



Public attitudes towards “pest” management: Perceptions on squirrel management strategies in the UK

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ABSTRACT

The impacts of non-native, invasive grey squirrels (*Sciurus carolinensis*) on broadleaf woodlands and red squirrel population (*Sciurus vulgaris*) are well recognised among wildlife professionals, yet efforts to control the species across its expanding range require substantial time and resources. Through collaboration, wildlife professionals and communities can more effectively implement the population monitoring and control programmes necessary to conserve native species under threat. However, for such collaboration to be successful, wildlife professionals must first understand public attitudes towards grey squirrels, and the control methods available. Through a national level survey ($n = 3758$) we examine the UK public's attitudes to red and grey squirrels, and the acceptability of seven control methods. Results show that much of the public have little knowledge of the grey squirrel's negative impacts. In fact, contrary to the notion of a pest species, the presence of grey squirrels is often desirable. Furthermore, those control methods recommended by wildlife professionals are regarded by the public as some of the least acceptable. Those most accepting of controls include males, older generations, those most knowledgeable about squirrels and people who are aware of squirrel management being practiced in their local area. To foster more fruitful collaboration, wildlife professionals should raise awareness of why particular control methods are preferred, highlight the damage grey squirrels cause to other valued species, and offer local communities a variety of roles which contribute to the wider goal of native species conservation.

1. Introduction

Changes in wildlife abundance may induce changes in human perceptions, serving to redefine species as a precious resource to be protected versus a pest to be controlled (Destefano and Deblinger, 2005). For example, perceptions of white-tailed deer (*Odocoileus virginianus*), black bear (*Ursus americanus*), beaver (*Castor canadensis*), and Canada geese (*Branta canadensis*) have all been observed to morph as their populations and the subsequent frequency of interactions with humans have changed (Leong, 2009). The potential extent of these fluctuating perceptions is exemplified with the UK's red squirrels (*Sciurus vulgaris*), which were once regarded as vermin due to the damage they caused to planted trees and bird populations (Holmes, 2015). In fact, between 1903 and 1946, the Highland Squirrel Club received “tail bonuses” for killing around 102,900 red squirrels (Rotherham and Boardman, 2006). Today the red squirrel is protected under Appendix 3 of the Berne Convention (Convention on the Conservation of European Wildlife and Natural Habitats) and is a Priority Species within the UK (and therefore the subject of a Biodiversity Action Plan).

Despite the new found affection for the red squirrel, wildlife management that involves the eradication of one (non-native invasive) species to conserve another (native one) can be controversial, particularly when the targeted species has been prevalent in gardens, parks and the countryside for decades, as in the case of grey squirrel (*Sciurus carolinensis*) populations in the UK, Ireland and parts of Italy. The management of such species can be considerably more effective if there is collaboration between key stakeholders, notably local community members, relevant policy and decision-makers, scientists and management practitioners. For example, collaborative actions can influence the conservation success of red squirrels by improving the frequency and coverage of presence-absence monitoring (Shuttleworth et al., 2015; Goldstein et al., 2014). Yet the success of these collaborative actions may be underpinned by the social acceptability of what is trying to be achieved – in this case the eradication of grey squirrels where red squirrels are present (Bertolino and Genovesi, 2003).

In contrast to red squirrels, grey squirrels were introduced to Great Britain from North America on a number of occasions between 1876 and 1929, often as fashionable additions to wealthy estates (Middleton,

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1930; Shorten, 1953, 1954). Once a rare and novel curiosity, they proved well suited to the British landscape, and have now spread over most of England, Wales and southern Scotland. Similarly, the population in Ireland, arising from the release of six pairs of animals in 1911 (O' Teangana et al., 2000), has continued to expand to the extent that complete eradication is no longer considered economically feasible (Goldstein et al., 2016). In Italy, the grey squirrel has been introduced on at least three separate occasions, initially in Piedmont in 1948, where colonisation has reportedly occurred at a rate similar to that seen in Britain (Currado, 1998; Bertolino and Genovesi, 2003). Although, Italy's grey squirrels are the only populations in continental Europe (Mitchell-Jones et al., 1999), models indicate that the species will cross the Alps and reach France by 2050, before spreading to Switzerland, and eventually much of continental Eurasia (Lurz et al., 2001a, 2001b; Bertolino et al., 2008; Di Febbraro et al., 2013). Introductions of grey squirrels have also occurred in South Africa and Australia (Bertolino, 2008) albeit with less success. Peacock (2009) recounts the eradication of grey squirrels from Melbourne, Ballarat and Adelaide citing (un) suitable habitat, predation, competition and control effort as the pivotal factors. Despite its failure to colonise in this instance, the grey squirrel remains of great concern and is duly included in the IUCN's international list of "100 worst invasive non-native species".

The grey squirrel's reputation as a pest is not exclusively attributable to its fecundity and expansive colonisation, but also the accompanying economic and ecological damage.

Squirrels remove bark from the main stem and branches in spring and early summer to feed on the sap and phloem underneath (Kenward, 1989). Historical data from surveys assessing presence of squirrel damage in Britain indicated 28% of the beech, 24% of the sycamore, and 7% of the oak were affected, resulting in an estimated loss of £10 million for that crop rotation (Mayle and Broome, 2013). Not only does bark stripping reduce the value of timber, it may also lead to infection and decay or breakage, potentially killing the tree. In some cases, squirrels actually function as a vector for the spread of tree diseases (Abbott et al., 1977). Woodland owners are now becoming increasingly reluctant to invest in planting broad-leaved trees because of the loss inflicted by grey squirrels when the trees reach the most vulnerable age, between 10 and 40 years old (Gill, 1992; Nichols and Gill, 2016). As well as the adverse impacts to trees it has long been suspected that grey squirrels have negatively impacted red squirrel populations (Shorten, 1962). It is now understood that grey squirrels compete with red squirrels for food and transmit the squirrel poxvirus (SQPV) which is fatal only to red squirrels (Gurnell et al., 2004; Rushton et al., 2006). It seems not all populations of introduced grey squirrels carry the virus, with no outbreaks having been reported in Scotland or Italy. However, in those areas where grey squirrels carry the virus, the replacement of red squirrels by grey squirrels occurs some twenty times faster (Gurnell et al., 2006). The loss and spreading of parasites from grey squirrels may also be detrimental to native red squirrels; through a phenomenon known as "enemy release" grey squirrels were noted to have lost some of their parasites following introduction to Italy, leading to increased reproductive viability for the individual and expansion of the population's range. Moreover, grey squirrels may harbour non-native parasites which are transmitted to red squirrels ("spillover") where the two species' ranges overlap. If red squirrels are maladapted to alien parasites there could be very severe ramifications for the population (Romeo et al., 2014, 2015).

Efforts to control grey squirrels have been driven by desires to prevent damage to woodlands, reduce the loss of agricultural crops, and to conserve native red squirrel populations (Signorile and Evans, 2006; Gurnell and Pepper, 2016). Early attempts to encourage eradication through bounty schemes in Australia and Britain yielded vastly different results; in Adelaide grey squirrels were first seen in the wild in 1917. By 1920 a bounty scheme was introduced, and by 1922 the animals were eradicated (Peacock, 2009). In Britain a similar scheme was introduced in the 1950s but was abandoned later that decade having

made negligible impact to a population that had already exploded beyond a containable size (Coates, 2011). In the 1960's warfarin – an established rodenticide – was increasingly used to control squirrels. Although regarded as the most cost effective means of protecting woodlands, its approval for use as a grey squirrel control method was withdrawn in 2015 amid concerns over lack of specificity and humaneness (Barr et al., 2002; Shuttleworth et al., 2017).

While the use of traps, shooting and drey poking (the disturbance of a nest with a pole) remain common forms of squirrel control, proposals to develop and apply fertility controls are now also being championed (Barr et al., 2002; Yoder et al., 2011). Contraception is generally regarded as a favourable means of wildlife control (Bremner and Park, 2007; Fitzgerald, 2009) though to be effective a vaccine may need to be long lasting or applied to a large proportion of the population. For example, a study on fox squirrels concluded that for a vaccine to reduce the population it must last at least two years or be applied to 71% of females (Krause et al., 2014).

The potential for pine marten (*Martes martes*) to act as a natural form of biocontrol is also being explored, particularly in Ireland where populations of the native predator have increased and expanded following the introduction of protective legislation in 1976 (O'Mahony et al., 2006, 2012). Research has shown a negative correlation between high density pine marten populations and grey squirrels, though precisely why this occurs is not entirely clear (Sheehy and Lawton, 2014, 2015). Sheehy et al. (2014) recently recorded the first evidence of the European pine marten preying on the grey squirrel, and found that grey squirrels are more likely to be preyed upon than red squirrels where the three species' ranges overlap. In addition, a reduced feeding rate in grey squirrels in response to marten odour has been observed, suggesting that the mechanism for the negative correlation may not be exclusively attributable to predation, but also disturbance (Flaherty, 2016). Whether such findings can be replicated in Wales, Scotland and Italy is the subject of ongoing research (Sheehy and Lawton, 2015).

Owing to its successful spread not only to woodlands but other rural and urban landscapes, grey squirrels can establish themselves as some of the most commonly sighted wild mammals in their new host countries (Wright et al., 2014; Flaherty, 2016). Although accounts of damage to buildings are occasionally reported, grey squirrels are seldom regarded as a nuisance in urban areas. The wider public therefore may not share the same negative experiences with squirrels as those involved in woodland management or conservation, and many may be unaware of the need for squirrel control at all.

This study assesses how people value red and grey squirrels, and explores knowledge, opinions and beliefs about grey squirrel management. By assessing the UK public's attitudes towards squirrels and their management we seek to answer the following research questions.

- i) How familiar are the public with squirrels and how are the two species valued?
- ii) What are the most and least acceptable forms of control method, and why?
- iii) How do attitudes differ in respect of demographics, connectedness to nature, and knowledge of squirrels?

Additionally, we consider what these findings mean for wildlife managers who are likely to require public support and collaboration in order to conserve the native red squirrel populations.

2. Materials and methods

2.1. Survey design and sampling

To address the research aims, a survey composed of 30 questions was organised into five sections; demographics; interest in woodlands and forests; attitudes towards wildlife; management of squirrels; and trust and communication. Some of the questions (e.g. those pertaining

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