Reintroducing the European Beaver in Britain

European Beaver. Mike Lane/Natural Image

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After many years of debate and planning, in 2009 European Beavers *Castor fiber* will for the first time be released legally into the wild in Britain.

There have been a number of well-publicised projects across Britain concerning the European Beaver, most notably the trial reintroduction in Knapdale Forest, in Argyll (Gaywood 2001, 2005). Following the inclusion by Scottish Natural Heritage (SNH) of the European Beaver as a species to be targeted for management action in Scotland's 'Species Action Framework', a licence application was submitted on behalf of the 'Scottish Beaver Project' alliance of partners for a trial reintroduction at Knapdale (see text box). This was approved by the Minister for Environment of the Scottish Government, Michael Russell MSP, in May 2008. South of the border, partnerships are now looking at the feasibility of releasing animals not just into enclosures, but into the wider English and Welsh countryside.

SNH has been investigating and advising on matters concerning beaver reintroduction for over 12 years. The aim of this article is to share some of our experiences, to summarise some of the complex issues that have created so much debate, and to

The Knapdale trial beaver reintroduction

In May 2008, the Scottish Wildlife Trust (SWT) and the Royal Zoological Society of Scotland (RZSS) received a licence from the Scottish Government to release up to four families of European Beavers in Knapdale Forest, Argyll. The site is owned by Forestry Commission Scotland. Animals will be collected from Norway in autumn 2008, quarantined, and released in spring 2009. Over the following five years the ecology of the beaver in the Scottish environment, and its effects on the environment, will be monitored. At the end of that period the results will be collated and assessed, and a decision made by the Scottish Government on the next stage. An exit strategy is built into the project. Mammals Trust UK is also providing support.

Knapdale, the Scottish trial-reintroduction site. Martin Gaywood

There are 31 conditions associated with the licence. Some of these concern mitigation relating to the Natura sites at Knapdale. A key condition relates to SNH's role – the monitoring of the trial will be undertaken independently of the rest of the project, and a group led by SNH will report results direct to the Scottish Government. SNH will also report on whether the conditions of the licence are being fully addressed on the ground.

inform those interested or involved in any further reintroduction projects. The work which SNH has pursued in Scotland has been guided by the 'Reintroduction Guidelines' produced by the IUCN (1995). These provide a simple and pragmatic set of procedures for species reintroduction projects, and their use has been formally adopted by all of the GB country conservation agencies (JNCC 2003). Any beaver reintroduction proposal should ensure that they are fully addressed. Recently, a few individual animals have escaped from private collections. These were not planned reintroductions, and so attempts are being made to recapture them.

Ecology and history

A fuller description of beaver ecology can be found in Kitchener (2001), but it is worth summarising some of the most significant aspects as they are important factors in the discussions surrounding reintroduction of beavers in Britain.

The European or Eurasian Beaver is a large (11-27kg for animals over three years), semi-aquatic rodent that was once found from the Chinese-Mongolian border in the east, to western Europe and Britain in the west. The fossil record indicates that the species was living in Britain 2 million years ago, 1.3-1.5 million years before the first humans. The other extant beaver species, the North American Beaver *Castor canadensis*, is superficially similar in appearance and requires close and expert examination to allow the distinguishing features to be determined. In places where they both occur in the wild, such as Finland, where the North American species was introduced in 1933-37, they appear not to hybridise.

Beavers do not eat fish. They are totally herbivorous and feed on a wide range of terrestrial and aquatic plant species. Herbaceous species tend to be favoured more in the warmer months, but towards autumn the diet tends to switch to higher proportions of broadleaved woody plants. Species such as Aspen *Populus tremula* and willows *Salix* are preferred but others are also taken, depending on availability. Conifers are rarely browsed or felled. Although much larger trees may also be felled, beavers tend to fell shrubs and trees with trunk diameters in the region of 3-8cm in order to feed on the bark, twigs and leaves and, when necessary, to use the wood for their engineering works. Woody material may be cached underwater to provide a winter source of food.

Beavers require two basic elements in their habitat: fresh water and broadleaved woodland. A large part of their lives are spent in or near water, and they usually forage little more than 10m from the water's edge, and very rarely more than 100m.

Territory sizes vary, depending on the quality of the habitat concerned, and have been recorded as covering from as little as 0.5km of riparian edge per family to up to 12km or considerably more. The animals live in family units, typically consisting of an adult pair with 2-3 young (kits) of the current year plus young from the previous year. Individuals leave their families when they are about two years old and set up their own territories. The Wolf *Canis lupus* can be a major predator, although there are records of kits being taken by such animals as Otter *Lutra lutra*, White-tailed Eagle *Haliaeetus albicilla* and Fox *Vulpes vulpes*. American Mink *Mustela vison* has been recorded as taking North American and European Beaver kits.

Beaver dens tend to be situated next to standing or slow-moving fresh water, with the entrance usually underwater to provide safety from predators. If water levels are low, beavers will dam streams less than 10m wide, using wood, stones, mud and other materials to create 'beaver ponds'. Some reports suggest a tendency for the North American species to build larger dams than the European species. Dens may be dug directly into river or loch-side banks, or incorporated within constructed lodges. The beavers' engineering skills can also extend to the construction of 'canals' to enable them to stay in water as they move around their territory.

Identifying the time when the beaver became extinct in Britain, even to the nearest century, has proved challenging. The last record north of the border was made by Hector Boece in 1526, in his 'Cronikils of Scotland', in which he referred to beavers as abundant in the Loch Ness area (Kitchener & Conroy 1996). Coles (2006) refers to beavers as disappearing from the historical record in Wales around the same time, but suggests that they may have hung on well into the late 18th century in Yorkshire.

The cause of extinction within Scotland is thought to have been primarily over-exploitation, mainly for the highly valued pelts. Meat and castoreum (a scent-marking secretion from the castor sac, believed to have medicinal qualities; indeed, it does contain salicylic acid, an active ingredient of aspirin) may also have been sought. Habitat destruction probably had a localised effect. This unsustainable level of exploitation was mirrored across the whole of Eurasia until, by the beginning of the 20th century, the species was heading for global extinction, with only around 1,200 animals left in eight isolated populations. In western Europe, a few hundred remained in three populations: in southern Norway, the Elbe in Germany and the Rhone in France.

The large, webbed hind feet and the smaller front feet, which are used for handling and carrying materials, can be clearly seen on this young beaver kit. Martin Gaywood

The 20th century was a period of remarkable turnaround in the fortunes of the European Beaver. Its value as a fur-producing species prompted its initial protection, and animals were reintroduced in parts of its historic range. There are now approximately 29 countries with European Beaver, and a total estimated global population of 634,000-732,000 (updated from Halley & Rosell 2003). However, this figure is heavily weighted towards eastern Europe and Scandinavia, especially Russia with 232,000-300,000 animals, the Baltic Republics with >161,000-181,000, and Sweden and Norway with >170,000. There are now 678 SACs (Special Areas of Conservation) within ten EU Member States where European Beaver is recorded as a Habitats Directive Annex II interest (an increase from 85 SACs in four EU Member States in January 2002).

Potential effects of a reintroduction in Britain

In order to gain a more detailed picture of the possible effects of reintroducing the beaver, a number of reviews have been commissioned by SNH, and liaison with specialists across Europe and North America has been undertaken.

Land use (agriculture, forestry, fisheries)

There is little published information available on the interactions between beavers and agriculture. Intensively farmed fields simply do not provide good beaver habitat. We have come across no reports of beavers grazing grass crops to significant extents, but they have been reported as feeding occasionally on orchard trees, maize, corn, oil-seed rape, potatoes and sugar-beet near riparian zones, and sometimes causing localised flooding. In the flatter regions of the Baltic Republics, beavers have colonised the extensive network of Soviet-era drainage ditches. We have some reports that bank damage, resulting from burrowing activities of beavers, can present localised problems, for example for artificial fish ponds. Conversely, colleagues in France have reported the value of beavers in improving river-bank stability by regularly coppicing larger trees leaning from river banks.

The burrowing activities of beavers have been raised as a potential concern in relation to canal banks. The Netherlands reintroduced beavers in 1988, and our Dutch colleagues have reported one example of a beaver hole dug into the base of a dike which then had to be repaired. The number of other reported problems in The Netherlands is low.

Opponents to reintroduction often raise Bavaria as an example of where the beaver population of 10,000 animals sometimes results in problems. The beaver-management specialists based there reported in late 2007 that around 500 animals are removed each year (most are killed), although in 90% of casework any problems, or perceived problems, can be resolved without animals being removed. They report agricultural damage as still being relatively small (a cost of a few thousand euros per year).

A review by Reynolds (2000) found no reports of nationally significant economic or ecological damage to woodlands in Europe caused by beavers, nor have the authors following more recent investigations. Localised problems do occur, sometimes in relation to grazing of broadleaved commercial species, but more often as a result of damming and flooding, which can cause tree death, the flooding of tracks and the blockage of culverts. On the other hand, woodland managers see the benefits of beavers creating wildlife habitat, clearing scrub, slowing down the succession of open-water habitats and providing visitor attractions.

Interactions between beavers, fish and fisheries have been examined in some detail by Collen (1997), who concluded that beavers may have positive effects on some fish species in some places and negative effects in others. Most concerns have surrounded the effect of beaver dams on the migratory movements of commercially important fish such as Atlantic Salmon *Salmo salar*. Halley & Lamberg (2001) undertook a preliminary study over one year on a 1.3m-wide Norwegian spawning stream, with four beaver dams present along a 250m length. Salmon and Sea Trout *Salmo trutta* in their first and second years were found all along the stream, including between the dams and above the highest dam. There were young, growing Salmon above all the dams.

A recent study by Parker & Rønning (2007) indicated that most landowners in their Norwegian study area were unequivocally positive about having beavers together with Salmon and Sea Trout on their streams. They also concluded that most Salmon reproduction in the study area was undisturbed by beavers.

The Danish trial reintroduction at Klosterheden showed temporal effects on Sea Trout movements and assumed that its populations may become isolated upstream of dams at times of low water flow (Salmon were not present at the site, but the researchers believe that the species would not be so affected in this way). However, the barrier effects of dams will constantly change as water levels change in response to rainfall, as water bypasses form and as the 'leakiness' of the dams alters. Minimal effects on populations of Eel *Anguilla anguilla* and Brook Lamprey *Lampetra planeri* were observed, and populations of other fish species, such as Roach *Rutilus rutilus* and Stickleback *Gasterosteus aculeatus*, may benefit from beaver ponds at Klosterheden in the longer term.

There is a concern also that the release of beavers could result in the introduction of the flatworm *Gyrodactylus salaris* into our native population of Salmon. This is a parasite of fish that occurs in several European countries and has devastated some Salmon stocks. It can survive for several days in damp or wet conditions, such as on fishing equipment, clothing, etc. Beavers have been suggested as potential external carriers of the parasite. Checks should therefore be made to

find out if potential source locations of beavers for any British reintroduction are free of *G. salaris*, and government precautions should be followed to ensure that animals are free of any such parasites before leaving quarantine.

In summary, it is important to acknowledge that there can be problems caused by European Beavers in certain places and at certain times, but the level of damage at a national scale is not reported as significant. This has to be balanced with the wider benefits that beavers may bring.

A European Beaver dam. If water levels are already sufficiently high at a site, beavers may not need to build dams. Martin Gaywood

Hydrology, geomorphology, and water chemistry

Beaver dams have been described as having the ability to ameliorate downstream flooding events during periods of high rainfall (particularly significant as climate change is expected to result in higher winter rainfall and increased incidences of flooding events) and to act as sediment and pollutant traps. Gurnell (1997) suggested that, after a Scottish reintroduction, the predicted preference of beavers for floodplain and minor tributary areas for dam construction would result in a relatively small hydrological and fluvial geomorphological impact on main river channels. Damming of small rivers would result in an increase in open-water and wetland habitat, and reductions in the load of moving sediment, including suspended sediment. Sediments trapped behind dams may eventually form 'beaver meadows'. Undammed stretches of river may become morphologically more complex as a result of the sediment-storage and energy-dissipation impacts of dams. There is a possible increased risk of blockages of man-made structures caused by coarse woody debris (CWD), although most pieces of wood cut by beavers tend to be relatively small (less than 2m in length). The role of CWD in freshwater systems is of increasing interest to river managers.

A recent study in the Tatarstan Republic, Russia, examined the effect of 21 reintroduced beavers above a lake suffering from degradation resulting from agricultural soil deposition. The beavers created three dams that, during a flooding period, stopped an estimated 4,000 tonnes of sediment. In water downstream of the dams, the mass of sediments decreased by 53%.

Biodiversity

Studies have shown that the habitat changes brought about by beavers affect the other species present, the creation of beaver ponds favouring lentic (still-water) species over the lotic (running-water) species that may have been locally present before. The effects of beavers on different species groups and habitats are well reviewed in Rosell *et al.* (2005). More recently, effects on biodiversity were studied at an enclosed Scottish site (Jones 2005). The general view is that the presence of the European Beaver has a positive effect on a range of wildlife, for example aquatic invertebrates, deadwood insects, amphibians, birds (such

Beaver grazing of trees can open up patches of the woodland floor to sunlight. Martin Gaywood

as waterfowl and species which use nest holes in dead trees) and bats. This is backed up by anecdotal observations made by some of our European colleagues, which includes such events as Otters recolonising areas that have become more suitable for them following beaver colonisation.

The term 'keystone' species therefore seems particularly apt for the beaver. Species reintroductions are often criticised for being too expensive, and it is claimed that the money could be better targeted at existing species. However, the reintroduction of the beaver would not only result in the restoration of a native species to our fauna, but could also have a positive impact on a wide range of other species.

There are also positive, indirect effects that the beaver may have on biodiversity through its use as a potent symbol for raising awareness and resources for wide-scale riparian and Aspen woodland restoration programmes (Batty 2002). Any future reintroduction would have to ensure there was suitable management to protect certain biological features if they were judged to be particularly vulnerable (e.g. some woodland stands with lichen assemblages of high conservation value), but this could be combined with using beavers as a focus to provide new opportunities to restore and extend habitats. Education and interpretation programmes directed at more general biodiversity could also benefit by using the beaver as an example to explain the ecology and importance of wetland and woodland ecosystems.

Public health

The most common public-health issue raised in relation to the beaver is Giardiasis (Galbraith & Gaywood 2002). Giardiasis is caused through the ingestion of oocysts of the flagellate protozoan parasite *Giardia lamblia*, often via untreated water, and is one of the most common causes of diarrhoea. In North America giardiasis is often called, rather unfortunately, 'beaver fever'. In fact, the major source of *Giardia* infection in humans in North American is other humans. The term 'beaver fever' was apparently invented by a section of the press in the 1970s and reflects the fact that beavers exist in areas where many people camp, hike and may, on occasion, become infected.

Giardia and other potential pathogens, such as *Cryptosporidium,* already occur naturally in the British environment and within animal and human populations. We have found no reported instances of European Beavers causing health problems in humans from *Giardia* or *Cryptosporidium*, nor have we found any situations where European Beavers are viewed as a significant human-health problem. However, as part of any future reintroduction, the precautionary advice would be to carry out pre- and post-release monitoring of private water supplies and watercourses in the release area. At the Scottish release site, at Knapdale, public-health specialists undertook a regular programme of water sampling and water analysis

from 2002 to 2004 to build up a picture of the water quality prior to releasing beavers for subsequent comparison with the post-release situation (Morrison 2004). The views of specialists at the Scottish Centre for Infection and Environmental Health (SCIEH) were also sought, and the local authority was advised that, 'subject to the beavers undergoing appropriate quarantine and screening, the introduction of a limited number of animals and the provision of monitoring and controls, the project will not pose a significant additional public health risk…the risk of increased human cases of Giardiasis is significantly low that it should not be considered an obstacle to beaver introduction'.

Socio-economics

'Eco-tourism' is particularly important in Scotland, especially to more remote rural communities, and its promotion has become an important role for government agencies and commercial operators. The White-tailed Eagle reintroduction on Mull, for example, is estimated to bring in about £1.7m per year to the local economy. Opponents have suggested that the nocturnal behaviour of beavers would make them a poor tourist draw, but in fact the animals can often be seen in daylight, especially during the long summer days, and can become habituated to low levels of human disturbance. They also leave very distinctive and impressive field signs, such as browsed trees, canals, lodges and dams. Beavers were reintroduced in Klosterheden Forest, in west Denmark, in 1999 and by 2005 there were over 72 organised 'beaver tours' to the site, involving 2,064 people in that one year alone. In Belgium, beaver-themed holidays are advertised via the www.pays-descastors.be website.

European Beaver. Mike Lane/Natural Image

There are also the more indirect socio-economic effects, which can be significant but are perhaps harder to quantify. For example, there are the costs associated with the localised impacts of culvert-blocking, ditch-blocking and the felling of garden or commercial broadleaved trees. Benefits may arise from the environmental role of beaver dams, such as flood amelioration, and sediment and pollutant traps. For nature reserve and other land managers they also provide a free service by reducing scrub encroachment and slowing down the succession of standing waters. Campbell *et al.* (2007) have reviewed the economic effects and estimate that the benefits of beaver reintroduction could be around 100 times larger than the costs.

Managing beavers

There is a wealth of experience regarding managing beavers, both in North America and Europe. Measures include non-lethal trapping techniques, tree and crop protection, protecting culverts ('beaver deceivers') and regulating beavers' damming activities (e.g. pipe systems to regulate flow). Published material is widely available (e.g. Halley & Bevanger 2005), although not all management methods used overseas may be appropriate or legal in Britain. It will be important to ensure that local management expertise is in place prior to any British reintroduction.

Ecological feasibility of a reintroduction in Britain

Could viable populations of European Beavers survive in the British countryside? From a Scottish perspective, we are confident that reintroducing beavers is ecologically feasible and we have now built up a picture of potential reintroduction sites. Webb *et al.* (1997) used GIS (Geographic Information Systems) techniques to examine the availability of suitable habitat for the European Beaver across Scotland. The study showed that this habitat was not uniformly distributed across the country and riparian broadleaved-woodland patches

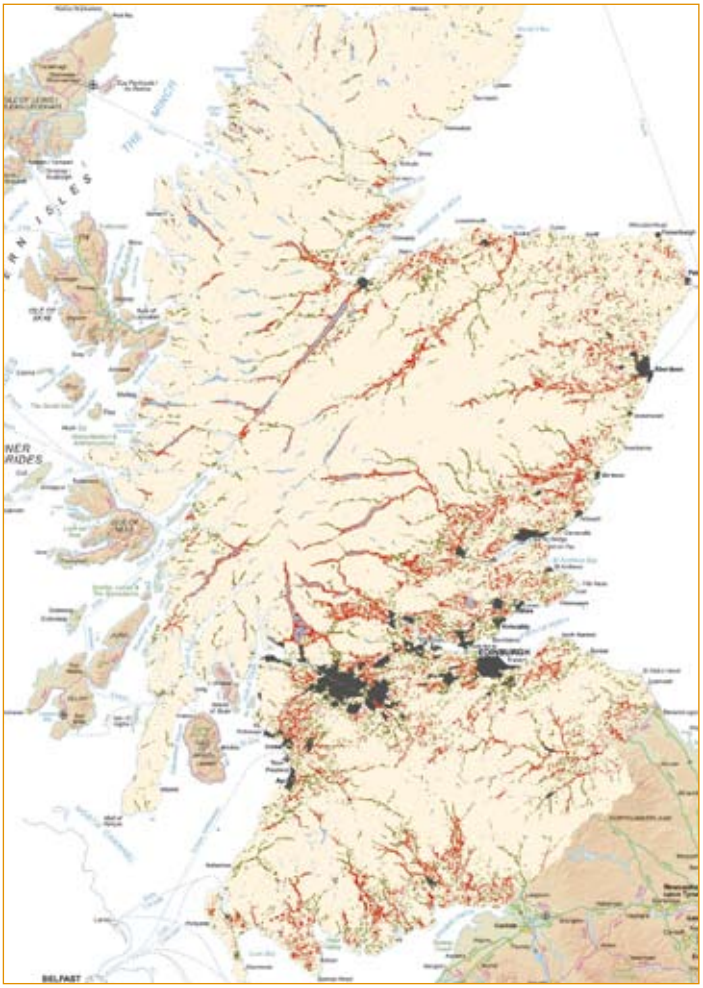

Figure 1 Distribution of possible suitable beaver habitat in mainland Scotland. The red areas indicate habitat networks which may be of sufficient size to support viable beaver colonies, whereas the green areas may be of insufficient size. Note that this provides a broad overview, and does not necessarily show suitable reintroduction sites; finer, detailed analysis is required when assessing more local sites.

tend to be fragmented (Fig. 1 shows an updated version of this study). However, it also demonstrated that suitable habitat was present in certain areas and judged capable of holding between 200 to 1,000 individuals.

Further analysis of habitat (Rushton *et al.* 2000; South *et al.* 2001) resulted in an increased estimate of 178-386 families (about 700-2,000 individuals) within 45 distinct patches in Scotland. These studies also applied predictive modelling techniques at a national scale, and these suggested that viable populations could be established under certain release scenarios. The predictive modelling tools were later refined and applied specifically to Knapdale to predict the outcome of a reintroduction there (Rushton *et al.* 2002).

The models developed for Scotland have also been applied to Norfolk, and these predicted that the county could support between 18 and 40 beaver families. The feasibility of reintroducing the species in parts of England is currently the subject of an ongoing project supported by Natural England and Mammals Trust UK, the results of which are expected in autumn 2008. In Wales, the follow-up to an initial scoping study on beaver reintroduction (Anthwal *et al.* 2005) is currently being considered.

Public desirability of a reintroduction in Britain

Article 22 of the EC Habitats Directive states that a 'proper consultation of the public concerned' is an important requirement before a reintroduction is carried out. The IUCN Reintroduction Guidelines also emphasise the importance of assessing public attitudes. We are unaware of any species-reintroduction project in Europe that approaches the extent of consultation that has been carried out for the proposed beaver reintroduction in Scotland over the last ten years.

National consultations

A national consultation exercise was organised by SNH during 1998 (Scott Porter Research & Marketing 1998). Three target audiences were approached. A total of 2,141 responses was received from a 'passive public' audience, of which 63% supported the proposal to reintroduce European Beaver in Scotland. Of the 1,944 responses received from a 'pro-active public' audience, 86% were supportive.

Key considerations for a beaver-reintroduction proposal

1 **Existing guidelines –** Address the IUCN Reintroduction Guidelines.
2 **Type of reintroduction and aims –** Is it an initial 'trial' (if so, what is its purpose and what are the success and failure criteria?) or a 'full' reintroduction?
3 **Project management –** The likelihood of success will be increased if it is properly managed and project team-member roles clearly set out. Matters such as staffing, access to specialist skills, health and safety, timescale etc. must be addressed.
4 **Legal issues –** Section 14 of the Wildlife & Countryside Act 1981 makes it an offence to release into the wild any animal that is of a kind 'not ordinarily resident' in Great Britain. Any beaver release, therefore, is subject to licence from government. Legal advice is recommended to define the legal status of released animals – European Beaver is currently not a 'European Protected Species' under domestic legislation (although it is listed on Annex IV of the Habitats Directive). During the Knapdale trial, Forestry Commission byelaws will provide for protection of animals on FCS land.
5 **Site selection –** Consider ecological suitability (Macdonald *et al*. 1997), the outcome of predictive modelling studies, presence of designated sites (e.g. Natura sites which are likely to require an 'appropriate assessment'), the expected future colonisation pattern for the area, and practical suitability for field officers.
6 **Local consultation –** Relevant local landowners, organisations and public.
7 **Donor country –** Norway is being used as the source of beavers for the Scottish trial, following the recommendations of Kitchener & Lynch (2000). As a precautionary measure, and until more information becomes available, we would strongly encourage other Great Britain reintroductions likewise to use animals of the Norwegian subspecies (*Castor fiber fiber*), because of the potential ecological risks that animals from other sources might pose to those from Norway (Rosell & Steifetten 2004).
8 **Capture/transport/quarantine –** The precautionary recommendation is that animals should be captured in autumn, quarantined for six months, and released in spring (spring capture risks harm to pregnant females, summer capture risks harm to very young kits, and winter capture may present difficult field conditions). The use of specialist zoo-based personnel is recommended to assist with issues such as arranging various permits and providing transport crates, government-vet-approved quarantine facilities and access to veterinary expertise (Gow 2002).
9 **Release –** A crucial stage. Various methods can be used to reduce the risk of animals moving away from the release site: e.g. release whole family groups rather than individuals, use temporary fencing, provide food, place animals into artificial lodges which have entrances temporarily blocked, and use bottled beaver scent to fool the animals into thinking that there are other beaver territories upstream or downstream. All beaver families should be released into the reintroduction area at the same time, otherwise the first beaver group will establish very large territories before the next are released. Precise release sites should provide good habitat, be accessible to field workers and be suitable for the management of visitors.
10 **Management of animals –** Ensure that suitable local support is available to monitor beaver activities, and to deal with any management problems. Set up procedures to deal with any damage.
11 **Exit strategy –** Set out reasons for implementing an exit strategy. Options may include trapping and repatriation to donor country (unlikely) or transfer to other reintroduction programmes, housing in zoological collections, sterilisation of the animals or humane destruction.
12 **Monitoring strategy –** The type of scientific monitoring will vary depending on the type and aim of the reintroduction. Subjects for monitoring may include the beavers themselves, other ecological factors (species, habitats, hydrology, fluvial geomorphology, etc.), land use and public health.
13 **Resourcing –** A well-managed beaver reintroduction will be expensive!
14 **Public relations and communications –** Project partners should co-ordinate their communications, and ensure that the public are kept well informed.
15 **Wider opportunities –** The project may be developed further to make the most of opportunities for public access and interpretation, education (e.g. school field studies), local eco-tourism and economic development. Care is needed to minimise disturbance to the beavers that may result from these activities. The beaver can also be used as a charismatic symbol to kick-start wider conservation and habitat-restoration programmes, for example Aspen woodland.
16 **Further phases –** Consider options for the next stages after the current project has been completed.

A total of 281 approaches was made to the third, 'key consultees' audience, with 144 responding. The levels of support varied, conservation and academic sectors giving the strongest support, and with reservations expressed by other interest groups, especially within agricultural and field-sport sectors, the fishing sector being the most opposed. A trial reintroduction was viewed by many as a preferred mechanism for addressing some of the concerns expressed.

The beaver was included as a species for targeted management action in Scotland's 'Species Action

The arguments for reintroducing the beaver

Environmental – Beaver can have an overall positive effect on biodiversity through creating coppiced woodland (Green 2000), standing and fallen dead wood, new ponds and other wetland features. It could be used as a symbol in raising awareness and resources for wide-scale woodland-habitat restoration programmes.

European law – European Beaver is listed on Annexes II and IV of the EC Habitats Directive 1992. Article 22 of the Directive requires Member States to 'study the desirability' of reintroducing species listed on Annex IV.

Socio-economic – Beavers are likely to be a draw for tourists, and a focus in developing education and interpretation programmes. Beavers provide 'ecosystem services' such as flood amelioration, the reduction of river siltation etc.

Moral grounds – Humans were responsible for beaver extinction and so a reintroduction helps to right this historic act. Britain is a rich nation that should play its part in restoring biodiversity.

Public desire – Large numbers of people want to see beavers restored to the countryside.

Also see Kitchener & Conroy (1996) and Woodroffe (2005).

Framework', the consultation for which was run by SNH in 2006. Responses noting support for including the beaver within this were far more frequent than were opposing ones, and the Framework received a ministerial launch in 2007 (SNH 2007).

Local consultations

If a reintroduction project is to succeed, it must take account of the views of local people, and address concerns and opportunities in the planning and operation of the project.

For the Knapdale trial proposal, two local consultations have now taken place. The first was undertaken in late 2000, during which local individuals and organisations were encouraged to pass on their views to SNH. This was done in a number of different ways, including 'beaver information days' at a local venue, the distribution of information leaflets and the presentation of proposals at the Community Council meeting. The outcome of that local consultation was positive overall and indicated that a majority of the public, local bodies and organisations were in favour of the trial.

The second local consultation was run by the SWT and the RZSS in late 2007. It followed a broadly similar approach to the first, although a much greater proportion of the responses were received from mid-Argyll as a whole compared with the area immediately local to Knapdale. Interestingly, whereas the level of public support for a beaver trial was strong across mid-Argyll, there was a small majority against the trial amongst those local to Knapdale (Scottish Beaver Trial 2007). Some respondents expressed concern that beavers might damage salmon fisheries and could carry disease, or simply felt that the money to be spent on the project might be better used elsewhere. However, many others were enthusiastic about the proposed project, seeing benefits for wildlife and the natural heritage of Knapdale and, potentially, for tourism.

Other surveys

A question on the Knapdale proposal was also put to the independently co-ordinated Citizens' Panel by the Argyll and Bute Community Planning Partnership in June 2002. A total of 46% of 680 Argyll and Bute residents agreed that a Knapdale trial should be undertaken and 21% disagreed (33% unconcerned either way).

The Scottish Economic Policy Network (Scotecon) also publicised a report on public attitudes towards the control of wild animal species in Scotland (Philip & Macmillan 2003). In their study, involving detailed interviews of 71 participants, the reintroduction of the beaver was supported by 72% of participants (14% did not support it and 13% were not sure either way). There was also a willingness to pay an average of £24 per household per year for ten years to fund a pilot beaver-reintroduction project.

Conclusions

Two key questions have been addressed in the preparatory work undertaken to date: is it feasible to reintroduce the beaver, and is it publicly desirable? The answer to both questions is a clear 'yes', although in both cases there are a number of caveats, some of which will be examined during the trial at Knapdale. A beaver-reintroduction project has to be carefully planned to maximise the chances of success and to take account of beaver welfare. Beavers are also known sometimes to cause management problems and so, understandably, there are people who have concerns. However, on the basis of the experience of the 24 European countries which have reintroduced beavers so far, the costs of beaver reintroduction appear to be outweighed by the benefits, which is reflected in the fact that, although some countries

have active beaver-management programmes, we have found no evidence of reintroductions being halted or reversed because of adverse effects.

There are few wildlife conservation projects that have been more intensively scrutinised in Europe than the proposal to reintroduce the European Beaver in Scotland. That scrutiny is possibly set to continue, with a trial reintroduction in Knapdale in spring 2009. Elsewhere in Britain, the prospect of reintroducing the species is also being given serious consideration. After all the planning and debate, are we finally about to experience, once again, what it is like to share our countryside with this extraordinary and charismatic animal?

Acknowledgements

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References

All SNH publications listed below can be accessed via www.snh.gov.uk/speciesactionframework, together with further information on the European Beaver.

Anthwal, V, Goodger, B, & Kirby, J 2005 Scoping study for the reintroduction of the Eurasian beaver *Castor fiber* into Wales. *CCW Contract Science Report* 690, Bangor

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 in Kingussie, Scotland, 25th May 2001*, pp. 41-44. The Cairngorms Local Biodiversity Action Plan, Grantown-on-Spey, UK

Campbell, R, Dutton, A, & Hughes, J 2007 *Economic Impacts of Beaver.* Report for the Wild Britain Initiative

Coles, B 2006 *Beavers in Britain's Past*. Oxbow Books, Oxford

Collen, P 1997 Review of the potential impacts of re-introducing Eurasian beaver *Castor fiber* L. on the ecology and movement of native fishes, and the likely implications for current angling practices in Scotland. *SNH Review* 86, Battleby

Conroy, J, & Kitchener, A 1996 The Eurasian beaver (*Castor fiber*) in Scotland: a review of the literature and historical evidence. *SNH Review* 49, Battleby

Galbraith, C A, & Gaywood, M J 2002 The proposed trial re-introduction of European beaver: The Giardia issue. *Environmental Health Scotland* 14 (4): 12-13

Gaywood, M 2001 A trial re-introduction of the European beaver to Scotland. In: Czech, A, & Schwab, G (eds) *The European Beaver in a New Millennium.* Proceedings of second European Beaver Symposium, 27-30 September 2000, Bialowieza, Poland. Carpathian Heritage Society, Krakow, Poland

Gaywood, M 2005 A proposed trial re-introduction of European beaver to Knapdale. In: Rooney, P, Nolan, P, & Hill, D (eds) *Restoration, Reintroduction and Translocation*. Proceedings of the 20th Conference of the Institute of Ecology and Environmental Management, 9-11 November 2004, Southport

Gow, D 2002 *The transport, quarantine and captive management of European beaver* Castor fiber. Unpublished report to SNH by Wildwood, Kent

Green, T 2000 Coppicing like a beaver. *British Wildlife* 11: 239-241

Gurnell, A 1997 Analysis of the effects of beaver dam-building activities on local hydrology. *SNH Review* 85, Battleby

Halley, D J, & Bevanger, K 2005 *The beaver – management for hunting, wildlife and environmental resource. A handbook of modern methods for practical management of beaver populations.* NINA Report 21.61s. (in Norwegian)

Halley, D J, & Lamberg, A 2001 Populations of juvenile salmon and trout in relation to beaver damming of a spawning stream. In: Czech, A, & Schwab, G (eds) *The European Beaver in a New Millennium.* Proceedings of second European Beaver Symposium, 27-30 September 2000, Bialowieza, Poland. Carpathian Heritage Society, Krakow, Poland

Halley, D J, & Rosell, F 2003 Population and distribution of European beavers (*Castor fiber*). *Lutra* 46: 223-234

IUCN 1995 *IUCN Guidelines for Re-introductions*. IUCN, Gland, Switzerland

JNCC 2003 *A Policy for Conservation Translocations of Species in Britain.* JNCC, Peterborough

Jones, K 2006 *Ecological effects of the feeding and construction activities of the Eurasian beaver (*Castor fiber*) in Scotland: implications for reintroduction*. PhD thesis, University of Stirling

Kitchener, A 2001 *Beavers.* Whittet Books, Stowmarket

Kitchener, A, & Conroy, J 1996 History of the beaver in Scotland and the case for its reintroduction. *British Wildlife* 7: 156-161

Kitchener, A, & Lynch, J M 2000 A morphometric comparison of the skulls of fossil British and extant European beavers, *Castor fiber. SNH Review* 127, Battleby

Macdonald, D, Maitland, P, Rao, S, Rushton, S, Strachan, R, & Tattersall, F 1997 Development of a protocol for identifying beaver release sites. *SNH Research, Survey & Monitoring* 93, Battleby

Morrison, A 2004 Trial re-introduction of the European beaver to Knapdale: public health monitoring 2001-3. *SNH Commissioned Report* 77, Battleby

Parker, H, & Rønning, O 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

Philip, L J, & Macmillan, D 2003 *Public Perceptions of Attitudes Towards the Control of Wild Animal Species in Scotland.* Report to Scotecon.net, Department of Land Economy, University of Aberdeen

Reynolds, P 2000 European beaver and woodland habitats: a review. *SNH Review* 126, Battleby

Rosell, F, & Steifetten, O 2004 Subspecies discrimination in the Scandinavian beaver (*Castor fiber*): combining behavioural and chemical evidence. *Can. J. Zool.* 82: 902-909

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

Rushton, S, South, A, & Macdonald, D 2001 Predicting the outcome of a proposed re-introduction of the European beaver (*Castor fiber*) to Scotland. *SNH Research, Survey & Monitoring* 153, Battleby

Rushton, S, South, A, & Lurz, P 2002 Predicting the outcome of a proposed re-introduction of the European beaver *Castor fiber* at Knapdale, Argyll. *SNH Commissioned Report* F022AC327, Battleby

Scott Porter Research & Marketing Ltd 1998 Re-introduction of European Beaver to Scotland: results of a public consultation. *SNH Research, Survey & Monitoring* 121, Battleby

Scottish Beaver Trial 2007 *Trial reintroduction of the European beaver to Knapdale, mid-Argyll.* Scottish Wildlife Trust

SNH 2007 *A Five Year Species Action Framework: Making a Difference for Scotland's Species.* SNH, Battleby

South, B, Rushton, S, Macdonald, D W, & Fuller, R 2001 Reintroduction of the European beaver (*Castor fiber*) to Norfolk, U.K.: a preliminary modelling analysis. *Journal of Zoology* 254: 473-479

Webb, A, French, D D, & Flitsch, A C C 1997 Identification and assessment of possible beaver sites in Scotland. *SNH Research, Survey & Monitoring* 94, Battleby

Woodroffe, G 2005 A trial reintroduction of the European beaver. *British Wildlife* 16: 381-384

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