland: the identification and suitability assessment of two potential release sites. MSc Thesis, University of Aberdeen & Robert Gordon University.

Kemp, P.S., Worthington, T.A. & Langford, T.E.L. 2010. *A critical review of the effects of beavers upon fish and fish stocks.* Scottish Natural Heritage Commissioned Report No. 349 (iBids No. 8770).

Kitchener, A.C. Birks, J.D.S. & Davison, A. (1999) Interactions between polecats and ferrets in Britain. In Birks, J.D.S. & Kitchener, A.C. (eds). *The Distribution and Status of the polecat* Mustela putorius *in Britain in the 1990s.* Pp 84-110.

Kitchener, A.C. & Bonsall, C. (1997) AMS radiocarbon dates for some extinct Scottish mammals. *Quaternary Newsletter* 83: 1-11.

Kitchener, A.C. (1998) Extinctions, introductions and colonisations of Scottish mammals and birds since the last Ice Age. In *Species History in Scotland* (Ed. by R.A. Lambert), pp. 63-92. Scottish Cultural Press, Edinburgh.

Kitchener, A.C. (2007) The fossil record of birds in Scotland. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Kitchener, A.C. (2010) The Elk. In: O'Connor, T & Sykes, N. (eds). *Extinctions and invasions: a social history of British fauna.* Pp36-42. Windgather Press, Oxford.

KORA website *Lynx and livestock damage statistics for Switzerland.* http://www.kora.unibe.ch/en/proj/damage/damagemain.html. Accessed 11/1/11

Landesfischereiverband Bayern E.V., (2005), Totholz bringt Leben in Flüsse und Bäche. Landesfischereiverband Bayern E.V. & Bayerisches Landesamt für Wasserwirtschaft.

Langley, P.J.W. & Yalden, D.W. (1977) The decline of the rarer carnivores in Great Britain during the nineteenth century. *Mammal Review*, **7**, 95-116.

Langton, T.E.S., Beckett, C.L., & Foster, J.P. (2001) *Great Crested Newt Conservation Handbook*. Froglife, Halesworth.

Lauder, T.D. (1830) An account of the great floods of August 1829 in the province of Moray and adjoining districts. MacGillivray & Sons, Elgin.

Law, D. (2011) Grey partridge. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Leaper, R., Massei, G., Gorman, M.L. & Aspinall, R. (1999). The feasibility of reintroducing wild boar (*Sus scrofa*) to Scotland. *Mammal Review*, **29**, 239-259.

Locker, A. (2010) Freshwater Fish. In: O'Connor, T & Sykes, N. (eds). *Extinctions and invasions: a social history of British fauna.* Pp166-174. Windgather Press, Oxford.

Love, J. A. (2007) White-tailed eagle. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Macdonald, D.W., Tattersall, F.H., Rushton, S. South, A.B., Rao, S. Maitland, P. & Strachan, R. (2000) Reintroducing the beaver (Castor fiber) to Scotland: a protocol for identifying and assessing suitable release sites. *Animal Conservation* **3**, 125-133.

MacGillivray, W. (1836) *Descriptions of the rapacious birds of Great Britain*. MacLachlan & Stewart, Edinburgh.

MacGillivray, W. (1855) *The Natural History of Dee Side and Braemar*. London.

Maggs, H. (2011) Corncrake. In: Francis, I. & Cook, M. (eds). *The Breeding Birds of North-East Scotland*. The Scottish Ornithologists' Club, Aberdeen.

Manning, A.D., Gordon, I. J. & Ripple, W. J. (2009) Restoring landscapes of fear with wolves in the Scottish Highlands. *Biological Conservation* 142: 2314-2321.

Marquiss, M., Whitfield, P., & Wilson, J. (2005) *A feasibility study of further translocations of white-tailed eagles. Phase II: a discussion of the advantages and disadvantages of potential sites for the further release of white-tailed eagles.*

Maxwell, J. (2007) Willow tit. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Mead, C. (1993) Willow tit. *In* Wingfield Gibbons, D., Reid, J.B., & Chapman, R.A. (eds) *The New Atlas of Breeding Birds in Britain and Ireland: 1988-1991*. T & AD Poyser, London.

Melling, T., Dudley, S. & Doherty, P. (2008) The Eagle Owl in Britain. *British Birds* 101: 478-490.

Müller-Schwarze, D. & Sun, L. (2003) The beaver. Natural history of a wetlands engineer. Cornell University Press, Ithaca & London.

Natural England website (2010). www.naturalengland.org.uk/about_us/news/2010/090610.aspx. Accessed 17/7/10

Neill, P. (1821) Account of some fossil remains of the beaver, (Castor fiber L.) found in Perthshire and Berwickshire, proving that the animal was formerly a native of Scotland. *Memoirs of the Wernerian Natural History Society* 3: 207-219.

Nethersole-Thompson, D. & Watson, A. (1981) The Cairngorms; their natural history and scenery. The Melven Press, Perth.

Nilsen E.B, Milner-Gulland E.J, Schofield L, Mysetrud A, Stenseth N.C, Coulson T. (2007) Wolf reintroduction to Scotland: public attitudes and consequences for red deer management. *Proc. R. Soc. B.* 274, 995–1002.

Nowald, G., Donner, N. & Modrow, M. (2010*) Influence of Climate Change on the Wintering Site Selection of Eurasian Cranes from Germany: first results*. Presentation at 7th European Crane Conference, Stralsund. October 14th to 17th, 2010.

Nummi, P. (2005) Keystone effects of beavers *Castor fiber* on wildlife, especially ducks. Conference proceedings.

Nummi, P. & Pöysä, H. (1997) Population and community level responses in *Anas*-species to patch disturbance caused by an ecosystem engineer, the beaver. *Ecography* 20: 580-584

Orr-Ewing, D. (2007) Red kite. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Packer & Birks (1999) An assessment of British farmers' and gamekeepers' experiences, attitudes and practices in relation to the European Polecat *Mustela putorius. Mammal Review* 29: 75–92.

Parish, D. (2007) Grey partridge. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Parker, H., Rosell, F. & Holthe, V. (2000). A gross assessment of selected Scottish riparian habitats for beaver. Scottish Forestry 54:25-31

Parker, H. and Rønning, Ø.C. (2007). Low potential for restraint of anadromous salmonid reproduction by beaver *Castor fiber* in the Numedalslågen River catchment, Norway. *River Research and Applications* 23: 752-762.

Pauly, Daniel (1995) Anecdotes and the shifting baseline syndrome of fisheries. *Trends in Ecology and Evolution*, 10: 430.

Philip, L.J. & Macmillan, D. (2003) Public perceptions of, and attitudes towards, the control of wild animal species in Scotland. Scotecon. pp80

Pollock, MM, Pess, GR, Beechie, TJ & Montgomery, DR (2004) The Importance of Beaver Ponds to Coho Salmon Production in the Stillaguamish River Basin, Washington, USA. *North American Journal of Fisheries Management* 24: 749–760,

Ripple, W.J. & Beschta, R.L. (2004) Wolves and the Ecology of Fear: Can Predation Risk Structure Ecosystems? *BioScience* 2004, Vol. 54: 755–766

Ripple, W.J. & Beschta, R.L. (2007) Restoring Yellowstone's aspen with wolves. *Biological Conservation* 138: 514-519

Ritchie, J. (1920) *The Influence of Man on Animal Life in Scotland*. Cambridge University Press, Cambridge.

Røed, K.H., Flagstad, Ø., Nieminen, M., Holand, Ø., Dwyer, M.J., Røv, N., & Vilà, C. (2008) Genetic analyses reveal independent domestication origins of Eurasian reindeer. *Proceedings of the Royal Society B* 275: 1849–1855.

Rosell F., Bozser, O., Collen, P. & Parker, H. (2005) Ecolgical impact of beavers *Castor fiber* and *Castor canadensis* and their ability to modify ecosystems. *Mammal Review* 35: 248-276.

Sandom, C., Bull, J., Canney, S. and Macdonald, D.W. (2012) Exploring the Value of Wolves (*Canis lupus*) in Landscape-Scale Fenced Reserves for Ecological Restoration in the Scottish Highlands. In Somers, M.J. & Hayward, M. (Eds) *Fencing for Conservation: Restriction of Evolutionary Potential or a Riposte to Threatening Processes?* Springer, New York.

Scott, R. (2011) Wild boar. In: Scott, R. (ed.). *Atlas of Highland Land Mammals.* Highland Biological Recording Group, Inverness.

Scottish Crannog Centre (2008) *Evidence of Ancient Beaver Activity Discovered in Loch Tay*: Archive news story from August 2008 at www.crannog.co.uk/docs/whats_new/ArchiveNews.html. Accessed 6th December 2010.

Scott Porter Research & Marketing Ltd (1998) *Re-introduction of the European beaver to Scotland: results of a public consultation.* Scottish Natural Heritage Research, Survey & Monitoring Report No. 121.

Shaw, G. (2007) European nightjar. In: Forester, R.W., Andrews, I.J., McInermy, C.J., Murray, R.D., McGowan, R.Y., Zonfrillo, B., Betts, M.W., Jardine, D.C. & Grundy, D.S. (eds). *The Birds of Scotland*. The Scottish Ornithologists' Club, Aberlady.

Simms, I. C., Ormston, C.M., Somerwill, K. E., Cairns C.L., Tobin, F.R., Judge. J. & Tomlinson, A. (2010). A pilot study into sea eagle predation on lambs in the Gairloch area - Final Report. Scottish Natural Heritage Commissioned Report No.370.

SNH (2007) *Great crested newt.* http://www.snh.gov.uk/protecting-scotlands-nature/species-action-framework/species-action-list/gt-crested-newt/. Accessed 19th September 2011.

SNH (2009) *Great crested newt – update.* http://www.snh.gov.uk/protecting-scotlands-nature/species-action-framework/species-action-list/gt-crested-newt/update/. Accessed 19th September, 2011.

SNH (2010) *Feral beavers to be recaptured*. SNH press release at http://www.snh.gov.uk/news-and-events/press-releases/press-release-details/?id=419. Accessed 6th December, 2010.

South, A.B., Rushton, S.P. & Macdonald, D.W. 2000. Simulating the proposed reintroduction of the European beaver (*Castor fiber*) to Scotland. *Biological Conservation*, 93: 103-116.

Stahl, P., Vandel, J.M., Herrenschmidt, V., & Migot, P. (2001) The effect of removing lynx in reducing attacks on sheep in the French Jura Mountains. *Biological Conservation* 101: 15-22

Stanbury, A. & UK Crane Working Group (2011) The changing status of the Common Crane in the UK. *British Birds* 104: 432-447.

Stevens, C.E., Paszkowski, C. A. & Foote, A.L. (2007) Beaver (*Castor canadensis*) as a surrogate species for conserving anuran amphibians on boreal streams in Alberta, Canada. *Biological Conservation* 134: 1-13.

Stewart, J.R. (*2007*). The fossil and archaeological record of the *Eagle Owl* in Britain. *British Birds* 110 (8): 481-486.

St John, C. (1863) *Natural history and sport in Moray*. Edmonston & Douglas, Edinburgh.

Sunde, P., Overskaug, K., & Kvam, T. (1999) Intraguild predation of lynxes on foxes: evidence of interference competition? *Ecography* 22: 521-523

Swenson, J.E., Sandegren, F., Soderberg, A., Heim, M., Sorensen, OJ, Bjarvall, A., Franzen, R., Wikan, S. & Wabakken, P. (1999) Interactions between brown bears and humans in Scandinavia. *Biosphere Conservation* 2: 1-9.

The Great Crane Project website (2011) *Cran-e-news*. http://www.thegreatcraneproject.org.uk/whats-new/cran-e-news. Accessed 18/8/11.

Thornton, C. (1786) *Sporting Tour*.

Tumlison, R., Karnes, M. & King, A.W. (1982) The river otter in Arkansas. II. Indications of beaver facilitated commensal relationship. *Arkansas Academy of Science Proceedings* 36: 73-75.

Valdmann, H., Andersone-Lilley, Z., Koppa, O., Ozolins, J., & Bagrade, G. (2005) Winter diets of wolf *Canis lupus* and lynx *Lynx lynx* in Estonia and Latvia. *Acta Theriologica* 50: 521-527

Valentine, I. (2005) Eager for beavers? *Shooting Times & Country Magazine*. 21 July 2005.

Wallace (1899) The wild boar in Britain. *Transactions of the Inverness Scientific Society and Field Club* 5: 296-305.

Warburton, T. (2010) *The eagle owl in Britain: native or alien?* The World Owl Trust, Ravenglass.

Watson, A. & Francis, I. (in press) *Birds in north-east Scotland then and now: field observations mainly in the 1940s and comparison with recent records*. Paragon Publishing.

Wildman, L., O' Toole, L. & Summers, R.W. (1998) The diet and foraging behaviour of the Red Kite in northern Scotland. *Scottish Birds* 19: 134-140

Wilson, C.J. (2004) Could we live with reintroduced large carnivores in the UK? *Mammal Review*, 34: 211-232.

Woolf, A. (2006) Dún Nechtain, Fortriu and the Geography of the Picts. *The Scottish Historical Review* 220: 182–201

Yalden, D. (1999) *The History of British Mammals*. Poyser Natural History, London.

ZSL website (2008) *Corncrakes calling again.* www.zsl.org/conservation/news/corncrakes-calling-again,490,NS.html. Accessed 11/1/11.