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Forage Preferences of the European Beaver *Castor fiber*: Implications for Re-introduction

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Abstract

By the beginning of the twentieth century, hunting and land use change had reduced the European beaver *Castor fiber* to a relict population of no more than 1200 individuals. In some European states, reintroduction has successfully established viable populations, whilst other schemes have failed. Environmental, social and economic issues associated with beaver re-introduction have given rise to a range of information needs in relation to the species«SQ» ecology. In 2005, six European beavers were translocated from Bavaria to a re-introduction site in southern England. The following year, a 6 month study was undertaken to investigate which tree species and size classes were most frequently utilised by the beavers, and to determine if the utilised species and size classes reflected resource availability within the home range. These questions were answered by comparing the use and the availability of foraged tree species in two ways: (1) using a survey of tree stumps; and (2) as a food choice experiment. The results showed that the re-introduced beavers were highly selective in relation to both the species and the size of the trees they used i.e. the re-introduced beavers selected species in significantly different proportions to their availability. However, they selected similar size classes between the preferred tree species, and did not utilise human «SQ»timber«SQ». The relevance of the study is discussed with respect to information needs associated with the re-introduction of a «SQ»keystone«SQ» species, overcoming negative perceptions, population viability, welfare and «SQ»soft release«SQ» strategies.

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Full Text

Introduction

HISTORICALLY, THE EUROPEAN BEAVER Castor fiber oc curred throughout the Western Palaearctic (Hartman 1996; Halley & Rosell 2002). By the beginning of the twentieth century, a relict population of no more than 1200 individuals remained in France, Norway, Poland, Russia and Sweden (Zurowski & Kasperczyk 1988). This substantial reduction resulted from the combined effects of changes in land use and hunting. The latter was either for fur (pelts) or for castoreum, a secretion of the scent gland believed to have medicinal properties (Nolet & Rosell 1998). During the second half of the twentieth century, beavers were re-introduced into many areas across Europe. In some countries, this resulted in populations known to be self-sustaining (e.g. Estonia, Latvia, Lithuania and Poland), while the long term viability is less clear in others (e.g. Denmark, the Netherlands, Belgium, Spain, Czech Republic, Hungary, Slovenia and Slovakia) (Halley & Rosell 2002). The total European population is currently estimated at around 300,000 individuals, but is not considered to be occupying all of its former range (Halley & Rosell 2002). There are also 12,000 American beavers C. canadensis established in parts of Scandinavia.

In the United Kingdom (UK), hunting exterminated the last recorded population from Scotland in the sixteenth century (South et al. 2000). The geographical isolation of the UK from mainland Europe means that beaver populations cannot be re-established through dispersal. Since 1995, the UK government's statutory conservation agencies have been investigating the potential for beaver reintroduction under the auspices of Article 22(a) of the European Council Directive 92/43/EEC. The UK gov-ernment has taken a strategic approach to re-introduction, using pilot programmes where animals are released on the understanding that should 'problems' arise they would be removed (Morrison 2004). They have also assimilated the issues raised by the re-introduction experiences of other European states, and undertaken extensive public consultation on potential environmental damage and economic loss (Wigley & Garner 1987; Jonker et al. 2006). Negative perceptions about beavers often persist in human communities, despite evidence of only relatively benign impacts, often balanced by benefits to biodiversity and local economies (Johnston & Naiman 1990; Collen & Gibson 2001; Rosell et al. 2005). Part of this perception is a result of the functional 'keystone' role of beavers within local ecosystems. This can be viewed as causing environmental 'impact' by land owners and the general public (South et al. 2000; Rosell et al. 2005).

The issues associated with re-introduction of the beaver in the UK (welfare, viability, land owner perceptions, dispersal, ecosystem impacts etc.), have given rise to a number of information needs in relation to the species' ecology, particularly feeding habits. This is important in understanding the forage requirements and local habitat interactions of re-introduced groups in the short and long terms. It is also important in addressing some of the negative perceptions of local people and land owners. Although there is an extensive body of research on beavers, much of this has been conducted in North America for C. canadensis. Relatively little work has focused on food preferences and size selection for C. fiber in different parts of its newly established range (Belovsky 1984; Rosell et al. 2005; Haarberg & Rosell 2006). In addition to the re-introduction activities of statutory agencies, recent efforts in Europe have also involved 'private' individuals undertaking release programmes under licence. Beavers are known to be able to feed on a very broad range of non-woody vascular plants (Parker et al. 2007), and so will have different diets at different sites. This study therefore focused on the use of tree species. Trees are felled by beavers for both food and construction of lodges, and the types and sizes of trees felled can have an impact on local ecosystem diversity and processes (Nolet et al. 1994; Hartman 1996; Haarberg & Rosell 2006). The present study was designed to answer two key questions in relation to the re-introduced beavers: (1) which tree species and size classes are most frequently utilised?; and (2) do the utilised species and size classes reflect resource availability within the home range?

Methods

Study Site and Re-introduced Animals

Six European beavers were translocated from Bavaria (southern Germany) and released under licence (DEFRA 2006) into the Flagham Fen lake on the Lower Mill Estate near Somerford Keynes, Gloucestershire, England. They were initially quarantined for a 6 month period from April 2005. The group comprised two families: a breeding pair and their male offspring from the preceding year, and a second breeding pair with a female offspring from the preceding year. The lake forms a part of a larger complex of 146 lakes called the Cotswold Water Park, resulting from the commercial extraction of sand and gravel. Nearly half of the lakes have some human activities associated with them e.g. fishing, water recreation or houses (O'Connell et al. 2007). The translocated beavers were contained within a fenced wildlife reserve, comprising 15 ha of lake, and 5 ha of embankments and mature planted woodland.

Tree Species and Size Class Preferences

Tree Surveys

In August 2005, a survey of all trees (n=3105) was conducted in the Flagham Fen wood by staff of the Lower Mill Estate. All trees were identified to species level, and their diameter (cm) at 50 cm above the ground placed into one of three categories: 30 cm.

Canopy Experiments

Based on the protocol of Aldous (1938) four tree 'canopies' (branches) were provided as forage for the beavers. Two of the trees used were abundant in the study woodland (willow Salix alba and alder Alnus incana), and two less common (ash Fraxinus excelsior and elder Sambucus nigra). Details of the data to quantify the availability of different tree species in the study woodland are provided below. Commercially available pine fence posts were used as a fifth 'canopy' to investigate the potential for foraging on this material. Canopies were approximately 1.5 m in length and 10 cm in diameter. A row of the five canopy types was placed in the ground (random order) amongst low vegetation, 1 m from the edge of the lake, and at four separate sites. A new set of canopies was provided at each site on fifteen occasions between July 2006 and March 2007. Gloves were used when acquiring and placing the canopies to minimise contact with the forage material. For each experiment, the canopies were left in place for 24 hours.

Stump Surveys

Between July and December 2006, monthly tree stump surveys were conducted in the Flagham Fen wood. Trees felled by the beavers were recognised by the conical stump shape, height from the ground, arrangement of teeth marks and the presence of wood chippings (Johnston & Naiman 1990). The diameter (cm) of each tree stump was measured immediately below the gnawed area (Belovsky 1984). A total of 108 trees (sixty-one willows, twenty-nine alders, seventeen aspens, one hawthorn) were felled during the study.

Analyses

The G statistic was used to identify significant differences in frequency distributions using a goodness-of-fit approach to calculate expected values i.e. for species preferences and stump size class preferences, expected values were calculated as a function of resource availability. Williams' Correction was applied where appropriate (Sokal & Rohlf 1994). Analysis of variance was used to identify between-species differences in the size of felled trees. An Anderson-Darling test was used to test data for normality prior to this procedure. Linear regression on arcsine transformed data, was used to investigate temporal changes in the proportions of the canopy types and stump sizes used (Cardinal & Aitken 2005).

Results

Tree Preferences

Canopy Experiments

The proportions of canopies removed did not change in relation to month (6) or site (4). Twenty-five per cent of the 300 canopies provided were removed. Willow (57 per cent of canopies removed) and alder (43 per cent of canopies removed) were preferentially selected over other canopies (G=136.1, P Felled Trees

Four species of trees (alder, aspen, hawthorn and willow) were felled by the re-introduced beavers. [Figure 1] shows the percentage of each species compared to their percentage availability within the woodland reserve area.

The number of trees felled for the four species used was significantly disproportionate to their availability (G=72.7, P Stump Size

The mean, minimum and maximum diameters of the 108 felled trees measured are shown in [Table 1].

There was no significant difference in the mean diameter of the four species utilised, and the diameter of trees used did not change between July and December. The size class distribution for felled trees compared to the size classes available in the wood is shown in [Figure 2]. Hawthorn is not compared as only one tree of this species was felled. For the three species, the size classes utilised were significantly disproportionate to those available (alder: G=15.8, P et al. 2000; Wanless et al. 2002; Hardman & Moro 2006). A major benefit of pilot studies is that they produce information to underpin and guide the implementation of larger scale releases. For example, baseline information on range size, feeding ecology and dispersal can be used for modelling the suitability of sites and landscapes for re-introduction. The information can be used either to quantify the number of individuals that could be maintained in a pre-defined area (South et al. 2000), or to identify sites where a predetermined viable population size could be maintained (Macdonald et al. 2000). Information from pilot schemes can also be used to overcome a number of beaver reintroduction problems that conservation agencies face. One of the major issues is that the species has been absent from the landscape for hundreds of years, and lacrustine and riparian habitats have reached new functional, economic and cultural equilibria in this time. Beavers are known to exert considerable ecosystem influences by altering environmental structure, diversity and function at local scales (see review by Rosell et al. 2005). This is potentially a difficulty for the conservation agencies involved in beaver re-introductions, because they also have statutory responsibility to ensure the maintenance of local species and habitats that may be vulnerable to the environmental changes resulting from beaver activity. Of course many elements of beaver influence have been shown to be environmentally 'positive', for example, they can increase plant diversity (Nolet et al. 1994; Rosell et al. 2005). Nevertheless, whilst overall diversity may increase, individual species of concern may be negatively impacted. Experiences from re-introductions in other countries may be of some use in this regard, but information from local pilot studies can provide a more species relevant indication of beaver impacts.

Another issue for re-introduction programmes is to ensure the welfare of the re-introduced animals over a range of timescales by ensuring the ongoing provision of adequate food and construction resources. Pilot projects can provide such information by identifying the range of tree species utilised, their relative preference in comparison to availability and the distribution of size classes preferred. At the Cotswold Water Park, the re-introduced beavers showed significant selectivity in relation to both species and size class. In particular, the importance of willow Salix spp. was identified. Nolet et al. (1994) also highlighted the importance of willow, and demonstrated that beavers re-introduced in a willow dominated wood in the Netherlands, reduced tree numbers by about 5 per cent (equating to about 30 per cent of total annual willow regrowth). Fryxell et al. (1994) suggested that food retention time in the digestive track and the resultant energy pay off is an important factor in food selection by the European beaver, and that willows are an important group because they allow beavers to optimise energy intake. The distribution and relative abundance of willow is therefore a key issue for re-introduction attempts. Furthermore, re-introduction programmes on mainland Europe suggest that post-release beaver population growth growth is secondary to an initial period of spatial expansion within a watershed (Halley & Rosell 2002). The implication of this is that suitable resources (including willow) need to be available over larger spatial scales beyond the release site.

The last issue for beaver re-introduction is in relation to negative perceptions of the species by landowners and the general public. Responsible statutory agencies often attempt to measure and assuage local negative opinions prior to releases, using questionnaires and public awareness techniques. The use of information from pilot studies can also play a key role in this area. For example at the Cotswold Water Park, the stump surveys and canopy experiments of the present study, showed that the beavers did not gnaw human constructions (e.g. fence posts), often a major concern of local people prior to reintroduction (Wigley & Garner 1987; Jonker et al. 2006). It has been known for some time that European beavers have strong olfactory senses, which they utilise in selecting preferred forage (Muller-Schwarze et al. 1994). However, the provision of new, locally gathered evidence is perhaps more persuasive for local communities. Importantly, this finding also has the management implication that timber fences can be used either to construct containment barriers at the initial release site, or to fence off areas from where the beavers need to be excluded.

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