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Title

Public Perceptions of Deer Management in Scotland: The Impact of Place of Residence, Knowledge and Demographic Factors

Abstract

Deer have a prominent public and political profile in Scotland because of their iconic status, environmental and socio-economic impacts, and the long-running controversies surrounding their management. However, few studies have examined public perceptions of deer management. This article investigates whether rural and urban place of residence and other demographic factors are significant influences on public perceptions of deer management. A survey (n=184) in rural and urban locations in Scotland explored public perceptions of deer

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management in contrasting localities. Place of residence, demographic information and self-reported knowledge levels were analysed to examine their impact on perceptions.

Respondents generally agreed that deer management is necessary, with fencing and culling the first and second most preferred management options. Rural or urban place of residence had a limited influence on opinions of deer management, with engagement in land-based employment playing a more important role. Self-reported understanding of deer management was the most important factor in shaping opinions; those with greater knowledge were more likely to support deer culling. The findings suggest that improved public education concerning the need for deer management would be beneficial, increasing public understanding of management practices.

Keywords

Scotland, public perceptions, deer management, environmental studies

Word count

6963

Introduction

Wild deer, specifically red deer, are an iconic Scottish animal and are often perceived as symbolic of Scotland's natural heritage (Scottish Government, 2014; Warren, 2009).

However, as wild deer populations in Scotland have steadily expanded, associated environmental and social impacts have grown, as has been apparent in North America for many decades (Fulton et al., 2004; Kilpatrick & LaBonte, 2003; NatureScot, 2016). Wild deer in Scotland have '*res nullius*' status under Scots Law, meaning that they are a shared resource belonging to nobody until they are captured or killed, which can lead to conflict over their management (Pepper et al., 2019). Deer have long been the focus of contentious debates in Scotland, and proactive management is regarded as an 'unavoidable necessity' to keep populations to sustainable densities (Pepper et al., 2019; Warren, 2009, p. 331).

With the need for more deer management comes increasing apprehension about public reactions, as public perceptions can have a significant effect on the success of wildlife management (Bremner & Park, 2007; Urbanek et al., 2012; Van der Wal et al., 2014).

Understanding public perceptions of deer management can help to reduce conflict by allowing perceptions to inform management policies, thereby increasing their effectiveness (Bremner & Park, 2007; D. Green et al., 1997; Van der Wal et al., 2014).

Since the 19th century, deer populations have predominantly been kept high by sporting estates in Scotland, and this has led to conflicts with foresters and crofters who have suffered the consequences of high deer densities (Pepper et al., 2019; Warren, 2009). Deer are managed under the 'voluntary principle', with landowners having the final say on how many deer to cull (Pepper et al., 2019). Although there have been calls for statutory deer

management policies, these have been resisted by the deer management industry (Pepper et al., 2019; Warren, 2009). Deer management remains a contentious and politically divisive topic, highlighted by its inclusion in the Land Reform (Scotland) Act 2016, and by several recent high-profile reports (NatureScot, 2016; 2019; Pepper et al., 2019; Scottish Government, 2021).

Over the last 200 years, both the populations and range of deer have grown in Scotland, as they have in much of Europe (Valente et al., 2020). There are now approximately 360,000-400,000 red (*Cervus elaphus*), 200,000-350,000 roe (*Capreolus capreolus*), 25,000 sika (*Cervus nippon*) and 8,000 fallow deer (*Dama dama*) (Albon et al., 2017; Pepper et al., 2019). These expanding populations are encroaching into urban areas (Fiorini et al., 2011; Pepper et al., 2019;). Deer densities in many areas of the country are beyond carrying capacity and are resulting in sustained negative impacts on the environment, on human activities and on the deer themselves (Fiorini et al., 2011; Pepper et al., 2019). Deer can have a variety of positive environmental and social impacts, for example, through provision of revenue streams in rural areas, seed dispersal, and their aesthetic and cultural appeal (Dandy et al., 2009; Gill & Beardall, 2001; PACEC, 2016). However, their negative impacts, including damage to woodlands and crops, reduced biodiversity from overgrazing, disease transmission and deer-vehicle collisions, are exacerbated when deer populations are at high densities (Côté et al., 2004; Dolman et al., 2010; Gilbert et al., 2012; Gill & Beardall, 2001; Langbein, 2019). Consequently, deer management needs to be improved and increased in parts of Scotland where high deer densities and expanding deer range are causing adverse impacts (Pepper et al., 2019).

Deer fencing and culling are the most commonly utilised deer management methods in Scotland (Dandy et al., 2011; Pepper et al., 2019). Current management practices are variable and often inadequate, with cull targets regularly not being met and adverse impacts are continuing despite a stabilisation of red deer numbers over the last 10 years (Albon et al., 2019; Pepper et al., 2019). There is therefore a need for more proactive deer management interventions but there is a risk that these may be negatively perceived by the public. A variety of studies have examined public perceptions of deer management in North America, with the public largely supportive of deer management, especially if they were aware of deer impacts (Fulton et al., 2004; D. Green et al., 1997; Kilpatrick & LaBonte, 2003; Lauber et al., 2001; Lee & Miller, 2003; Siemer et al., 2004). However, there has been far less research on the subject in Scotland and in much of Europe, with only studies by Dandy et al. (2009, 2011, 2012) and Ballantyne (2012) focussing explicitly on public perceptions of deer management methods in Scotland. Other relevant studies in Scotland have either not focussed on public perceptions, or not focussed solely on deer (Philip & Macmillan, 2003; Van der Wal et al., 2014). There is therefore a clear need for improved understanding of public perceptions of deer management.

Culling is considered to be the most controversial deer management method (Dandy et al., 2012; Lauber et al., 2001; Lee & Miller, 2003; Urbanek et al., 2012). Dandy et al. (2009, 2011) found that over 90% of respondents believed that culling should not be a first management response. By contrast, Philip and MacMillan (2003) found that over two-thirds of Scottish respondents were supportive of deer culling. In North America, research has revealed contrasting attitudes - some studies report majority support for culling while others report major concerns about its use (D. Green et al., 1997; Lee & Miller, 2003; Urbanek et al., 2012). Higher levels of support have been found for alternative deer management methods, with Dandy et al. (2009, 2011) finding fencing to be the most preferred

management option in Scotland, and non-lethal methods are also popular in North America, even when less effective than culling (D. Green et al., 1997). Doing nothing is regarded as the least acceptable approach both in Scotland (Dandy et al., 2009, 2011) and the USA (Fulton et al., 2004).

Although perceptions of deer management have been studied previously within Scotland, variation of opinions within different parts of the population have not been identified. It is recognised that demographic features, social structures and place of residence can shape an individual's perceptions (Lauber et al., 2001; Enticott, 2015; Kellert & Berry, 1987). It is often stated that rural and urban populations have significantly different perceptions of deer management, with rural populations assumed to be more familiar with nature and supportive of culling (Dandy et al., 2011; McCance et al., 2017; Warren, 2009). This contrast has not been investigated within the UK, but in their USA study Urbanek et al. (2012) found that there was no difference between rural and urban populations. Similarly, while the influence of demographic variables on perceptions of deer management has received very little attention in the UK, their influence has been investigated in North America where studies have found that gender, age and education can affect perceptions of deer management (Kellert & Berry, 1987; Lauber et al., 2001). Additionally, Dandy et al. (2012) have suggested that employment in land-based sectors can affect perceptions. However, no studies have looked at what this effect might be. This paper addresses this knowledge gap by using a questionnaire study to explore the impact of such variables on public perceptions of deer management in Scotland.

Materials and Methods

1. Study Sites

The research was conducted in central Scotland in May 2019. Public perceptions of deer management were elicited in Stirling, Callander and Killin (Figure 1). All three of these locations were selected due to their relative proximity to each other, whilst illustrating a mix of area types and because of the presence of all four species of deer (British Deer Society, 2017). Stirling was selected as an urban area, while rural participants were recruited from Callander and Killin. Both Callander and Killin are situated in the Loch Lomond and the Trossachs National Park, in upland settings, with respective populations of 3,160 and 700 (Scotland's Census, 2011). Stirling, on the other hand, is a city within a central lowland context, with a population of 91,600 (Scotland's Census, 2011; Stirling Council, 2019). All study sites are situated within the Stirling Council areas, and their socio-demographic characteristics are summarised in Table 1. The differences in the socio-demographic make-up of the survey respondents to the general population of these areas are highlighted in the results section.

[Figure 1 near here]

[Table 1 near here]

2. Data Collection

A self-completion questionnaire was used in this research, as questionnaires have previously been deemed the most effective way of gathering public perceptions on deer management in Scotland (S. Green, 2013). Some questions were based on the survey by Dandy et al. (2011), enabling temporal change between the two studies to be evaluated.

The questionnaire comprised mainly closed response questions, having refined the questions through a pilot study (n=5). Closed questions included Likert-style 5-scale response options exploring perceptions of different types of deer management methods. Open response options invited comments about respondents' perceptions of deer culling, with space for any other comments also provided towards the end of the survey. Socio-demographic questions were presented at the end of the survey, including questions about employment in land-based sectors (such as land management, rural or ecological employment) and self-reported knowledge of deer and deer management.

Invitations to participate in the survey were distributed in two formats: i) as a letter with a link to an online version of the questionnaire; and ii) as a paper copy with a pre-paid postal return envelope. The two different administration modes were equally divided across the target sample, with one or the other put through every other door in Callander and Killin and in an area of Stirling selected to be demographically similar to the rural locations, using average house price as an indicator. This provided a stratified, systematic and purposive sample (McGuirk & O'Neill, 2016), whilst also reducing overall costs and thereby maximising sample size. 350 questionnaires were distributed in Stirling and 350 were divided equally between Callander and Killin. 150 postal questionnaires and 200 online questionnaire links were distributed in the rural and urban locations.

3. Data Analysis

A mixed-methods approach was adopted in this study, utilising a dominant - less dominant design (quantitative data supported by qualitative material). This facilitated both breadth and depth of respondents' perceptions to be elicited, helping to limit the weaknesses and draw on

the strengths of both methods (Bryman, 2016; Creswell & Clark, 2018). The analysis and results reported below draw primarily upon quantitative data.

Quantitative data were analysed in SPSS Statistics (version 26) and were cleaned of incomplete or incorrectly answered responses and coded to aid ease of analysis. Descriptive techniques were first used to help understand public perceptions of deer management. Bivariate analysis was conducted, contingency tables were created and Chi-square tests or Fisher's Exact testing (with Monte Carlo simulations) were undertaken. These tests were used to determine whether there was a statistical association between rural and urban place of residence, or socio-demographic attributes (age, gender, highest educational attainment level, land-based employment, self-reported knowledge), and the variables measuring perceptions of deer management. Chi-square tests were carried out when under 20% of expected cases had fewer than 5 responses. Fisher's Exact testing was utilised when over 20% of expected cases had fewer than 5 responses. Where significant associations were found, descriptive techniques were used to analyse how the variables were associated. Text provided in open response options was coded and thematically analysed (Bryman, 2016). Themes emerging from these qualitative data were summarised and compared to quantitative responses, with themes graphed and individual quotes selected to add explanatory depth and triangulate the quantitative data.

Results

1. Respondent Characteristics

In total, 184 completed questionnaires were returned. The demographic characteristics of respondents and comparable 2011 census data can be found in Table 1. The response rates for

each location and method are shown in Table 2. The gender of respondents was closely aligned with that of the study communities (as reported in the 2011 census), but age and educational attainment profiles were not: there were more older respondents and fewer respondents with lower educational attainment levels than might have been expected (Scotland's Census, 2011). This was taken into consideration during analysis. There was no statistically significant difference between the responses generated from the two administration methods (online and postal).

[Table 2 near here]

2. Perceptions of Management Methods

In total, 62% of respondents agreed (47% agreed; 15% strongly agreed) with the use of culling to reduce deer populations and impacts. Only 10% of respondents disagreed (6% disagree; 4% strongly disagree) with culling. The most common reason cited for supporting culling was that it is simply necessary (n=32), with the second most common being that populations need to be kept to sustainable levels, often related to deer welfare (n=30). This is illustrated in the following open text responses: 'it is acceptable when necessary to protect the health of a herd', and 'deer herds should be kept to sustainable levels and culling of older and infirm deer is acceptable'. The three other reasons for supporting culling were (i) that it is necessary because of deer damage (n=12) ('it saddens me to hear people saying deer should not be managed; the environmental impact of not managing them would rapidly become

apparent, to the detriment of all'), (ii) because there are no natural predators of deer in Scotland (n=10) and (iii) in order to provide venison (i.e. meat for human consumption) (n=6). Reasons for opposing deer culling included the belief that it is not necessary (n=14) and should only be used as a last resort (n=12), that it is not humane (n=10) and that deer should not be killed for sport or recreation (n=5). Of the various deer management methods respondents were invited to rank, culling was the second most popular method, with 46% of respondents selecting it as either their first (24%) or second preference (22%) (Figure 2).

When respondents were asked whether deer stalking for sport should be allowed, support was much lower than for culling used for population management. 53% of respondents disagreed (22% disagreed; 31% strongly disagreed) with sport stalking while only 33% of respondents supported it (25% agreed; 8% strongly agreed). Although respondents were not asked to provide explanations for their attitudes towards sport stalking, many did comment. One respondent highlighted the benefits of sporting estates – ‘an excellent control of populations, bringing money to Scotland’ - whereas another was critical, suggesting that estates– ‘are partly responsible for excessive deer numbers and habitat damage’.

Fencing as a management method was perceived largely positively, with 67% of respondents agreeing (52% agreed; 15% strongly agreed) with its use, and only 11% of respondents opposing it. Fencing was most people’s top preference (67%) (Figure 2). Doing nothing was not a popular management preference, with 64% of the public selecting this as their least preferred option.

[Figure 2 near here]

3. Impact of Demographic Factors

The only significant association ($p=0.023$) between rural or urban place of residence and perceptions of deer management methods was whether deer fences should be used. The biggest differences between rural and urban perceptions were that those resident within rural locations were more likely to strongly agree (22%) with the use of deer fences than those from urban areas (9%), and those from urban areas were more likely to agree (60%) with their use than those from rural areas (42%) (Figure 3).

[Figure 3 near here]

Gender had significant associations with all questions regarding culling. A very significant association ($p=0.003$) was found between gender and whether culling should be used to reduce deer populations and associated impacts. Male respondents were found to be more likely to agree (54% agreed; 20% strongly agreed) with the use of culling than female respondents (40% agreed, 9% strongly agreed). An extremely significant association ($p=0.000$) was found between gender and whether stalking should be allowed for sporting activities, with male respondents more likely to agree (37% agreed; 12% strongly agreed) with stalking than female respondents (12% agreed; 3% strongly agreed). Female respondents were much more likely to strongly disagree (46%) with stalking than male respondents (18%). Gender also affected the ranking of culling as a deer management preference, with a significant association ($p=0.011$) evident. Male respondents (32%) were more likely to select culling as their first preference compared to female respondents (15%), with female respondents (31%) more likely to select culling as their fifth preference than male respondents (12%).

A very significant association ($p=0.003$) was evident between age and the ranking of introducing predator species as a deer management method. Older respondents were less likely to favour reintroducing carnivores than younger respondents, with those aged 76+ most likely to select predators as their fifth preference (77%, compared to 22% in 18-35 age category).

A significant association ($p=0.027$) was found between land-based employment and agreement with sport stalking. Those who had been employed in land-based sectors were more likely to agree or strongly agree (59%) that stalking for sport should be allowed than those who had not been employed in land-based sectors (29%). A significant association ($p=0.025$) was also found with the rating of culling as a preference for deer management, with those who had been employed in a land-based sector far more likely (53%) to select culling as a first management response than those who had no employment history in the sector (20%). Some qualitative comments made by those who had been employed in land-based sectors highlighted an awareness of the need for deer management due to the environmental impacts deer cause. For example, '[culling] needs to be done, as either deer will starve, destroy woodland areas or tree crop forestry' and '[culling is] a necessary management tool under current circumstances to protect vulnerable habitats and allow their regeneration'.

No significant associations were found between highest educational attainment level and deer management preferences. However, the most significant associations were found between respondents' self-reported knowledge of deer and their opinions of different deer management methods. An extremely significant association ($p=0.001$) was found between self-reported knowledge and support for culling as a means of reducing deer populations and impacts. Those who believed they were knowledgeable about deer were far more likely to

agree or strongly agree with culling (83%) than those who believed they were not knowledgeable (52%). A very significant association ($p=0.010$) was found between knowledge and perceptions of sport stalking, with those who believed they were knowledgeable about deer far more likely to agree or strongly agree that stalking should be allowed to take place (65%) than those who believed they were not knowledgeable (22%).

A significant association was found between self-reported knowledge and the selection of culling ($p=0.030$) as a preference for deer management and an extremely significant association was found between self-reported knowledge and the selection of deer 'scarers' ($p=0.001$). Those who believed they were knowledgeable about deer were more likely to select culling as their first management preference (47%) compared to those who believed they did not know very much (17%). They were also less likely to select culling as their fifth management preference (5%) than those who believed they were not knowledgeable (22%). Regarding deer 'scarers', those who believed they did not know very much about deer were more likely (15%) to select these as a first management response than those who believed they were knowledgeable (6%). Those who believed they were knowledgeable were more likely to select deer 'scarers' as their fifth management preference (44%) than those who did not believe they knew very much (8%).

Discussion

Given the high public profile of deer, and the intense controversies surrounding their management, it is surprising that public perceptions of deer management have been studied so little in Scotland, and that they have been largely overlooked in the recent deer management reports. This is especially surprising given the plethora of North American studies (Fulton et al., 2004; D. Green et al., 1997; Kilpatrick & LaBonte, 2003; Lauber et al.,

2001; Lee & Miller, 2003; Siemer et al., 2004), and the politically contentious nature of deer management in Scotland (Pepper, et al., 2019; Warren, 2009). This study is the first in Scotland to investigate how public perceptions of deer management are affected by place of residence, self-reported knowledge and other demographic factors.

Support for culling (62%) was much higher than found by Dandy et al. (2011) who report just one third of respondents supporting culling. The results were, however, similar to those found by Philip and MacMillan (2003), and to studies in the USA which highlighted greater support for lethal methods (Fulton et al., 2004; D. Green et al., 1997; Urbanek et al., 2012). The finding that culling was ranked as a high preference for managing deer also contrasts with Dandy et al. (2009, 2011) in which over 90% of respondents did not rank culling as a first management response. Results were more similar to Urbanek et al.'s (2012) study in the USA, where culling was a favoured management response. While these results may indicate that there has been an increase in support for culling over the last decade, it could also reflect Dandy et al.'s (2009, 2011) focus on different areas of Scotland. The participants in this study resided closer to the uplands than those in the earlier study. Given that the uplands have long been the focus of concern regarding deer populations and impacts, there is perhaps greater awareness of the need for deer management (Pepper et al., 2019).

Keeping deer populations at sustainable densities and reducing damage caused by deer were two of the main reasons respondents supported culling, which highlights a good understanding of the need for deer management. This was also reflected in Dandy et al. (2011). An understanding of these benefits of culling have been shown to increase support for it in the USA (Fulton et al., 2004; Kilpatrick & LaBonte, 2003). Those who do not support culling deemed it unnecessary, a finding also reported by Dandy et al. (2009, 2011).

Although many people may oppose culling, this belief that culling is unnecessary may reflect a lack of knowledge about the ‘deer problem’ in Scotland, given that the government, NatureScot² and other groups such as the Deer Working Group, have all concluded that increased management effort is necessary (NatureScot, 2019; Pepper et al., 2019; Scottish Government, 2021). This link between knowledge and perceptions of deer management is further examined below.

Levels of disagreement with sport stalking were similar to those reported by Philip and MacMillan (2003). Although no other studies have examined perceptions of deer sport stalking in the UK, hunting for leisure has proved controversial with the public in recent years (Dahlgreen, 2015; House of Commons, 2004; Ipsos MORI, 2016; The Guardian, 2020). Although deer hunting has not received much media attention, it is a contentious subject (Warren, 2009). The conflicting opinions about the effects of sporting estates on deer management are reflected in academic publications and government reports (MacMillan et al., 2010; NatureScot, 2012; PACEC, 2016; Pepper et al., 2019), emphasising the need to understand public perceptions of stalking and sporting estates.

Fencing was the most popular management method for respondents in this study, with levels of support similar to those reported by Dandy et al. (2009, 2011). This is likely due to the perception of fencing as a familiar and non-lethal method (Dandy et al., 2009, 2011). In contrast, doing nothing to manage deer was the least preferred management response. This also concurs with the findings of Dandy et al. (2009, 2011), and is reflected in studies in the USA where doing nothing to manage deer populations is often deemed unacceptable (Dougherty et al., 2001; Fulton et al., 2004). This may be because the public feel that there is

² Known as Scottish Natural Heritage before they rebranded in 2020. They shall be referred to as NatureScot throughout this paper to avoid confusion.

a moral and ethical need for something to be done if the environment, society or deer themselves are suffering (Fulton et al., 2004; Harrison et al., 1996).

This study indicates that rural or urban place of residence has little effect on perceptions of deer management. This finding contrasts with the assumptions of Dandy et al. (2011, 2012) and Warren (2009) and also with studies in North America (Dougherty et al., 2001; Fulton et al., 2004; McCance et al., 2017). Results were, however, similar to those found by Urbanek et al. (2012) and to studies focusing on other human-wildlife conflicts (Bremner & Park, 2007; Enticott, 2015). This lack of difference in rural-urban perceptions could be due to changes in social movement and communication. Increased mixing of rural or urban populations may be resulting in a convergence of opinions (Enticott, 2015). Simultaneously, rural living has itself become increasingly differentiated, with contrasting lifestyles and viewpoints apparent within such areas (Enticott, 2015; Heberlein et al., 2005; Marsden et al., 1993). Additionally, increased communication of opinions on environmental matters, not only due to increased mixing but also due to the growth of media and the internet, may reduce the effect of geographical location on perceptions (Archibugi & Lundvall, 2001).

Alternatively, this lack of rural-urban divide in perceptions of deer and deer management could be explained by an insufficient rural-urban contrast between the questionnaire locations, the fact that all locations surveyed are near areas traditionally associated with deer impacts, or the small sample size. Running a larger-scale survey across multiple urban, accessible rural and remote rural regions of Scotland would allow for this research question to be explored in greater depth. But if rural-urban place of residence does indeed have a limited influence on perceptions of deer management, it would suggest that debates that have traditionally been thought to be shaped by a rural-urban divide, such as sport shooting and species management, may now be influenced by a wider set of factors. This would be an

important change in the understanding of how perceptions are shaped, with implications for land management policymaking.

The demographic factors of gender and age had some effect on public perceptions of deer management. Females were found to be less supportive of culling and stalking than men. This pattern has been quite consistent in the deer management literature, with females often less supportive of lethal management, which is thought to be partly due to females having a stronger emotional attachment to animals (Kellert & Berry, 1987; Lauber et al., 2001; Siemer et al., 2004). Gender was the most influential demographic factor shaping perceptions of deer management. However, self-reported knowledge had more significant associations than gender, contrasting with Kellert and Berry's (1987) research that gender is the most important factor in shaping perceptions of wildlife.

Agreement that deer caused damage increased with age, concurring with Dandy et al. (2011) who highlighted that older people were more likely to have experienced deer impacts, and be more engaged with nature, which reflected their concerns. Older people were also less supportive of the reintroduction of predators as a management method, which may highlight increased risk aversion which has been previously found amongst older populations (Vroom & Pahl, 1971). Interestingly, educational attainment level did not influence perceptions of deer management, but this may be partly due to the very small sample of participants whose highest educational attainment level was below Higher/ A Level or equivalent high school qualification standard. Knowledge about deer management and experience in land-based employment were more influential factors in shaping perceptions.

Those who had been employed in land-based sectors were more supportive of culling and stalking than those who had not, with some leaving qualitative comments connecting the need to cull with deer impacts. This relationship with land-based employment may be a

reflection of increased familiarity with the Scottish countryside, ‘country sports’, and increased knowledge of natural processes and deer impacts (Dandy et al., 2011; Lauber & Knuth, 2000; Siemer et al., 2004; Stewart, 2011). The expected divide between rural and urban respondents was not apparent. It appears that perceptions are not simply affected by place of residence, but are more complex, and affected by active involvement and knowledge of nature.

Self-reported understanding of deer management was the most influential factor shaping perceptions. Those with higher self-reported knowledge levels were more supportive of deer management methods, especially culling to reduce deer impacts and as a first management preference. They were also more supportive of stalking for sport. This is a pattern that has been apparent in the USA, and in research on the management of other wildlife species, with lethal management more accepted by those who know more about the subject and are aware of the impacts of deer (Bremner & Park, 2007; Connelly et al., 1987; Fulton et al., 2004; D. Green et al., 1997; Kilpatrick & LaBonte, 2003; Siemer et al., 2004). Those with higher self-reported knowledge about deer and deer management were less supportive of the use of deer ‘scarers’, which may be due to a lack of knowledge surrounding these as they are rarely used in Scotland, with respondents preferring well-known methods (Putman et al., 2004).

It is evident that there is a relationship between knowledge of deer management, experience of land-based employment and perceptions of deer management. Those who know more about deer or who have more experiences in natural settings through land-based employment are more supportive of their management, especially culling. This is most likely due to such people being more aware of the need to mitigate deer impacts, an awareness demonstrated in some of the qualitative comments. It follows that increased education about deer and their impacts may lead to more understanding of the need for deer management, especially lethal

management, amongst the general public. This has been shown within North America, where education programmes have increased knowledge of deer impacts and support for management projects (Connelly et al., 1987; Lauber & Knuth, 2000; Stewart, 2011). It is recognised that not everybody will approve of management, however, due to moral beliefs (Fulton et al., 2004).

By increasing education of the public in locations where deer management is necessary, whether through encouraging the public to directly see deer impacts or experience deer management, or by highlighting the impacts to them through schooling or media, the public's knowledge and understanding should increase (Bremner & Park, 2007; Siemer et al., 2004). Public educational initiatives have been encouraged by the Lowland Deer Panel, for example by promoting pre-existing small initiatives such as the 'Deer on Your Doorstep' campaign (Lowland Deer Panel, 2019). According to the relationship found in this study between knowledge and acceptance, this may result in more widespread acceptance of deer management, including culling, which could reduce potential backlash against deer management methods (Bremner & Park, 2007; Lauber & Knuth, 2000). By incorporating public perceptions when creating deer management policies, more publicly acceptable policies can be generated. Although NatureScot recognised the importance and lack of knowledge of public perceptions in their 2016 report, little has been done to understand or address this by the agency, and it was not mentioned in their 2019 follow-up report (NatureScot, 2016; 2019). The importance of public perceptions and education are also areas overlooked in the otherwise comprehensive Deer Working Group Report and Scottish Government response (Pepper et al., 2019; Scottish Government, 2021).

This paper has explored the influence of place of residence, knowledge and demographic factors on public perceptions of deer management in central Scotland. Fencing was the

management method with the greatest support and culling the second most popular. Stalking for sport was opposed by more than half of respondents, and there were conflicting opinions about the role of sporting estates in deer management. In this study, rural-urban place of residence had a very limited effect on public perceptions of deer management, with gender, experience in land-based sectors and knowledge about deer all playing a more significant role in shaping perceptions. Overall, knowledge levels were the most significant influence on perceptions of deer management; those with higher self-reported knowledge were more supportive of deer management, especially lethal methods. If deer management methods are to be more widely supported, public understanding of deer management needs to be increased, and this may, in turn, help increase the success of deer management measures. Educational outreach initiatives, inclusion in the national curriculum or signposting where deer are present, could help increase understanding of the need for deer (and other wildlife) management where deer impacts are problematic.

This novel study has provided an enhanced understanding of public perceptions of deer management in Scotland, and how these are affected by place of residence, knowledge and demographic factors. It has the potential to contribute to more informed and effective deer management policies, thereby helping to reduce potential conflicts, and highlights the need for public perceptions of deer management to be incorporated within policy-making. Despite the importance of public perceptions being largely ignored by the recent reports on deer management in Scotland, further studies in this area could provide greater understanding of potential areas of contestation, leading to more proactive and effective land management decision-making.

Acknowledgments:

We are very grateful to our survey respondents in Stirling, Callander and Killin, and also to the two anonymous reviewers whose comments improved the clarity of this paper.

Declaration of interest statement

No interests to declare.

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Tables with captions

Table 1: Socio-demographic attributes of respondents and comparable 2011 Census data for

Stirling Council Area.

Socio-demographic attributes of participants	Stirling (urban) (%)	Callander / Killin (rural) (%)	Socio-demographic attributes (comparable groupings on 2011 census)	2011 Census-Stirling Council Area (%)
Age	18-35	4	18-29	21
	36-45	9	30-44	23
	46-55	19	45-59	26
	56-65	31	60-64	8
	66-75	26	65-74	12
	76+	11	75+	10
Gender	Male	52	Male	48
	Female	48	Female	52
Highest educational attainment level	None	3	No qualification	22
	Standard Grades/ GCSEs or equivalent	2	Level 1: Standard Grades or equivalent	20
	Highers/ A Levels or equivalent	13	Level 2 or 3: Higher Grades/ HNC or equivalent	25
	Undergraduate degree	32	Level 4: Degree or above	33
	Postgraduate degree	50		
Experience of land-based employment	Yes	9	N/A	N/A
	No	91	N/A	N/A

Table 2: Response rates in Stirling, Callander and Killin for the different survey methods.

	Stirling	Callander and Killin
Total surveys distributed	350	350
Total surveys returned	108	76
Total response rate	31%	22%
Postal surveys distributed	150	150
Postal surveys returned	71	53
Postal response rate	47%	35%
Online surveys distributed	200	200
Online surveys returned	37	23
Online response rate	19%	12%

Figures:
Figure 1:

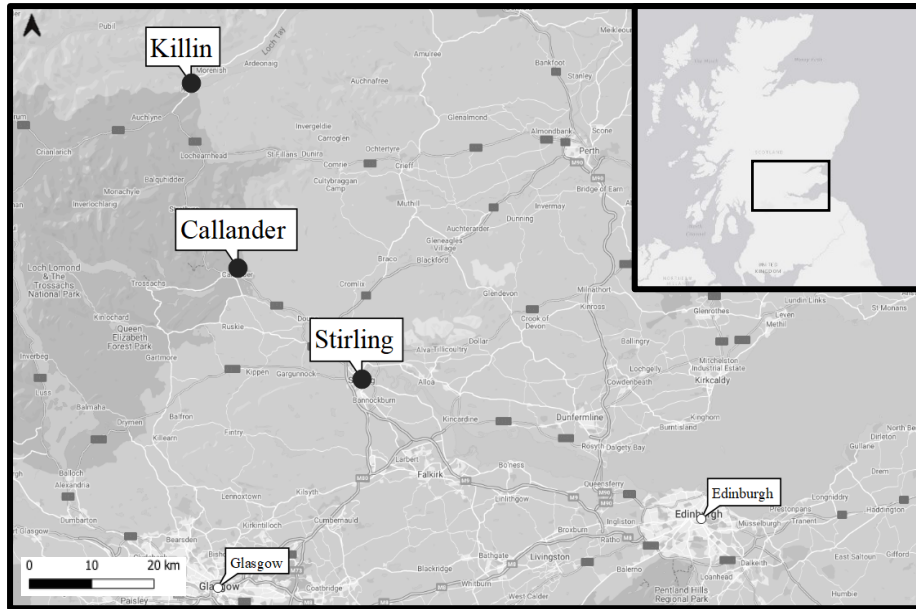


Figure 2:

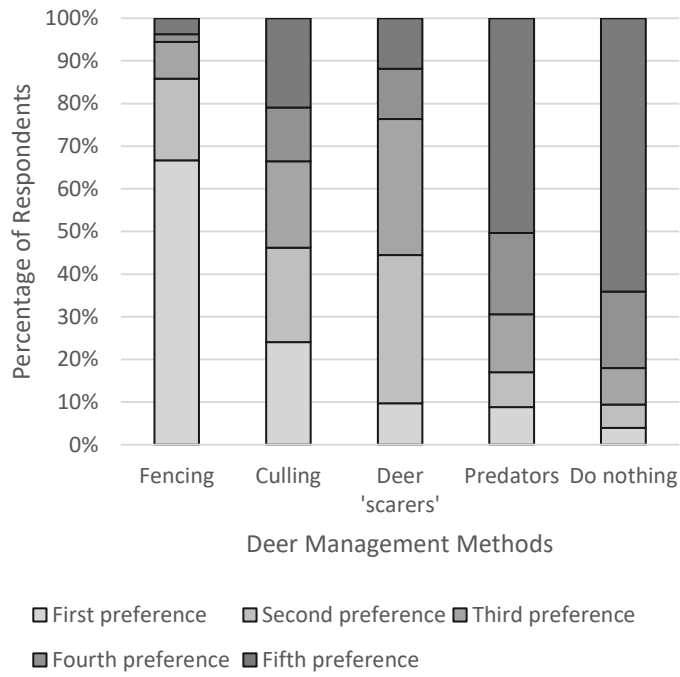


Figure 3:

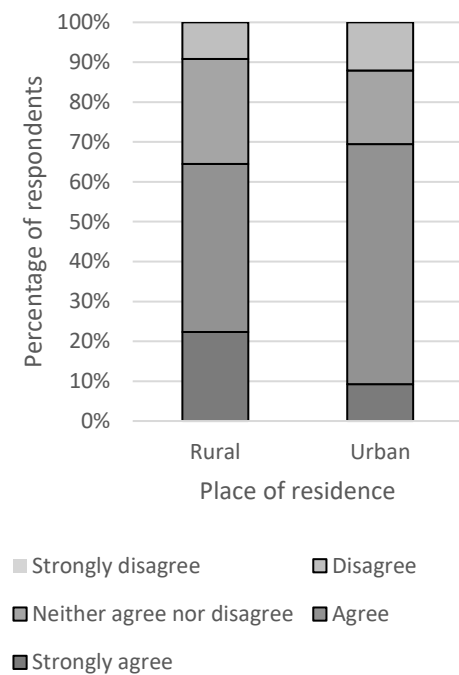


Figure captions:

Figure 1:

Figure 1: Study area. The darker shaded area of the main map is the Loch Lomond and the Trossachs National Park, where both Killin and Callander are situated.

Figure 2:

Figure 2: Deer management preferences of respondents.

Figure 3:

Figure 3: The views of rural and urban respondents (n= 184) about whether deer fences should be used.