Forest Research

The management of roe deer in peri-urban Scotland

Final Report

Norman Dandy,
Stephanie Ballantyne,
Darren Moseley,
Robin Gill
&
Chris Quine

The Research Agency of the
Forestry Commission

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Executive Summary

Introduction and methods

1. This report is an output from the research project entitled 'The Management of Roe Deer in Peri-urban Scotland' (Ref: CR/2007/30) funded by the Scottish Government, administered by the Deer Commission for Scotland and conducted by Forest Research. The project ran from the end of November 2007 until the end of May 2009. Throughout the project the Forest Research project team worked to a Steering Group of individual representatives from stakeholding organisations

2. Peri-urban areas are transitional and consist of those areas around settlements characterised by a mosaic of mixed land-uses, often including housing, transport infrastructure, industry, agriculture, forestry and 'natural' areas. Peri-urban areas often straddle administrative boundaries between rural and urban authorities, along with cultural 'boundaries' between rural and urban lifestyles. These areas are thus sites of very significant interactions between people, and between people and their environment.

3. Wild deer are increasingly being encountered within peri-urban areas and this is widely perceived to present a complex management issue. New issues are arising, and new stakeholders are becoming involved. The Deer Commission for Scotland has been charged with developing a 'responsibility of care' for all deer managers, including those in the peri-urban environment. This research informs that process.

4. The research focused on the peri-urban area defined by the boundary of the Central Scotland Forestry Trust. It drew upon evidence from a wide range of sources including existing data-sets, and new primary research; the latter involved ten focus-groups; wide distribution of questionnaires; deer census in two study sites using thermal imaging; and discussions with stakeholder organisation representatives.

5. The project team focused upon the 'management of people-deer interactions', rather than 'deer management', as this facilitates the recognition of complexity and presents opportunities to both innovate management solutions and share responsibility for management across stakeholders.

Results and discussion

6. Scoping of the broad people-deer interactions [Section 2.1] identified six possible positive interactions (values) and nine possible negative interactions (impacts). The importance and meaning of these interactions were explored within focus groups of community and land manager participants [Section 2.2], as was the

need for, and appropriateness of, different management methods to increase value capture or mitigate impacts.

7. Of the six values, those associated with seeing and sharing the local environment with deer are clearly most the important for, and relevant to, peri-urban communities. The cultural and food resource values of wild deer are also of some, although less, importance. Other values, such as economic and environmental values, are not currently considered relevant to peri-urban communities, nor is there currently sufficient evidence available to indicate relevance. Whilst wild deer are valued highly, only limited value is captured by peri-urban communities.

8. Of the nine impacts, the exposure of deer to deliberate acts of cruelty is of greatest importance for, and relevance to, peri-urban communities. The involvement of deer in road-traffic accidents is considered highly important although of limited relevance to peri-urban communities (in that communities did not link it to, or experience it directly in, their own community). All other potential impacts of wild deer are considered either of low importance and/or low relevance to peri-urban communities. Overall, peri-urban communities experience only very limited impacts from wild deer. A consequence of this perceived absence of impacts (and lack of deer numbers) is that there is substantial scepticism regarding the need for management activities to be conducted in the areas local to these communities

9. Despite the scepticism over local need for management, there was support, in principle, for it being necessary and that a number of methods were appropriate [Section 2.2.3]. Fencing is consistently and clearly the most preferred direct management response to impacts relating to wild deer in peri-urban areas. The use of 'scarers' to affect deer behaviour and avoid impacts is also strongly favoured. Culling is clearly and consistently considered a 'last resort' to be used when and where other options have failed. In these circumstances, however, culling has some significant support so long as it is conducted selectively, humanely and professionally.

10. Problems associated with deer are commonly ascribed anthropogenic 'causes', such as urbanisation, the removal of predators and poor driving. As a consequence of this preferred management responses often include changes to human behaviour (such as, for example, the introduction of speed limits) prior to management of the deer population itself.

11. Spatial and statistical analysis [2.3] considered the distribution of road-traffic accidents (RTAs), and of deer populations, but was limited by the patchy data available. There was the suggestion of a trend to increasing RTAs over the period 2004-2008 in data from SSPCA, and when combined with data extracted for the study area from national survey, there was a clear seasonal peak in RTAs in May (consistent with known ecology of roe deer). Location of RTAs was clustered and preliminary analysis indicates correlations between both the probability and number of road-traffic accidents involving deer and high traffic volumes and less

open ground adjacent to roads. Nevertheless the absolute incidence of RTAs relative to traffic flow was very low – consistent with the lack of direct community experience.

12. Deer census surveys, using thermal imaging techniques [2.4.4], observed relatively low numbers and densities of deer (0.8 – 3.3 deer km-2) in the two case study areas (near Linlithgow and Ravenscraig). This is consistent with participant comments, but not with expert opinion over presence of deer in the area – and requires further work to ascertain the complexities of spatial and temporal distribution.

Decision Support Framework

13. A key finding of this research is the clear need to establish appropriate reasons for deer management, and that these reasons must have a very strong evidence base familiar to local communities and managers. This requires a new approach to management.

14. This report (Section 3) presents a Decision Support Framework for the management of deer in the peri-urban environment. This Framework links people-deer interactions to management responses to stakeholder roles and responsibilities. Its objective is to facilitate the development of customised ('bespoke') management partnerships responsive to local conditions and requirements, balancing positive and negative interactions, by any interested stakeholder. The framework identifies five phases, with detailed supporting classification for each, which are scoping, solutions, involvement, implementation and monitoring. Iterative use of the framework would allow partnerships to review situations where changes were driven by external factors (e.g. land use change in vicinity), or by management implemented by the partnership.

Conclusions

15. This report provides evidence illustrating the breadth, complexity and distribution of interactions between people and deer in the peri-urban environment of Scotland, along with a new Decision Support Framework within which to address their management.

16. A number of opportunities are identified for management and research in the context of people-deer interactions in central Scotland [Section 4]. A key recommendation is that the Decision Support Framework be tested further in case study areas – to allow for further refinement, and clearer view of which stakeholders might be seen as responsible for initiating use of the framework in particular contexts.

1. Introduction

This report is an output from the research project entitled 'The Management of Roe Deer in Peri-urban Scotland' (Ref: CR/2007/30) funded by the Scottish Government and administered by the Deer Commission for Scotland. The project ran from the end of November 2007 until the end of May 2009. Throughout the project the Forest Research Project team worked to a Steering Group of individual representatives from stakeholding organisations (see Appendix C).

The report is presented in four sections, with additional appendices. Section 1 introduces the research, its background context, approach, location and objectives. The bulk of the report is found in Section 2 which presents the results of the research and the methods used to generate these. This Section is itself sub-divided into four sub-sections. The first of these presents, briefly, the results of the initial phase of the project during which desk-based analysis of secondary data, along with widespread consultation, scoped the complexity and breadth of individual deer-people interactions in the peri-urban environment. The subsequent three sub-sections report, respectively, the methods and results of the social research, spatial analysis, and thermal imaging based ecological analysis conducted to scale and map these interactions. Section 3 brings together the broad analysis via a Discussion and subsequent 'decision support framework' which offers a new and innovative approach to deer management for the peri-urban environment. Section 4 offers Conclusions and Recommendations relating to the management of people-deer interactions in peri-urban Scotland.

1.1 Background – Wild deer in the peri-urban environment

There is a strong perception amongst those individuals and organisations involved in deer management that wild deer, especially roe, are increasingly present and encountered more frequently in the peri-urban environment of Scotland, and that this raises specific issues and management problems.

Deer have long impacted upon interests in rural areas (e.g. forestry and agriculture) and legislation and institutions have developed to manage these. Some of these longstanding impacts are likely to be transferred into peri-urban Scotland through, for example, recent initiatives to plant and establish woodlands in and near urban areas. However it seems clear that the expansion of peri-urban areas, and potentially the increased penetration of wild deer into established urban areas, has the potential to increase the volume and range of impacts of wild deer including involvement in road-

traffic accidents (RTAs[1]), garden and horticultural damage and the potential transmission of tick-borne diseases (e.g. Lyme disease). Also, as deer encounter increasing numbers of people they may be progressively more exposed to risks from anti-social behaviour/acts of cruelty – a significant welfare concern. Further to this established legislation, institutions and management methods are not necessarily appropriate in peri-urban areas, nor have the legitimacy held in rural areas. In short, as wild deer are encountered in peri-urban areas both new issues are arising and old issues are still occurring but with new stakeholders, some of whom are not used to deer nor familiar with management options. This creates a complex management setting.

The presence of wild deer in and around Scotland's urban areas, and the issues this raises, are significant concerns for the Scottish Government and its agencies[2]. As a result of its 'Consultation on the Close Seasons' in 2005, the Deer Commission for Scotland was charged with developing a 'Responsibility of care for deer managers', aimed at achieving consensus from stakeholders on the principle of 'who is responsible for what' in relation to deer welfare. It is considered that in peri-urban areas incidences of dog or airgun attacks and RTAs involving deer may effectively be taking the place of established control methods more appropriate to the maintenance of high deer welfare standards. Consequently 'doing nothing' in these areas *may* constitute a welfare or responsibility 'issue' under the Deer (Scotland) Act 1996. Further concerns noted in this sector are the potential impact of wild deer upon natural heritage/biodiversity interests, private gardens and other publicly important sites (such as graveyards, parks and golf-courses) in urban and peri-urban areas.

What is often overlooked in this debate is, however, the increased opportunity for positive interaction between people and deer presented by the expansion of peri-urban areas, and the capacity of this to offset some negative impacts. People often enjoy seeing deer around their homes and community and, as highly mobile animals, deer may provide as yet unrecognised ecological services through making connections, for example through seed dispersal, between patches of habitat in a fragmented landscape (particularly useful in a peri-urban mosaic).

Against this background, this research project seeks to clarify the range and scale of interactions between people and roe deer in peri-urban areas, and to provide guidance on the necessary procedures and partnerships needed to manage these interactions. The shift, within this research, from using the term 'deer management' to 'the

[1] In this report we prefer to use the phrase 'involvement of deer in road-traffic accidents' instead of the term 'deer-vehicle collisions' (DVCs). The project team considers that the latter term is not adequate to describe the phenomenon as accidents can often occur due to drivers' attempts to avoid deer on the road, thus there is not necessarily contact between vehicle and deer. However, where we refer to data obtained from the National Deer Vehicle Collisions Project, we do use the term.

[2] see *Scotland's Wild Deer: A National Approach* (2008) www.dcs.gov.uk/information/Publications/Wild%20Deer%20Strategy%20Final%20Proof.pdf and associated *Action Plan 2009-2011* (2009) at www.dcs.gov.uk/information/Publications/wDNA%20Action%20Plan%202009-11%20FINAL.pdf

management of deer-people interactions' is (a) a deliberate acknowledgement of the complexity involved, (b) to encompass the opportunity for positive interaction, and (c) a response to the need to consider management options beyond directly affecting wild deer behaviour and numbers.

1.2 Research Approach

Key to this project is the recognition of complexity - primarily that issues arising from the interaction between deer and people in peri-urban Scotland are not caused *only* by the increasing presence of deer, and that consequently additional management strategies should move beyond simply reducing their presence. There is a tendency within the deer management debate to focus exclusively upon the number, distribution and density of deer in the landscape as the 'cause' of increasing interaction between people and deer. This project argues that the interaction between people-deer is in fact a far more complex situation and that it is critical to understand the range of 'drivers' and the pressures they create in order to manage the situation effectively.

Recognising and addressing the complexity of people's interaction with deer can in fact be of significant benefit within the management process. This is because recognising the issue as multi-dimensional raises the potential for multiple management options, and thus affords significant opportunity for innovation. Furthermore, the recognition of the multiple causes, or 'drivers', of an issue spreads responsibility to act across the range of actors who can affect those multiple 'drivers'. The research has used a DPSIR framework, similar to that developed and used by institutions such as the European Environment Agency (EEA 1999) and the World Health Organisation[3] (illustrated in outline in Figure 1). More recently the methodology has been considered by elements of the Scottish Government (Scottish Executive 2007). By focusing at the system level, this

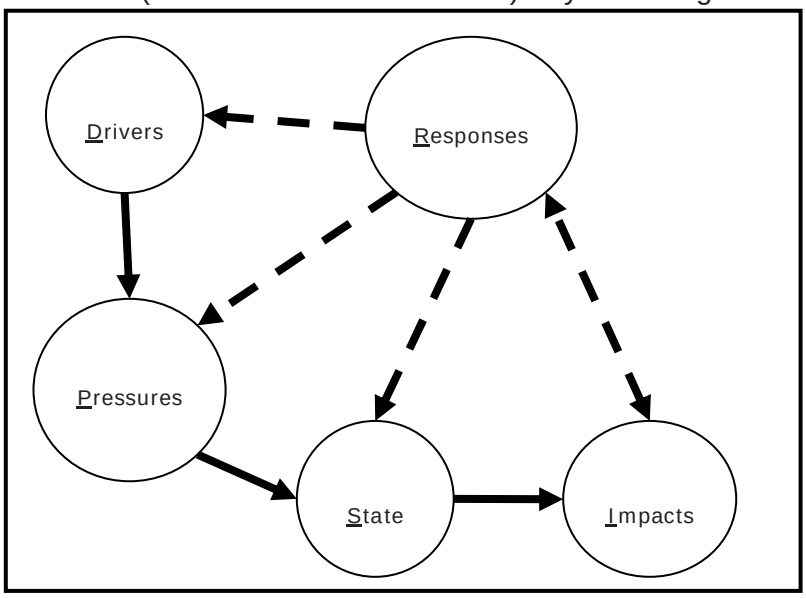


Figure 1 - The DPSIR Framework in outline

approach allows researchers to identify the breadth and complexity of relationships between initial Drivers, the Pressures they create, the resultant State of the environment, the Impact of this and the range of Responses available. It also facilitates understanding of the cyclical nature of many environmental issues, and that responses can be made at various stages of this cycle. Appendix G contains a populated DPSIR diagram pertaining to wild deer in the peri-urban environment produced at the scoping stage of this project. As typical of the peri-urban environment in Scotland in its mosaic of built and 'natural' landcover, the boundary for this research project is the area of the Central Scotland Forest. The project has sought to identify, and assess the scale of, interactions between people and wild deer through research at two levels. Secondary data for the whole area have been gathered and collated, along with substantial primary social and ecological research within smaller 'case-study' areas (see Figure 2) to fill key knowledge gaps.

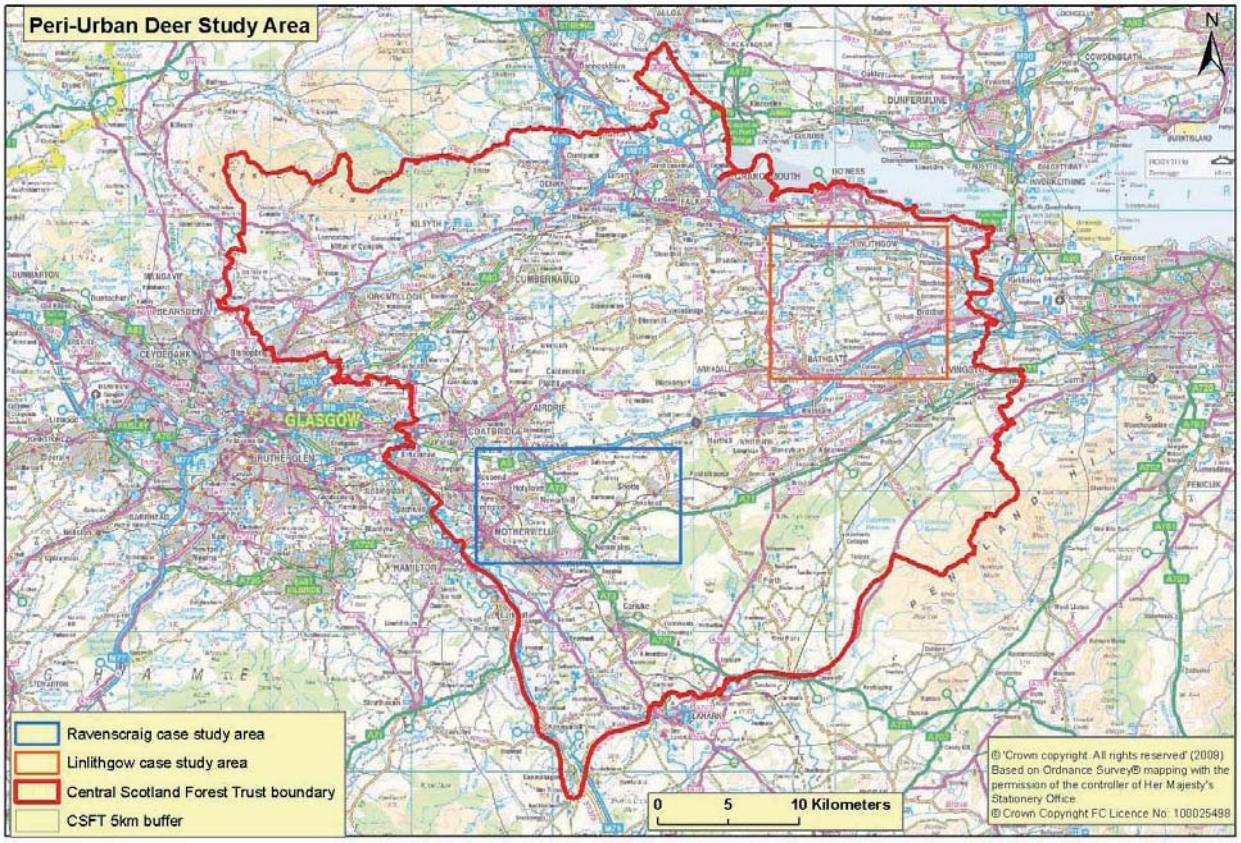


Figure 2 – Whole study & case-study areas - The Central Scotland Forest

The project has drawn upon a Steering Group for guidance on the overall project direction, important elements of secondary data, and additional contacts pertaining to the study. The case-study areas were also selected in consultation with the project's

[3] http://www.euro.who.int/EHindicators/Indicators/20030527_2

Steering Group. The Steering Group also participated, along with a range of other stakeholding organisations, in a Stakeholder Workshop towards the end of the project.

1.3 Characterising the 'peri-urban' environment

Peri-urban areas are by definition transitional, blurring the divide between 'fully' urban and rural areas. They consist of those areas around settlements characterised by a mosaic of mixed land-uses, often including housing, transport infrastructure, industry, agriculture, forestry and 'natural' areas (see Figure 3). Peri-urban areas often straddle administrative boundaries between urban and rural authorities, along with cultural 'boundaries' between urban and rural lifestyles. These areas are thus sites of very significant interactions between people, and between people and their environment. The twin contemporary demands for increased housing provision and the amenities provided by the natural environment have led to increasing new-build housing development and the planting of new woodland around existing urban areas (e.g. the Forestry Commission's WIAT – Woodlands in and Around Town - initiative), thus greatly expanding peri-urban areas.

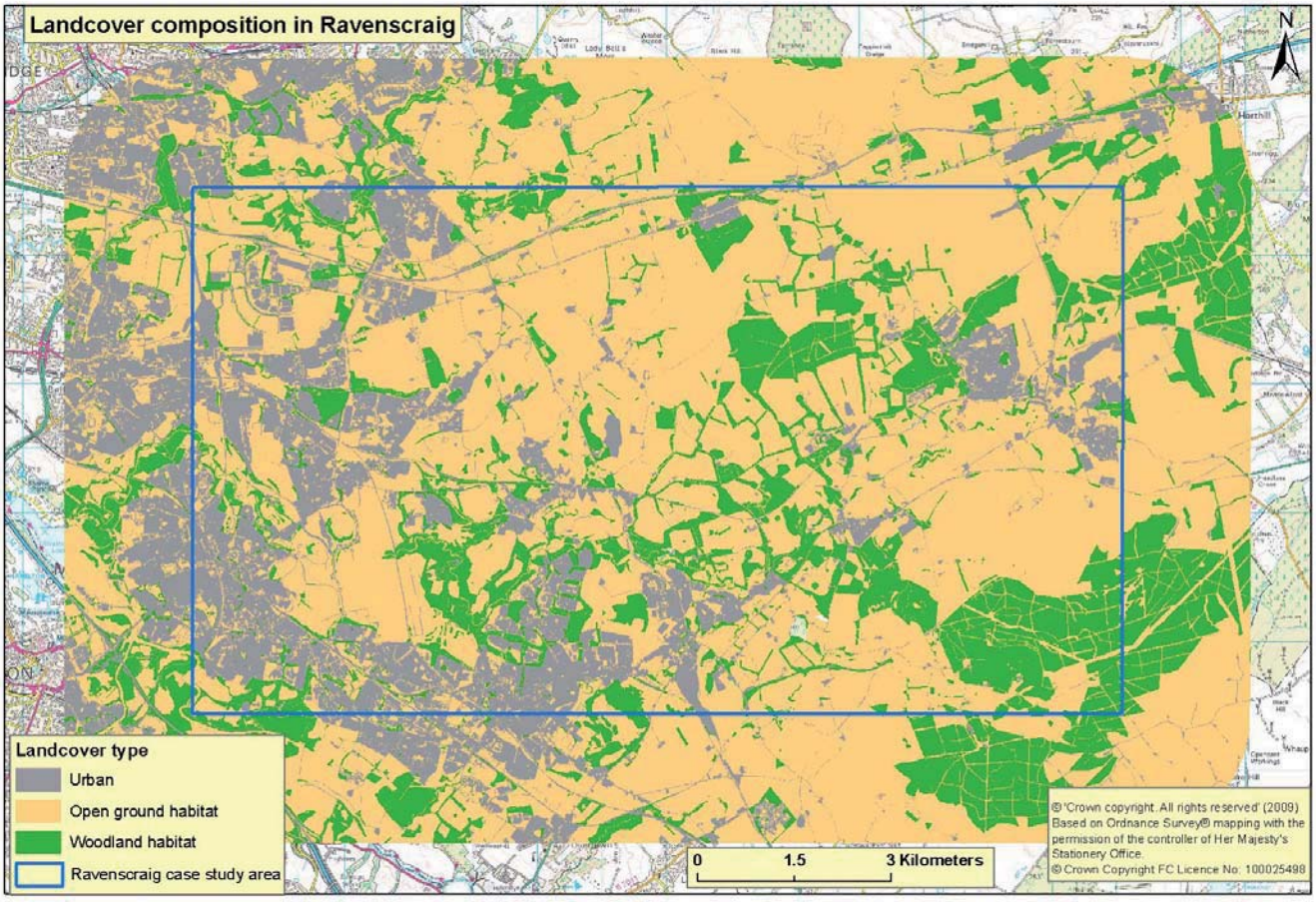


Figure 3 - The landcover mosaic of the peri-urban environment

Figure 4 - The visual peri-urban landscape, a patchwork of trees, green-spaces and the built environment

1.4 Project Objectives

1. To provide an understanding of the relationship between people and deer in peri-urban areas.
2. To identify, scale and map the distribution of the 'drivers' of people-deer interactions in peri-urban areas.
3. To provide guidance on a variety of procedures to manage the interaction of people and deer in peri-urban areas.

Objectives 1 and 2 are met with the results of social, spatial and ecological research described in Section 2. Objective 3 is met via the discussion and Decision Support Framework presented in Section 3.

2. Methods and Results

This section describes the results of the research undertaken by the project team and provides details of the methods and analysis techniques used to generate them. These results fulfil Objectives 1 and 2 of the project, and are presented in four sub-sections. The first of these (2.1) summarises the results of the initial scoping phase of the project and identifies the range of people-deer interactions to be investigated further by the project. The remaining three sub-sections present the results of the social (2.2), spatial (2.3) and ecological survey (2.4) research respectively.

2.1 Scoping 'people-deer interactions'

The first phase of this research project involved scoping the range of potential deer-people interactions in the peri-urban environment, exploring their causes ('drivers' and 'pressures'), and collating relevant secondary data applicable to the Central Belt. This was completed via an extensive desk-based review in parallel with consultation with the project's Steering Group and relevant external organisations and individuals. Appendix G summarises this initial scoping in diagrammatic form, and illustrates the substantial complexity involved. Complexity is encountered not only at a 'whole system' level but also in terms of individual interactions. One of the most complex is perhaps the occurrence of road-traffic accidents involving deer. The breadth and depth of the 'causes' behind this interaction are illustrated in Figure 5.

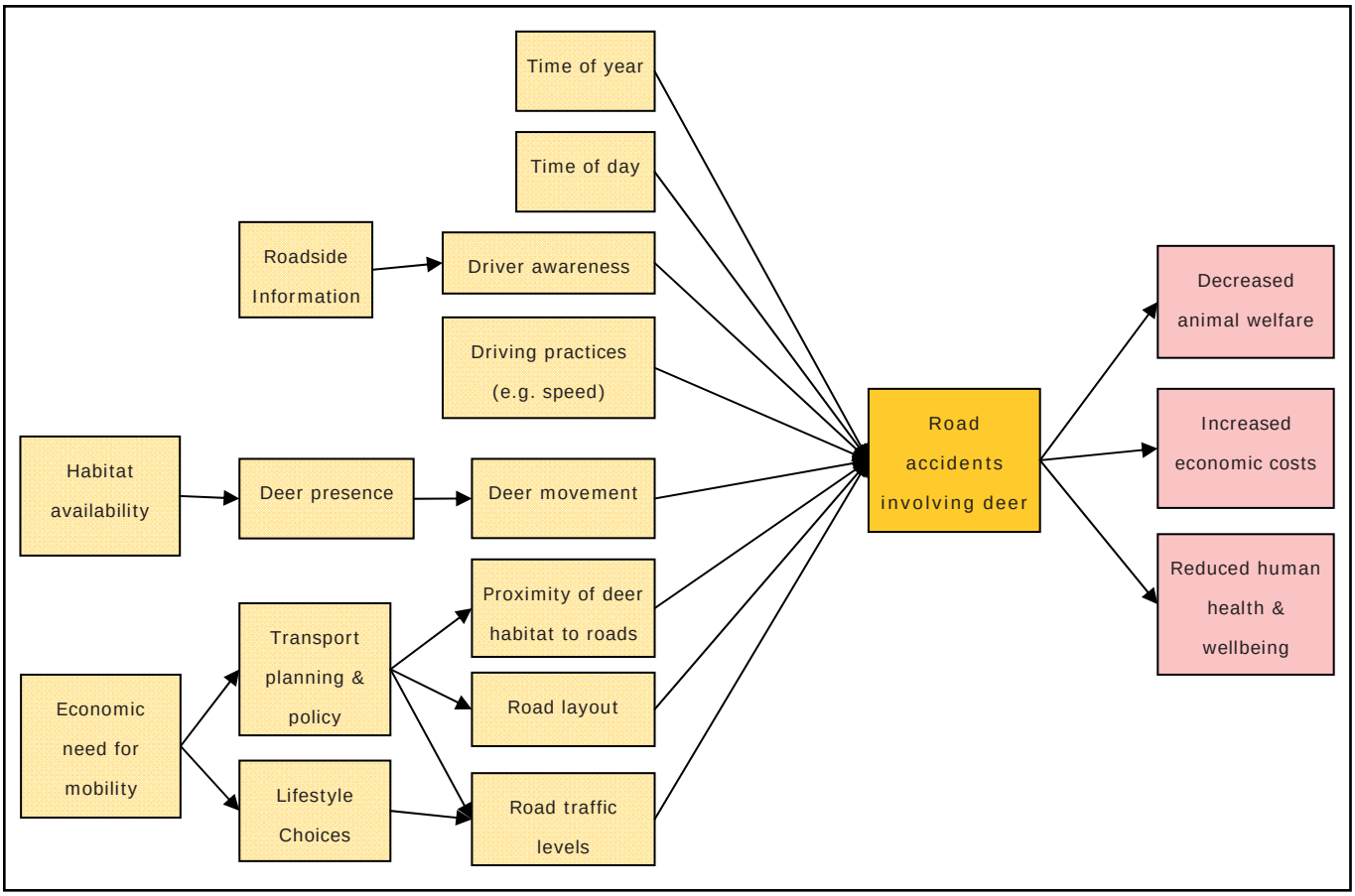


Figure 5 - The 'causes' of road traffic accidents involving deer

Key Interactions

This initial review identified 15 key interactions of relevance in the peri-urban environment – 6 positive interactions ('values'), that is ways in which people benefited via their interactions with wild deer, and 9 negative interactions ('impacts') listed in Table 1.

Table 1 - Key people-deer interactions in the peri-urban environment

Positive Interactions (Values)	Negative Interactions (Impacts)
Cultural value	Agricultural and commercial horticultural damage
Ecological services	Woodland damage – economic production
Seeing deer (aesthetic value)	Woodland damage – natural heritage
Economic value 1 – through recreational stalking	Private garden damage
Economic value 2 – as a 'tourist' attraction	Road-traffic accidents
Venison consumption	Acts of cruelty towards deer
	Intake of toxins by deer
	Disease transmission
	Damage to publicly important sites (parks & public gardens, graveyards, golf courses)

Values

Wild deer can hold considerable cultural value as symbols of Scotland and Scottish national identity. Whilst this value might more readily be associated with the red deer stag and the Highland 'open hill' environment, it is possible that other deer species in other environments are also valued in this way. Deer species can perform important ecological services such as browsing, disturbance, and seed dispersal (Gill and Beardall 2001). These may be of particular significance within a fragmented habitat lacking other herbivores and large mammals – such as the peri-urban environment. Economic value takes at least two forms in relation to wild deer. Perhaps the most significant quantity of economic benefits accrue through the value of deer as quarry species for recreational hunting. However, their contribution as one part of the more general tourist appeal of Scotland is also significant. Venison can also offer significant economic value, along with being a relatively healthy wild meat. Deer are generally acknowledged to be aesthetically attractive animals and also, being Britain's largest remaining land mammal, are highly charismatic.

Impacts

There are a number of impacts that wild deer may potentially have upon the environment and communities in which they occur. Agricultural, horticultural, and

woodland interests can all be negatively affected by browsing, trampling and other deer behaviours (Wilson 2003; Putman and Moore 1998). These impacts can include the prevention of natural tree regeneration, damage to young or small fruit or forestry crop trees, and reduced pasture grazing. It is widely considered that private and public gardens can also be affected by similar behaviour and damage. Wild deer roam freely across much of the British landscape and can be involved in road traffic accidents when these movements take them across roads. These accidents, sometimes referred to as 'deer-vehicle collisions', can result in significant damage to vehicles, high repair costs, injury or death of deer and, in some instances, injury or death of vehicle drivers and passengers (Wilson 2003).

Wild deer can be victims of targeted acts of cruelty such as attacks with inappropriate firearms and dogs. It is not uncommon for concerns over deer welfare to be conflated with 'poaching'. This generalisation is explained in part by the tendency to use the term to refer to any unlawful act relating to wildlife, along with the perceived tendency to conduct this activity at night when shot accuracy is perhaps likely to be poor. The intake of toxins by wild deer from contaminated land could potentially constitute a further welfare issue. Literature illustrates that contaminants like fluorides, mercury, heavy metals and radioactive substances can translocate into deer tissue via the environment and bioaccumulate (Pokorny 2000). Although published research is very limited, potential welfare issues could include 'loss of functional tooth shape' (Kierdorf *et al* 1996) and loss of antler strength through rapid growth (Keirdorf *et al* 2000). Wild deer populations are strongly implicated in the maintenance of tick populations and there is widespread concern regarding the transmission of tick-borne diseases such as Lyme disease – both to humans and other animals.

2.2 Social Research

Initial scoping of deer-people interactions in peri-urban Scotland and available related information revealed significant knowledge gaps relating to the importance and relevance attached to different interactions by local stakeholders – particularly members of the local communities and local deer and land managers. Furthermore, no information was available regarding the prioritisation of management objectives, or attitudes towards and preferences for management responses by local stakeholders. Primary social research was therefore conducted in the case-study areas with the main objectives of:

- assessing the importance and relevance of key people-deer interactions to local members of the community and deer / land managers[4],
- prioritising these interactions in terms of management responses, and,

[4] The deer and land managers involved in this research were drawn from within the study area and are thus, of course, themselves members of the local community. The terminology is used here to facilitate a distinction between local residents with different relationships to wild deer.

- revealing the attitudes, opinions and preferences of local community members and managers to individual management options.

The primary social research consisted of focus-groups, a questionnaire survey, and a Stakeholder Workshop.

Focus-group method

Ten focus-groups were conducted within the project's case-study areas. Seven of these drew participants from members of the local communities, with the remaining three engaging deer stalkers and land-managers with interests and responsibilities in the 'Central Belt' area. Fifty-five individuals from local communities and nineteen deer/land managers participated in these groups, an approximate average of eight and six individuals per group respectively[5]. (See Appendix A for further details of where and when the focus-groups were conducted, and their structure and content). The focus-group method is distinct from other research techniques in that its purpose is to obtain data from the interaction amongst its participants, and thus it is the group, not the individual, that is the unit of analysis. The overall objective is to establish a discussion in which participants (rather than researchers) stimulate responses from one another and establish a conversation focused upon the relevant subject matter with as little input from the researcher as possible. Focus-groups are particularly useful for exploring issues which have received little prior attention (as it allows participants to share knowledge and to learn from one another), and the data generated can readily complement parallel data, such as from surveys, by finding rich descriptions of identified phenomena or relationships (For further guidance on the planning, conduct and analysis of focus groups see Robson 2002, 284-289 and Burnham *et. al.* 2004, 105-113).

We generated our sample of participants primarily through widespread contacts with local social, sporting and cultural associations in the case-study areas. Letters of invitation were sent, and telephone calls made, to association Secretaries and, later, the project questionnaires were distributed through the same route and featured an opportunity to volunteer for participation in discussion groups (see Appendix A for a list of contacted organisations). We also placed announcements in local press (*Linlithgowshire Journal and Gazette* and *Wishaw Press*) and displayed poster materials about the events at the focus-group venues prior to the events. In order to facilitate high levels and diversity of participation discussion groups were held at various venues across the case-study areas and were scheduled for various times of day. The spatial distribution of focus-group participants across the communities is illustrated in Figure 6. Focus-group discussions were recorded and transcribed. These transcriptions were then coded thematically, and analysed via the construction of conceptually clustered matrices

[5] Brown (1999) suggests that a minimum of 4 or 5 groups is necessary for data saturation – that is, a full exploration of the issues. A group size of between 5-10 individuals is generally accepted as appropriate, with 6-8 being optimum. Focus groups with this number of participants should last between 1-2 hours.

(see Miles and Huberman 1994: 127-131). The basic categorical content of these matrices is summarised as Table 5 and Table 6 below, and the specific textual content is illustrated through quotations within the text of Section 2.2. – 'Social Research'.

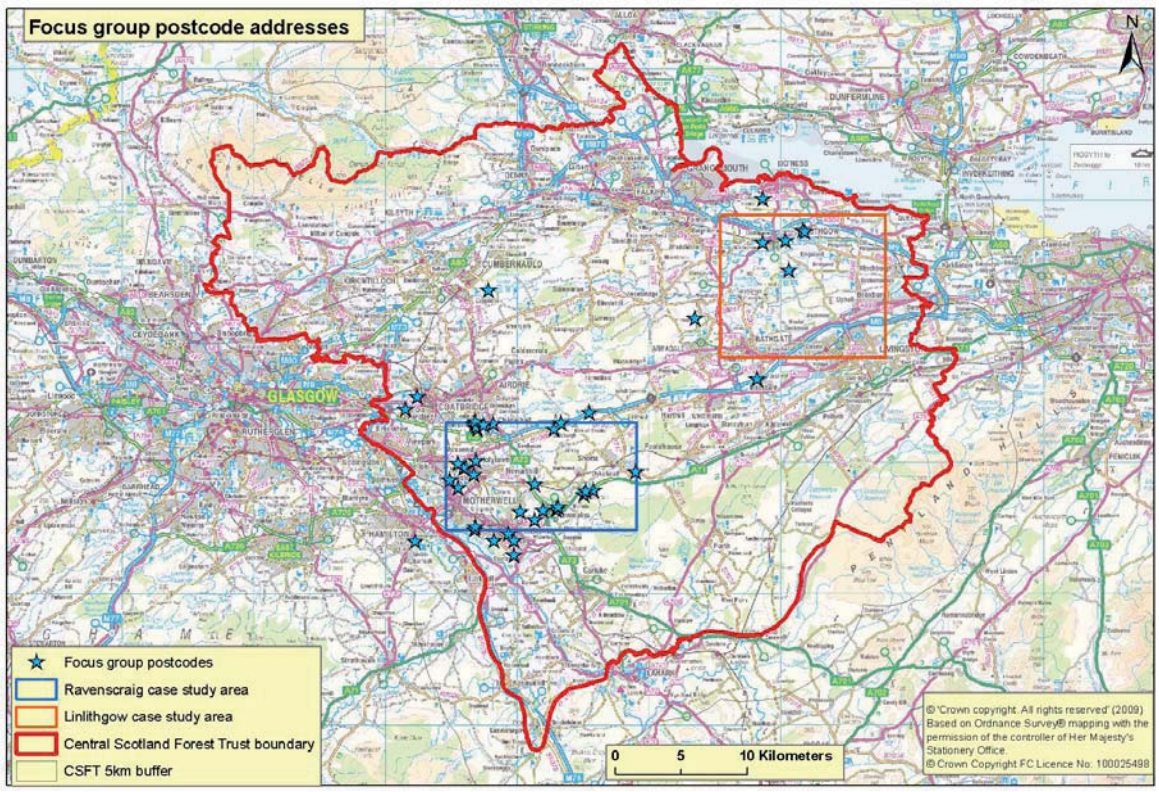


Figure 6 - Distribution of attendees of the focus groups undertaken within the case study areas

Questionnaire method

415 questionnaires were distributed to members of the local communities in the project's case-study areas. Of these 154 were returned, representing a 37% response rate. Our questionnaire was distributed through the same means, and to the same local groups, as were invitations to attend the focus-groups. The spatial distribution of questionnaire respondents across the communities is illustrated in Figure 7. Three significant benefits were considered to underpin the use of a questionnaire survey, first to provide broader more general data relating to local resident's attitudes towards deer and deer management to complement the focus-group research, second to facilitate the capture of data from local residents unable to attend the specific focus-groups at the scheduled times, and third to provide an opportunity for questionnaire respondents to volunteer further and participate in later focus-group research.

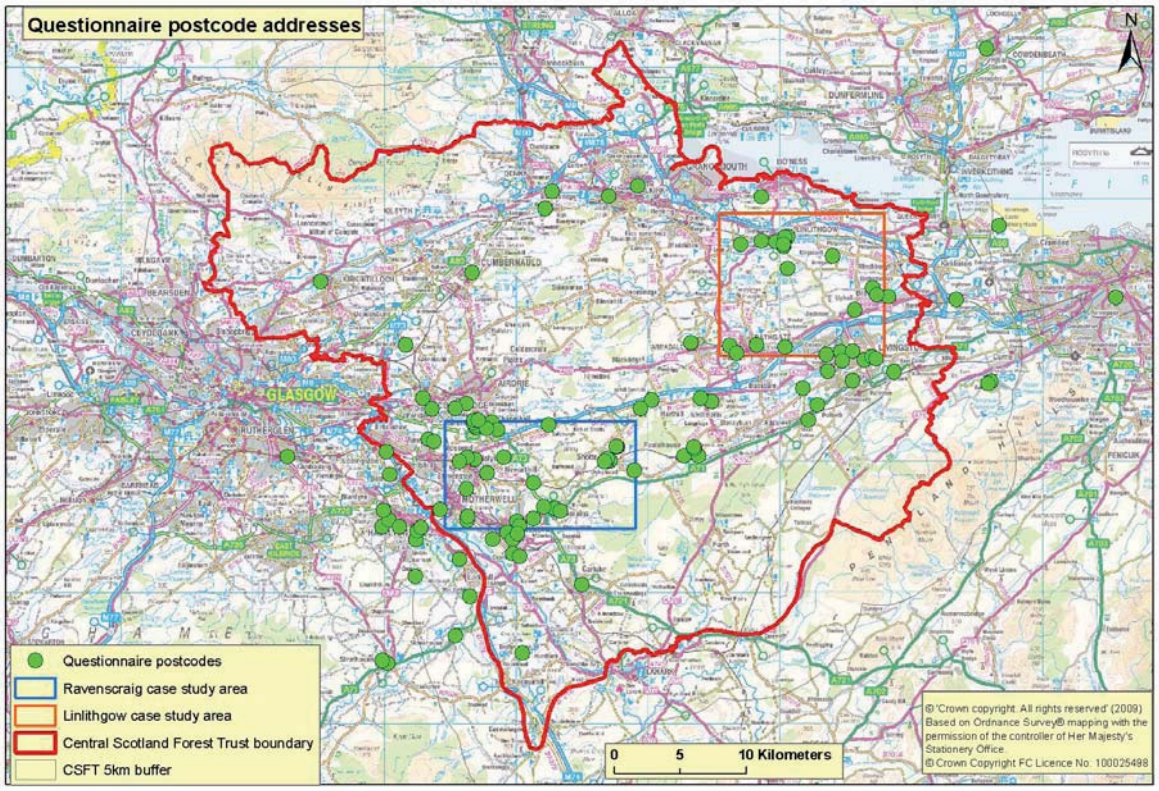


Figure 7 - Distribution of questionnaire respondents

In order to characterise the sample population and gain insight into their relative priorities relating to the management of wild deer the questionnaire sought responses to a series of attitudinal statements (see Table 2). The results of this are contained within Figures 8-10. Figure 8 shows average levels of agreement with the statements across the whole sample (n=154), the larger the bar the greater the level of agreement over the statement. Figures 9 and 10 are box-plots representing the spread of opinion in relation to each statement, presented comparatively so as to illustrate the consistency between respondents across two geographical communities. In these figures the smaller the bar size the greater the consistency of opinion in relation to the statement.

Table 2 - Statement Key

Letter	Statement
A	Deer are beautiful animals
B	It does not matter if deer damage local gardens
C	Maintaining the welfare of individual deer is important
D	People should be allowed to make a living from deer through deer watching tourism
E	Deer are important symbols of Scottish culture
F	Deer should not be allowed to damage local woodlands
G	Maintaining the health of the deer herd is important
H	People should be allowed to obtain economic value from deer though sport hunting

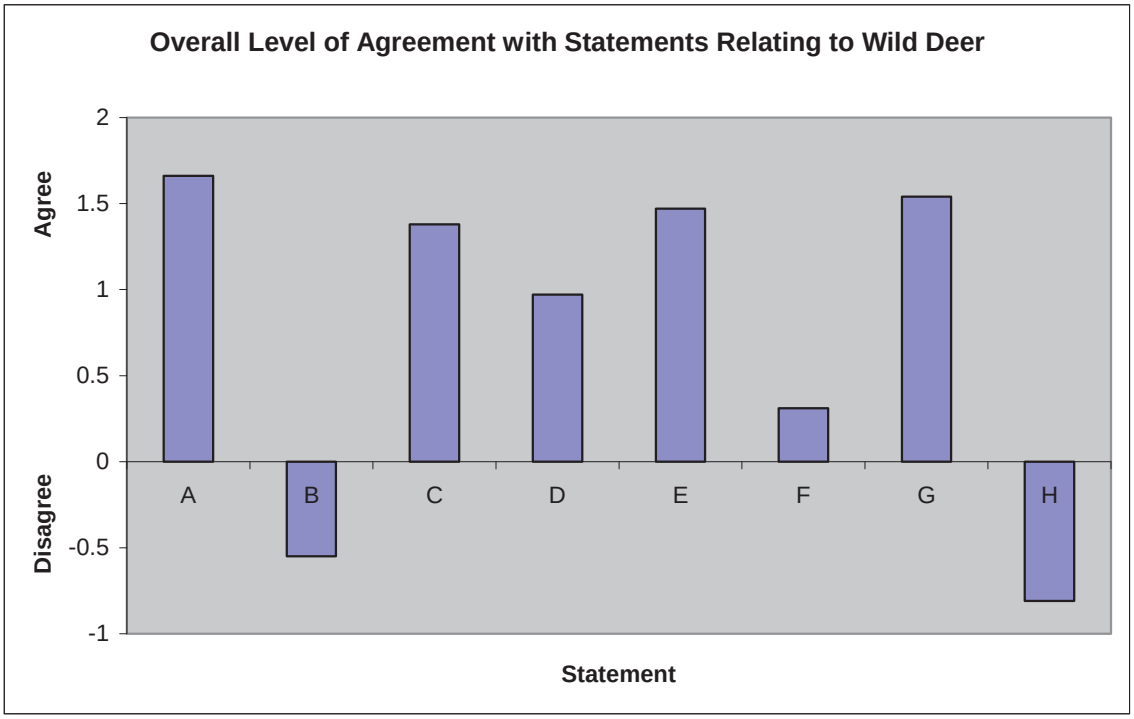


Figure 8

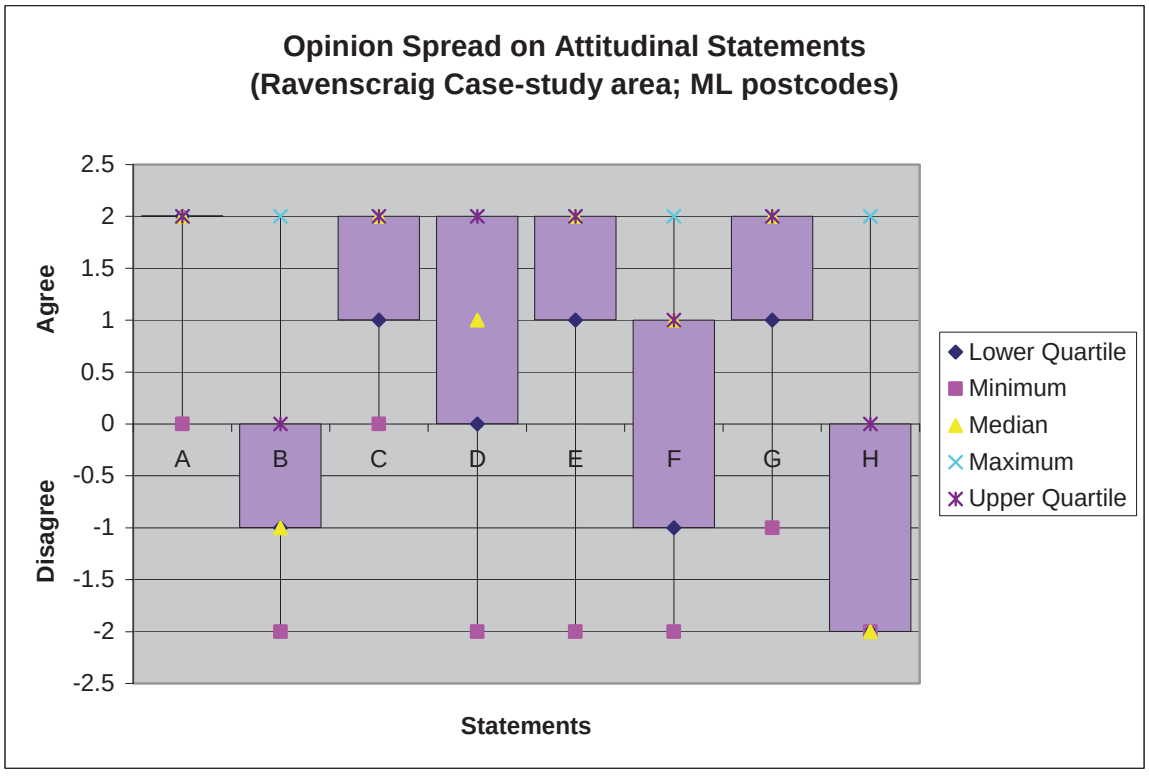


Figure 9

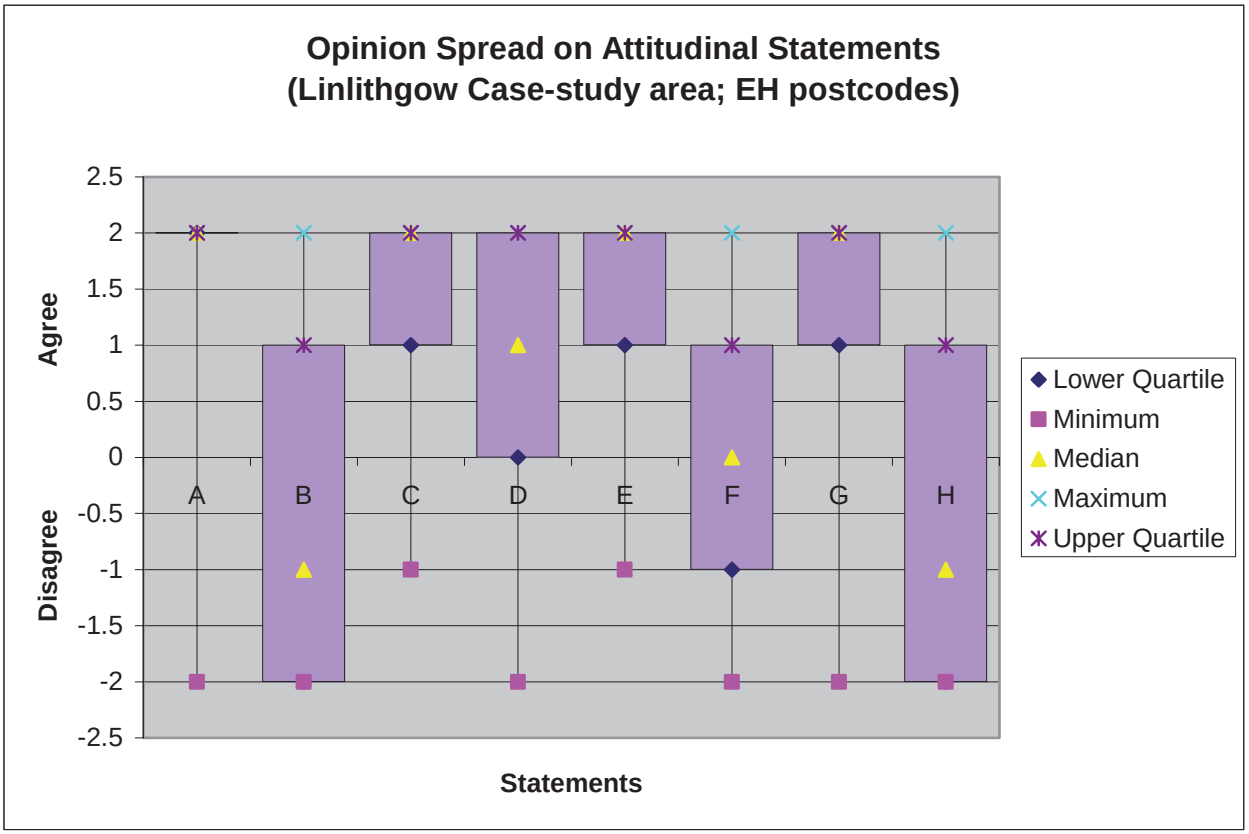


Figure 10

The data contained within Figures 8-10 indicate considerable consistency between the two geographical communities in our case-study areas, and overall consistent and high levels of agreement with the following statements (not necessarily in order of importance):

- Deer are beautiful animals (Statement A)
- Maintaining the welfare of individual deer is important (C)
- Deer are important symbols of Scottish culture (E)
- Maintaining the health of the deer herd is important (G)

There is also very clear agreement, although less consistently strong, with the statement:

- People should be allowed to make a living from deer through deer watching tourism (D)

There is overall weak disagreement, although with considerable opinion spread in the Linlithgow case-study area, with the statements:

- It does not matter if deer damage local gardens (B)

- People should be allowed to obtain economic value from deer though sport hunting (H)

Opinion is very widely spread and inconsistent regarding the statement:

- Deer should not be allowed to damage local woodlands (F)

2.2.1 The values of wild deer (positive interactions)

The values associated with seeing deer and knowing that deer exist in the local environment were the most widely held and considered locally relevant by the community members and land managers that participated in our research. The cultural value of wild deer, particularly as a national symbol, is also of some importance and relevance to the local community members. Finally, deer are identified as a potentially valuable source of food (venison), although there exists a significant lack of familiarity with this. The economic and environmental values of deer are not generally considered relevant to communities in peri-urban areas. Table 3 indicates the occurrence and distribution of data relating to the values of wild deer across the focus group research, in particular highlighting this dichotomy between values which were considered relevant to local communities and those which were not. This dichotomy emerged clearly from the analysis.

Table 3 - Data distribution relating to the values of wild deer

Group		Value Type / Category											
		Relevant to local individuals and community, or whole of Scotland						Relevant to other communities but not relevant locally.					
		Aesthetic (seeing deer)	Existence	Cultural	Economic	Food (venison)	Environmental	Aesthetic (seeing deer)	Existence	Cultural	Economic	Venison	Environmental
Community Members	CG1	✔	✔	✔							✔		
	CG2	✔											
	CG3	✔	✔	✔	✔	✔					✔		
	CG4	✔		✔						✔	✔		
	CG5			✔							✔	✔	
	CG6	✔		✔							✔		
	CG7	✔	✔			✔					✔		
Managers	MG8	✔				✔							
	MG9	✔		✔		✔					✔		
	MG10	✔	✔	✔	✔								

Aesthetic and existence values

The value of seeing deer in the local area is clearly the most widely held category of value associated with wild deer in the peri-urban environment, with nine groups expressing it as important and relevant to local communities. Some of this value accrues due to the aesthetic attractiveness of deer, but of equal if not greater significance is the value placed upon sharing the environment with wildlife. This 'existence' value is often closely associated with seeing deer, but does not rely on this. Sharing the environment with deer (and other wildlife) is valued for a variety of reasons including the fact that it is considered to reduce the perceived artificiality or unnaturalness of the urban environment (wild deer provide a link to the 'natural' world), and/or challenges the problems faced by the community (such as, for example, anti-social behaviour).

> "*It's made my day when I've seen them. .... It makes all the difference ... Fantastic difference*." CG1

> *"...it is nice to know that they are around. It just makes people feel more natural, a more natural environment."* CG7

> *"... it makes you rejoice thinking that you've got all the shenanigans going on in the dark. And there's underage drinking and all of these things that you hear in the papers. But the animals can survive that disruption."* CG7

Cultural Value

The next most widely held value associated with wild deer relates to their cultural value as symbols of Scottish identity. The reasoning behind the importance of this value, its relevance to peri-urban communities, and its connections to other forms of value make this perhaps the most complex category of value. Of particular importance is that, whilst it is perceived that the Highland red deer stag, rather than the peri-urban roe deer, possesses much if not all of this cultural-symbolic value (*"It's the glens and the deer."* CG6), participants clearly considered that peri-urban communities accrued at least some of the benefit of this value. Participants linked this category of value to identity (Scottish), specific cultural activities (Highland dancing), and the economic value of deer ("*It sells a lot of whisky! ... The stags on Glenfiddich*" CG6). Furthermore cultural value was linked to power and the political value of wildlife, by a small number of participants, through its appeal to decision-makers and those in positions of authority.

> *"It is an important symbol of Scotland, the deer ...."* (CG4)

> *"... if the 'top of the tree' is quite happy for deer to be part of our culture, part of our structure, then more things will happen. ... [I]f the 'top of the tree' ... is for the environment to be a certain way ... they'll find a way of achieving it ..."* (CG1)

Having noted this, some participants considered the association of deer with Scotland to be rather 'twee' for example;

> Participant A: *"It sort of goes a bit with the tartan and the bagpipes, you know your stag with 8 points and all that."* ... Participant B: *"On the front of your biscuit tins type of thing, but people identify us with that kind of thing."* (CG1)

Food Resource Value

When discussing the values of deer, and in particular their economic value, research participants commonly raised venison as a subject. It is clear that many participants considered wild venison to be a significantly under-utilised resource with considerable potential. There was extensive debate around this centring particularly on the perceived 'healthiness' of the meat, the economics of importing other meats and its class-related status. Venison is considered a very healthy meat being low in fat and cholesterol. Considerable frustration was also expressed at the idea that meat might be imported from elsewhere to Scottish shops when a supply of venison was available locally. Two reasons were identified for the lack of demand for venison, firstly its perceived status as a meat consumed by the 'elite' upper classes (although some participants noted that at some points in history venison was considered a '*poor man's meat'* (CG6)), and secondly its direct association with an aesthetically attractive animal.

Economic Value

It is acknowledged by participants in our research that wild deer possess economic value, primarily in relation to recreational shooting and tourism in general. Having said this, participants are explicit in their consideration that this value is captured elsewhere, and indeed by other people, and is thus of no value to their communities or individual members of them.

> *"In the grand scheme of things I think they're of significant value to the economy."* (CG4)

> *"I couldn't see them [tourists] coming here and saying 'while we're in Motherwell and Lanarkshire, we'll go and see deer'. But I would think they might think that way if they were heading for the Glen Coe area for instance or above Stirling..."* (CG1)

> *"... I think the economy would probably have been in relation to the red deer, in my opinion, rather than roe, I know they are making a lot of money in estates and on the islands and stuff through deer..."* (CG5)

> *"Foreign visitors don't come to Glasgow to look at deer, they would go up North*." (MG9)

Those participants who made a connection between the cultural value of deer and decision-makers, also made a connection (perhaps more strongly) between the economic value of deer and their political acceptability as an element of Scotland's landscape.

Environmental Value

The environmental value of wild deer, that is their role as a keystone browsing species and their performance of certain ecological 'tasks' such as seed dispersal, is the least important value associated with wild deer by the research participants. This value is not widely known or understood and although there were expressions of interest during group dialogue, there was very little subsequent discussion thereof. Rather than being of environmental value *per se*, wild deer were more commonly perceived as indicators of a good or healthy environment. This is associated closely with the perception of deer as 'natural' and as forming a link between people and nature identified above.

> *"If you catch sight of the deer, it means the environment is on a high because they're in the area. And if you're not getting good ecology and good feeding grounds they just move away, you see less and less of them. ... It's letting you know that the environment and the ecology in the area is really good."* (CG6)

Other values

Regular opportunities were given for research participants to identify additional values that wild deer may actually or potentially hold for them. There was little raised at these points, with just an 'educational' value being identified during the Stakeholder Workshop. This referred to the opportunities afforded by wild deer, and activities related to them, to communicate formal educational information regarding their ecology and management.

Summary - Implications of values identified

The character and relative importance of the values associated with wild deer have direct implications for deer management. Whilst wild deer are in general valued highly by peri-

urban communities, in fact, little of this value is actually captured by individual members of the community. This is because deer are not a prominent dimension of the local environment and the relationship between deer and most people in these areas is not strong (i.e. interaction between people and deer is limited). Seeing deer and sharing the environment with them is seen as an important but fairly basic value (e.g. "*Just seeing them"* (CG6); *"I'd settle for aesthetic value"* (CG4), emphases added). This is, however, somewhat fragile, or tenuous, due to the deer's lack of prominence and the fact that they are perceived to naturally be 'very elusive'. This lack of prominence for community members contrasts with the perception of increasing presence held by other stakeholder groups. Sharing the environment with wild deer is valued because, as indicators of a 'healthy' 'natural' environment they reduce the perception of living in the 'unnatural' built environment, and to a certain extent challenge the problematic human activities that are ongoing in the local area. That is, wild deer (as wildlife in general) can form a link to a 'natural', less problematic 'world'. In light of all this, it can be concluded that management actions that may reduce the presence of deer in the local environment are likely to be perceived as both diminishing opportunities to see deer and diminishing the already fragile link between peri-urban communities and the natural world. The limited capture of this value by local communities (i.e. rarity of opportunity to interact with deer) results in any management being perceived as unnecessary. Culling can be perceived as a particularly aggressive 'attack' on these values and linkages.

The research participants recognised that wild deer could provide considerable tangible benefits (via their exploitation for tourism, venison, sport shooting and as a marketing symbol), however the majority of this, primarily economic, value is perceived as accruing to persons elsewhere – most notably in more rural areas. The likely consequence of this is that management actions are considered to be at the request, and for the benefit, of *others* – that is, *not* community members in peri-urban Scotland, although there was only limited explicit evidence from the discussion groups to illustrate this point. In such cases management would be unlikely to receive support. The importance of values associated with wild deer by community members and land managers in the peri-urban community is summarised in Table 4 below.

Table 4 - Importance of values associated with wild deer in the peri-urban environment

Importance	Values
High	❖ Seeing deer ❖ Sharing the environment with deer
Medium	❖ Cultural value ❖ Food resource - venison
Low (no data)	❖ Economic value 1 – through recreational stalking ❖ Economic value 2 – as a 'tourist attraction' ❖ Ecological services

The Stakeholder Workshop (see Appendix A for details) provided an opportunity to identify the relative importance of values from a wider perspective. In response to the question "How important do you feel the values are to members of the community in peri-urban areas?" stakeholder representatives produced the following rankings for values:

1. Seeing deer
2. Sharing the environment with deer
3. Economic value 1 – through recreational stalking
4. Cultural value
5. Economic value 2 – as a 'tourist attraction'
6. Venison consumption
7. Ecological services

2.2.2 The impacts of wild deer (negative interactions)

Whilst road-traffic accidents were considered the most serious impact that wild deer were implicated in, there was a considerable contrast between members of the local community and local deer/land managers in relation to the perceived relevance of this impact to the local community. Members of the community considered deer welfare as more relevant locally, and clearly expressed that road-traffic accidents were relevant only elsewhere. Woodland damage and disease transmission were noted as occurring, or potentially occurring, locally, but perceived to be of limited importance. Managers, however, considered road-traffic accidents to be the impact of primary importance, although deer welfare was also key (Table 5 indicates the occurrence and distribution of data relating to the impacts of wild deer across the focus group research).

Research participants raised and acknowledged a broad range of causes of the impacts discussed. In many instances these causes were human (anthropogenic), and included increasing urbanisation of previously rural spaces, driving practices (e.g. high speeds), removal of predatory animals and inappropriate underlying ethical principles (e.g. the widespread 'domination' of wildlife's interests by human interests). There were also clear correlations perceived between impacts and ecological causes such as the number of deer in the local environment. However these, especially deer numbers, were widely considered to be 'unnatural' phenomena themselves caused by human factors. In fact, participants most commonly correlated the perceived low numbers of deer in the local environment to the perceived absence of impacts and a consequent lack of need for management (see Section 2.2.3 – Management).

> *"the population have built houses on what was the deer's natural habitat and you can't just stop the deer going because somebody has built a house on it. ... if you built a house where deer have the normal run of you can't expect them not to come in"* (CG2)

"Is it ground that used to be for the deer, and we've built the houses on it? And deer are just coming back into their own land." (MG10)

"As the predominant species on the planet we have to make every other species sub-ordinate to what we want to do. Do you have to fence every road in the highlands with a six-foot high deer fence or do you say to motorists 'There will be deer on the roads, there may even be cows on the road, so drive accordingly'." (MG10)

Table 5 - Impacts associated with wild deer

Group		Relevant to local individuals and community, or whole of Scotland					Not relevant to local community					Important, but relevant only to others or elsewhere				
		Woodland damage	Road-traffic accidents	Gardens or special sites	Deer Welfare	Disease	Woodland damage	Road-traffic accidents	Gardens & special sites	Deer welfare	Disease	Woodland damage	Road-traffic accidents	Gardens & special sites	Deer welfare	Disease
Community Members	CG1	✔							✔				✔	✔		
	CG2	✔						✔	✔				✔	✔		
	CG3	✔			✔	✔		✔								
	CG4				✔		✔	✔	✔				✔			
	CG5							✔	✔				✔			
	CG6	✔			✔	✔		✔					✔			
	CG7			✔	✔											
Managers	MG8		✔		✔	✔			✔							
	MG9	✔							✔	✔						
	MG10		✔		✔		✔				✔					

Road-traffic accidents (RTAs)

Members of the community involved in the research clearly consider road-traffic accidents to be the most serious of the impacts linked to deer – and the potentially significant costs, especially for the individuals involved, are recognised. However, community members perceive virtually no link to their own communities. This is in contrast to the perceptions of the local deer managers who participated in the research. Local residents either have no experience of deer related RTAs in the local area, or very limited experience with considerable time lapse. Some participants do, however, recognise that deer-related RTAs are a problem elsewhere – especially in the 'North' or 'Highlands'. A few participants question the relative importance of specifically deer-

related RTAs – relative, that is, to the many other causes of RTAs, including those involving other animals. Concerns are raised, for example, that there could be many RTAs involving domesticated animals such as horses, cattle and sheep. Further to the points noted above, some participants questioned the notion that deer cause deer-related RTAs identifying instead human causes, for example, *'... road traffic accidents ... it's drivers that need educating not deer. It's rank rotten driving as far as I'm concerned*' (CG1). Various notions of how deer might behave on or near roads were communicated by participants, with the view that deer were cautious of roads, especially main roads, being a broadly held opinion. There was some limited awareness of techniques used to manage deer behaviour near roads – such as sound emitting devices. Typical responses from members of the community to the issue of road-traffic accidents include:

> *"I've not heard of any in this area ... very seldom you hear about it*" (CG6)
>
> *"a guy going to work in the morning caught a deer ... this is maybe 20 years ago."* (CG3)
>
> *"it's mainly the motorways and stuff like that, up North, it's the country roads..."* (CG2)
>
> *"... you get them on a regular basis up the north."* (CG6)
>
> *"When you take the back roads then you see them, but on the major roads they tend to shy away."* (CG3)

Local deer managers perceive road-traffic accidents as having a much clearer impact upon local communities, although these participants describe a complex set of causes behind this impact. Increased numbers of vehicles on the road, road layout and verge-side vegetation, and increased traffic at times of day when deer are active were all reasons given to explain the occurrence of deer-related road-traffic accidents, in addition to increasing deer numbers. Increased awareness of the issue was also widely considered to have increased the *perceived* importance of the issue, even if road-traffic accidents had not actually increased in recent years, for example *"All of a sudden, its a calamity!"* (MG8).

> *"... lots of people ... are reporting to me local accidents now, that never happened before."* (MG10)

Deer welfare / Acts of cruelty towards deer

The welfare of individual deer was of significant importance to the community members and managers participating in our research. Of all of the 'impacts' discussed within this research deer welfare was the most relevant to the local communities. The issues were

clearly familiar to community members. The most prominent form of this concern relates to chasing wild deer with dogs, with some concern regarding the use of firearms and bows. There was also some unease regarding the negative impact of fencing, particularly inappropriately designed or especially high fencing. Whilst calls to address welfare issues were forthcoming from across all groups, a few participants made the distinction between the need to address issues caused directly by humans such as road-traffic injuries, and other 'natural' welfare issues such as disease which managers could not be expected to mitigate. This concern over welfare was not limited to deer, but extended to a range of other animal species also. One further dimension of this issue was that concerns amongst individuals in the community about potential acts of cruelty in some instances discourages them from openly discussing deer (and other wildlife) and hence slows any community knowledge and capacity building relating to wild deer.

> *"...the welfare of individual deer, I think anybody that has got any concerns for humanity has got concerns for any other animal..."* (CG7)

> *"I've heard there's quite a few poachers that use lurchers, they've actually started to breed them now for taking down a deer."* (CG6)

> *"That's happened in North Lanarkshire certainly."* (CG4)

> *"I care quite a lot about the welfare from things that we have caused, ... but when you are talking about the welfare of individual deer from a natural disease and things like that I think nature takes it's course."* (CG7)

> *"... it's not only happening to deer it's happening to other animals."* (CG3)

It is clear from this project's advisors (the Steering Group) that not all individuals engaged in committing acts of cruelty live locally to where the offences occur, instead a high number may travel some substantial distance to engage in these acts.

Woodland damage

Despite some examples being given of deer impacting upon new planting locally ("*The deer got all the ones we planted!"* (CG1)), overall the perception was that this impact was not important in the local area. In general participants felt that other sources of damage, such as vandalism and grazing livestock (e.g. sheep) and squirrels, were a greater threat than wild deer to local trees and woods. Additionally, damage to trees was perceived as relatively small-scale and primarily an economic concern, for example, '*I presume you budget for couple of trees being damaged*' (CG4).

> *"... [in] the peri-urban situation a lot of that [new planting] will want to be landscape woodlands where you're not interested in having 1000 trees an acre. So if you lose even quite a lot of your crop from the aesthetics of the peri-urban area losing individual trees isn't very important. ... In terms of damage to woodlands in the peri-urban situation I don't think its really at all important."* (MG10)

Woodland damage may be of limited importance to the research participants due to the limited occurrence of designated woodland habitat within the project's boundaries (see Figures 15 and 16, Section 2.3.2).

Disease transmission

Participants identified the transmission of disease to other animals and to humans as another significant impact that wild deer might have on their local communities. The most prominent elements of this concern related to the presence of ticks, and to Lyme Disease and Foot and Mouth Disease.

> *"I see there is potential for ticks increasing in urban areas... So you've obviously get Lyme's disease on the back of that."* (CG4)

Damage to gardens or other publicly important sites

More so even than the potential impacts upon road traffic and woodlands identified above, the potential impact of wild deer upon private gardens was not seen as relevant to local communities by the majority of participants in this research. Once again however, the potential impact was understood, and recognised as a problem for communities and individuals elsewhere. Further to this the severity and relative importance of this impact is strongly questioned, to the point that some perceived that deer presence in gardens would likely be a positive interaction (value) rather than a negative one (impact).

> *"I haven't seen a deer in the garden here."* (CG1)

> *"It's not a problem at all in this area I don't think."* (CG2)

> *"I don't see why they should be in the gardens because I grow vegetables every year and I don't even get a rabbit on it."* (CG5)

> *"I've seen them destroying a garden. I've got relatives that stay in Dunoon* [in Argyll and Bute] *and quite openly they come into the garden and eat the roses ..."* (CG1)

> *"I think most people round here, if they saw deer in their garden they'd see it as a positive thing."* (MG9)

A very similar perception existed relating to damage to publicly important sites such as golf courses and cemeteries with, for example, one participant noting that deer presence *"... probably adds value to your tour around the golf course."* (MG8).

Other Impacts

Two of the impacts identified by the project team during the project's initial phase did not emerge at all through the primary social research conducted – agricultural and commercial horticultural damage, and the intake of toxins by deer. This is in part due to an absence of secondary data upon these impacts both generally and in the study area. Contacts were made by the research team with relevant organisations in attempts to obtain data but this was either not forthcoming or did not exist. It remains unclear whether the contacted organisations already perceive this to be an issue or not.

Summary - Implications of impacts identified

Participants recognise and acknowledge that wild deer can have significant impacts upon some communities, however impacts are not currently felt in any strong way by the local communities represented in the research. Community members identified ensuring the welfare of deer and the incidence of road traffic accidents involving deer to be the most serious impacts, although only deer welfare was perceived as an issue relevant to the local communities involved. Damage to trees and woods was known to occur yet not considered significant, with damage to gardens, 'special' sites and the risk of disease transmission all acknowledged as potential impacts but with no relevance to the communities involved in the research. This means that none of the identified impacts which could directly affect the community are considered relevant to the peri-urban communities involved in the research. Table 6, below, summarises the overall relevance and importance of the impacts associated with wild deer.

Whilst clearly the widespread lack of experience of any impacts is the primary reason for this perceived lack of relevance, the (associated) perceived lack of high numbers of wild deer in the local environment is a further factor. Whereas it is clearly possible for an individual deer to suffer from acts of cruelty directed against it, other identified impacts (that is, all those which impact upon the community or individuals within it) can be perceived as related to deer numbers. Consequent to this perceived lack of deer numbers and absence of impacts, there is substantial scepticism regarding the need for management activities to be conducted in the areas local to these communities.

Table 6 - Impacts associated with wild deer

Importance	High		• Road-traffic accidents	• Acts of cruelty towards deer (Deer welfare)
	Medium	• Disease transmission		
	Low	• Damage to private gardens • Damage to 'special' sites • Woodland damage – forestry crop • Agricultural & commercial horticultural damage	• Woodland damage – natural heritage	
		Low	Medium	High
		Relevance to Local Community		

The Stakeholder Workshop (see Appendix A for details) provided an opportunity to identify the relative importance of impacts from a wider perspective. In response to the question "How important do you feel the impacts are to members of the community in peri-urban areas?" stakeholder representatives produced the following rankings for impacts:

1. Road-traffic accidents
2. Acts of cruelty towards deer
3. Private garden damage
4. Damage to 'special' sites
5. Woodland damage – Natural Heritage
6. Agricultural and commercial horticultural damage
7. Woodland damage – Forestry crop
8. Disease transmission
9. Intake of toxins by deer

2.2.3 Managing people-deer interactions

Management Priorities

The data obtained through the focus-group and questionnaire research, and presented in the previous section, illustrate the relative prioritisation of impacts and values associated with wild deer by the participants in this research. In addition to this, the questionnaire provided a specific opportunity for community members to prioritise objectives for management in the local area encompassing both some values and some impacts. In response to the question "If the number of deer in the area where you live increased, which of the following would be the most important priorities?", respondents produced the following ranking:

1. Preventing road-traffic accidents involving deer
2. Ensuring the welfare of individual deer
3. Maintaining the cultural value of deer in Scotland
4. (Joint) Preventing deer damaging local woodlands
4. (Joint) Preventing deer damaging gardens and other vulnerable sites
6. Making a living from deer through deer-watching tourism
7. Obtaining economic income from deer through sport shooting 'stalking'

Management Methods

Discussion of the methods available to manage wild deer interactions with people revealed relatively low levels of awareness amongst participants. The discussions regarding management methods should be considered in light of the perceived lack of need for such activities amongst the peri-urban community members involved in the research. The consequence of this is that the discussions were frequently conducted in hypothetical terms, with the researchers requesting that participants consider the management methods in relation to a potential future scenario where deer were more prominent in their local environment and were having an impact.

In terms of direct management, the use of fencing and 'scarers' consistently gained the most widespread support, although there was little apparent prior knowledge of these methods (especially of the use of 'scarers') and consequently only brief discussions. By far the most talked about direct management method was culling. In the majority of instances management methods, particularly culling and fencing, were discussed in both positive and negative terms. Table 7 (next page) indicates the occurrence and distribution of data relating to direct management methods across the focus group research.

As noted previously, participants commonly discussed the human causes of negative interactions (impacts) and consequently often discussed options beyond direct management. The most common of these included managing drivers and driving practices, 'education' of individuals and groups involved in anti-social behaviour / acts of cruelty, better/wider policing, more informed advanced planning and changes in roadside vegetation management.

Table 7 - Preference for direct management methods

Group	Support (Positive Sentiment)			Opposition (Negative Sentiment)		
	Fencing	Scarers	Culling	Fencing	Scarers	Culling
CG1	✔	✔		✔		
CG2	✔	✔	✔	✔		✔
CG3						✔
CG4				✔		
CG5		✔				
CG6			✔	✔		✔
CG7	✔		✔	✔		✔
MG8	✔		✔			✔
MG9	✔				✔	✔
MG10	✔		✔	✔		✔

The questionnaire survey included four questions specifically structured to assess any changes in preferred management response in relation to changing impact. Table 8 illustrates this data. Fencing clearly emerges as the most preferred response to all impacts for which participants are able to select it as a response. Participants' second preference overall is the use of 'scarers' to move deer away from the areas in which the impacts are occurring. The option to 'do nothing' was most preferred after these methods, and was widely preferred over and above the option of culling.

Table 8 - Ranking preferred responses to specific impacts

Response to:	1st Preference[6]	2nd Preference	3rd Preference
Increasing deer-vehicle collisions	Fencing (58.3%)	'Scarers'	Speed limits
Damage to local woodland	Fencing (73.5%)	'Scarers'	Do nothing
Damage to gardens and allotments	Fencing (73.4%)	'Scarers'	Do nothing
Increase in cruelty towards deer[7]	Increased Policing (72%)	'Scarers'	Do nothing

[6] Percentage in parentheses indicates proportion of survey respondents who selected this management response.
[7] Fencing not a given option.

Fencing

The use of fences and other protective devices to manage the potential impacts of wild deer is, overall, the most popular management response amongst local community members – although some objections and problems were identified. For example, the conflict between the erection of fences and access to land was raised, along with the problems of maintaining fences and other protective devices in the face of damage by wildlife (including deer), weather and/or vandals. The efficacy of fencing as a protection against deer was also questioned via reference to their ability to clear relatively tall fences. The cost of fencing was commonly considered to be high – yet several community members felt this cost should be met by the landowners. Some participants identified a deer welfare issue in relation to fencing and potentially inappropriate designs which may 'catch' deer as they attempt to jump or otherwise breach it. Nearly all focus-group discussions of fencing as a management option featured both negative and positive views. Questionnaire data indicates much clearer support for fencing (see Table 8 above).

> *"I think fencing would be top priority. Fence them out of the area, if they can get in – fine, haven't put up the fence well enough, that's my view."* (CG1)

> *" [fencing] strikes me as something which would have a lot of public support ..."* (CG7)

> *"...fencing would be an answer ... but I don't know whether that's practical or not."* (CG2)

> *"You would need an awful lot of fences."* (CG2)

> *"Fencing in certain situations, such as on fast roads properly sighted, is an appropriate measure. ... But you need to be careful, I mean a lot of fencing is poor quality. ... a lot of places I go the fences aren't maintained..."* (MG10)

'Scarers'

The use of 'scarers' and other similar technologies to affect deer behaviour was popular although the knowledge, and thus discussion, of how they work and could be used was very limited. The need for any such devices to be vandal-proof was also noted.

> *"I think I would prefer the scarers rather than fencing."* (CG2)

> *"The idea of putting scarers I don't think it would be a too expensive option to do that,... that may be one of the best ideas."* (CG5)

Culling

Whilst culling is, for members of the local community, clearly the least favoured management method, within the discussion groups, it has widespread support at a general level, although this is strongly contingent upon key additional criteria being fulfilled. These are that (a) all other practical management options have been attempted (i.e. culling is a "last resort"), (b) there is an existing and problematic overabundance of animals in area in which the cull is to take place, and (c) any culling activities are selective, humane and legal.

> *"I think basically speaking that's what it is, it is a last resort, is it not, culling?"* (CG2)

> *"I think that's most of our thoughts here, culling last."* (CG5)

> *"as long as people do it properly, professionally, accurately... if you've got 150 to 160 animals coming in every year you can't ignore that fact ..."* (CG7)

This general support was counter-balanced by (a) some (limited) outright rejection of culling as an activity, (b) concern that overabundance (itself required to legitimise culling as a management response) is in fact 'unnatural' and itself caused by human activities (such as the removal of predators, fundamental environmental and landscape change, and climate change), and (c) considerable opposition to culling when contextualised into the local environment (based upon the perceived rarity of wild deer locally). There was also a tendency to assume that 'the public' more widely would object to culling.

> *"I think it's cruel the shooting of wild animals"* (CG5)

> *"... they're naturally just kept to a certain population level, in a certain area."*
> *"No, they'd over-produce." ...*
> *"... all that's, generally because of human activity. They're all stuck in a certain area because of us really. In natural circumstances that wouldn't be the case."* (CG6)

> *"I think it's sad to cull a couple of deer when you've only got maybe 2 or 3 deer in an area."* (CG3)

> *"...the thought of somebody shooting at them, there would be an outcry on that, simply because it is not something you see that much ... . So I would imagine people would be quite protective, the public would be."* (CG4)

For community members, the correlation between the concept of a 'cull' and a problematic overabundance of wild animals in a certain location is critical and leads some participants to question strongly any need for a cull in their own area where no

such perception of overabundance exists. Furthermore, this correlation combined with the conceptualisation of overabundance as 'unnatural' leads some participants to establish an argument where culling cannot emerge as a legitimate management response. This argument starts from the perception that deer are not overabundant and that it should thus be possible to manage their impacts without culling. If overabundance does occur attention is then directed towards criticism of the 'unnatural' human activities and demands for the restoration of lost natural processes, instead of towards a resolution through culling. Those participants more convinced of the need for culling commonly respond to this argument by expressing the perceived difficulties (or impossibility) of restoring natural processes. Further to this other participants expressed the opinion that the 'natural' alternatives, such as predation, could actually be a worse option than management by humans, particularly in terms of deer welfare. Indeed welfare arguments are, in fact, commonly deployed by community members in support of selective, 'professional' and humane culling.

> *"By taking away the top predators we have now created a situation where we have to cull the deer, we don't really have a choice about it."* (CG2)

Perhaps unsurprisingly, the deer managers and land managers who participated in the research were more accepting of the practise of culling as a regular deer management technique. Having said this, broad concerns were expressed regarding its appropriateness in a peri-urban environment, relating primarily to the practical difficulties involved and public opinion. In general, managers perceived that a broad undercurrent of opposition to culling existed amongst 'the public', but that it was acceptable where and when the need for it was clear. The majority of managers expressed the opinion that when discussions with members of the public took place and opportunities were taken to explain the specific processes of (and needs for) culling that most individuals found it acceptable. Several managers also noted that often the way in which culling was conducted was more important, in terms of acceptability to 'the public', than the fact that it was done at all. There was a particular concern expressed that elected officials (especially within Local Authorities) were 'afraid' to support culling, and this was important due to the significant amount of land owned by these Authorities in the peri-urban environment.

> *"... as soon as you get to the point where you're talking about culling things and such like, it goes against every, what people nowadays have been brought up to believe ..."* (MG10)

> *"If you're open with the public and explain why you're doing it, 90% of the public will accept it. If you start sneaking about at night in camouflage clothing with spotlights and silencers on the rifles you're actually creating a bigger problem."* (MG9)

> *"Certainly in [county name] we'd be kind of nervous of culling, it would have to be so discrete, and we'd have to prepare the way so to speak with a lot of education and something like that we'd even have to probably get past the councillors themselves."* (MG9)

In terms of management methods, culling was clearly the most widely discussed during the focus groups. This discussion highlights some important dimensions of the attitudes held by members of the peri-urban community towards culling, along with revealing assumptions relating to public attitudes and other concerns held by managers. As with discussions relating to fencing, nearly all focus-group discussions of culling featured both negative and positive views.

Other management options

Regular opportunities were provided within both the focus-group and questionnaire research for participants to express and comment upon alternative ideas for management. As noted previously, a broad range of suggestions were made and discussed particularly in relation to those impacts considered more relevant and important such as road-traffic accidents and welfare issues.

The questionnaire results indicated that increased policing was the most preferred management response to increasing incidences of cruelty to deer (see Table 8 above). Changing driving practices, especially reducing speed, were a very strong component of responses to incidences of road traffic accidents, illustrated through both focus-group and questionnaire data. In addition to these a number of other options were identified including:

- more appropriate roadside vegetation management,
- establishment of wildlife crossings,
- encompassing deer related issues into development planning more effectively,
- widespread 'education' of communities as to the values and impacts of wild deer and information on how to deal with impacts,
- increased availability of local venison,
- reduced tree planting and/or better tree protection in the peri-urban environment, and,
- increased wildlife professionals such as rangers and "keepers".

2.3 Spatial Analysis

The distribution of people-deer interactions can vary considerably across the landscape thus spatial analysis can be a very useful additional source of management information. Within this research project GIS mapping was used to illustrate and explore the spatial distribution of land-use, people-deer interactions and our research sample, characterise the peri-urban landscape and study area, and explore the causes of specific interactions. As such, this analysis permeates throughout the research and this report.

Deer distribution and suitable habitat in peri-urban areas were synthesised from available data (including 'deer vehicle collisions') and through the examination of land cover datasets. For the purposes of this analysis, the study area was defined as the Central Scotland Forest Trust (CSFT) boundary with a 5 km external buffer, to allow for external spatial influences (e.g. deer habitat, urban centres, and DVCs) to be incorporated into the analysis. A desk-based scoping study of existing data sets was undertaken to help establish roe deer population size, distribution and trends. Sources of data were Forestry Commission Scotland, Deer Commission for Scotland, the police, the Scottish Society for the Prevention of Cruelty to Animals, Transport Scotland, and the National Deer-Vehicle Collisions project. A digital map of landcover types was constructed from relevant data sources (see Appendix D); these were converted into a grid format to enable spatial analysis to be undertaken.

The analysis explored people-deer interactions across the entire study area, focusing on road traffic accidents involving deer (Section 2.3.1), with case-study scale analysis of Natural Heritage (Section 2.3.2) and landcover (2.3.3). The objective of this analysis was to examine locations within each case-study area where people-deer interactions were likely to be greatest through an analysis of current attitudes of local residents and those who might manage peri-urban deer.

Spatial analysis has demonstrated how GIS layers showing natural heritage, landcover, thermal imaging of deer locations and RTAs involving deer can be interrogated to can be used to inform the decision support framework by highlighting locations for particular deer-people interactions. However, the low numbers of deer (for statistical analysis purposes) has limited how much these interactions can be extrapolated outside the study areas and further work is required to increase the sample size.

Deer presence

Spatial data explaining deer presence were found to be very sparse, limited to DVCs and deer welfare incidents. Thermal imaging survey data provided an indication of small-scale habitat use by roe deer (Section 2.4), but did not provide enough data points to allow a spatial analysis to be undertaken to determine habitat usage.

2.3.1 Identifying attributes that may influence road-accidents involving wild deer through spatial and statistical analysis

Road-traffic accidents involving wild deer (deer-vehicle collisions, DVCs) can be traumatic for those involved and are widely considered to be one of the most important negative interactions between deer and people. Management actions that seek to reduce the incidence of these accidents are of high importance to both community members and managers. DVC occurrences were obtained from the National Deer-Vehicle Collisions project for the period February 2003 to December 2005 and supplemented by other reported DVCs from insurance companies, Local Authorities and the Scottish Society for the Prevention of Cruelty to Animals, with the latter also providing data for 2006 to 2008. As the time periods of these data are not consistent, comparison was undertaken using only the SSPCA data (Figure 11).

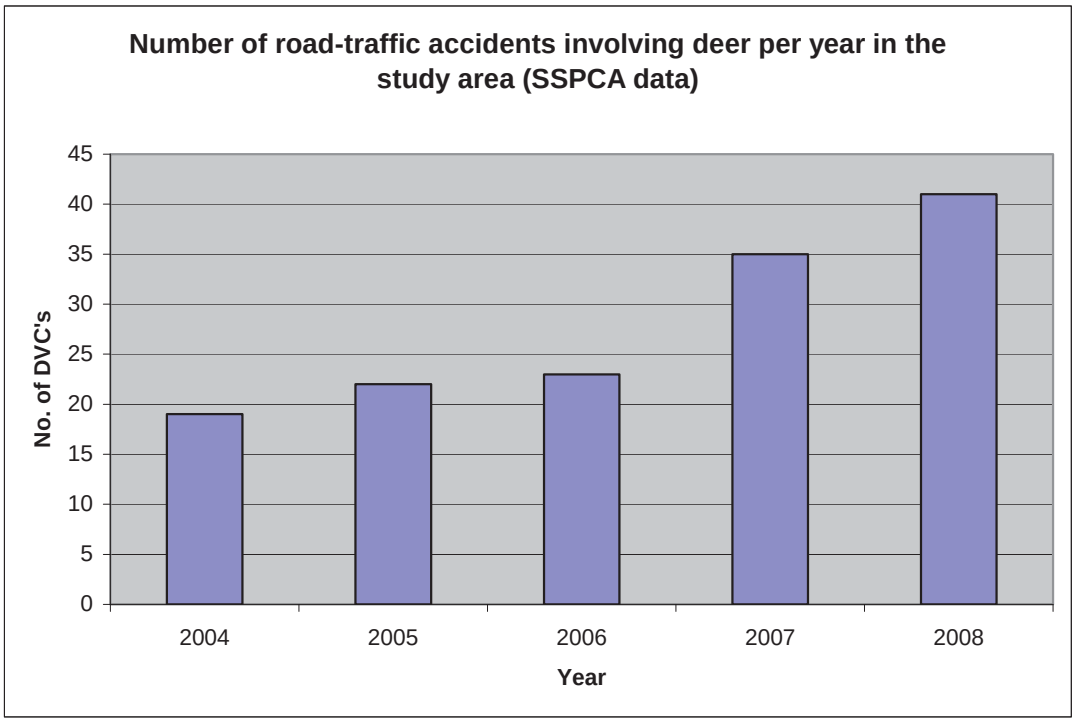


Figure 11 - Numbers of deer vehicle collisions (DVCs) reported by the SSPCA in the study area for the years 2004 to 2008

Figure 11 indicates a trend of increasing DVCs from 2004 to 2008 from SSPCA reports only. DVC's would otherwise be higher if more data were available from various stakeholders. An examination of all data averaged per month indicates a seasonal increase in the months April to June (Figure 12) with May being the highest (Figure 13).

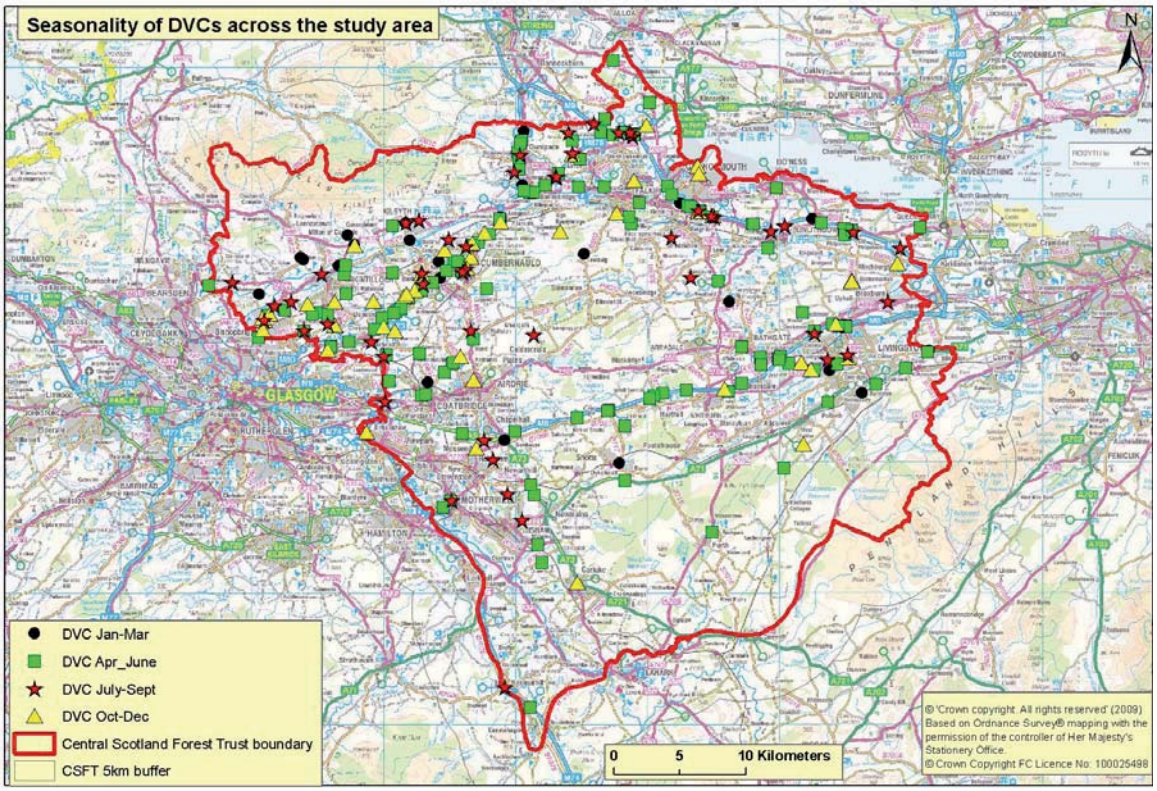


Figure 12 - Seasonality of DVCs across the study area. Each symbol represents a different three-month period

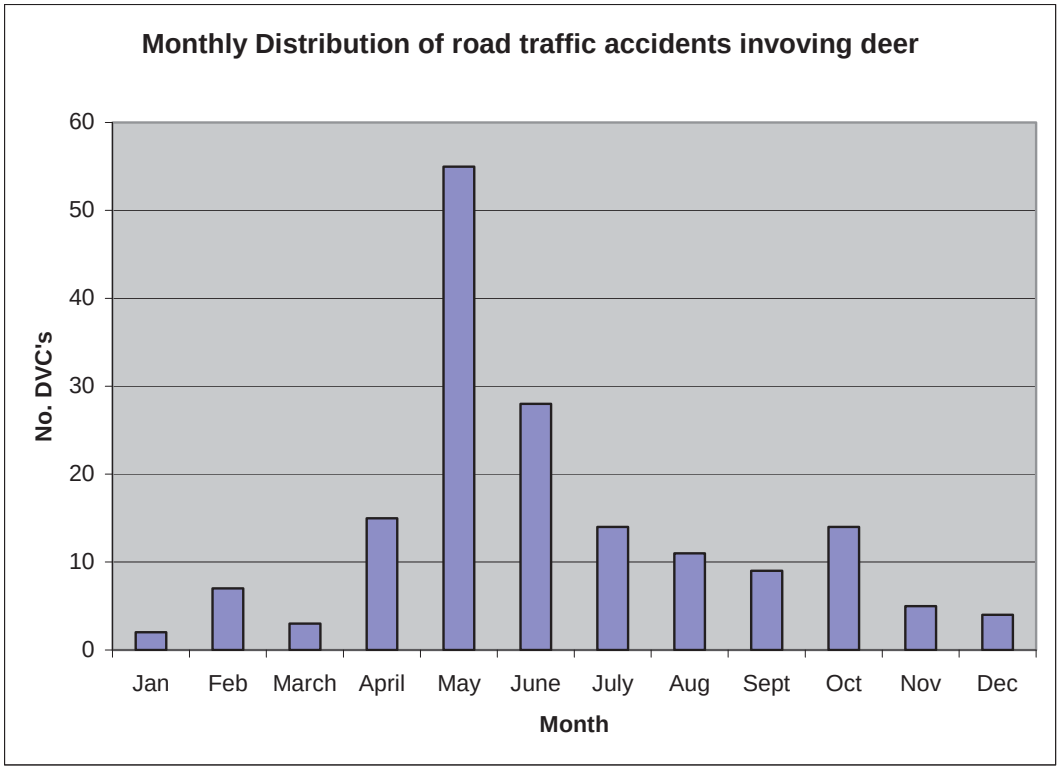


Figure 13 - Total number of deer vehicle collisions (DVCs) for the years 2004 to 2008, expressed per month

Cursory examination of the locations of DVCs indicated that some sections of roads have a higher incidence of DVCs than other sections of roads. A spatial analysis was undertaken to investigate whether there are relationships between factors that may affect deer presence (habitat and topography) and factors affecting traffic (volumes and speeds of vehicles). The analysis focused around the A80 and M9 roads as they both contained areas of high DVC occurrence and sections of road with no DVC's.

The length of the each roadway was determined by entry and exit points to the roads (junctions on motorways, major road intersections on A roads). Each roadway was subdivided into 1km sections along and adjacent to the road and values from the following data sets were extracted (Figure 14; Table 9; Appendix D):

- Traffic flow (numbers of vehicles and speeds)
- Elevation (variability in topography which may influence deer movement)
- Slope (an additional descriptor of topography, indicating the steepness of the ground adjacent to the roads)
- Landcover types (the types of landcover that may attract deer to areas surrounding the roads)

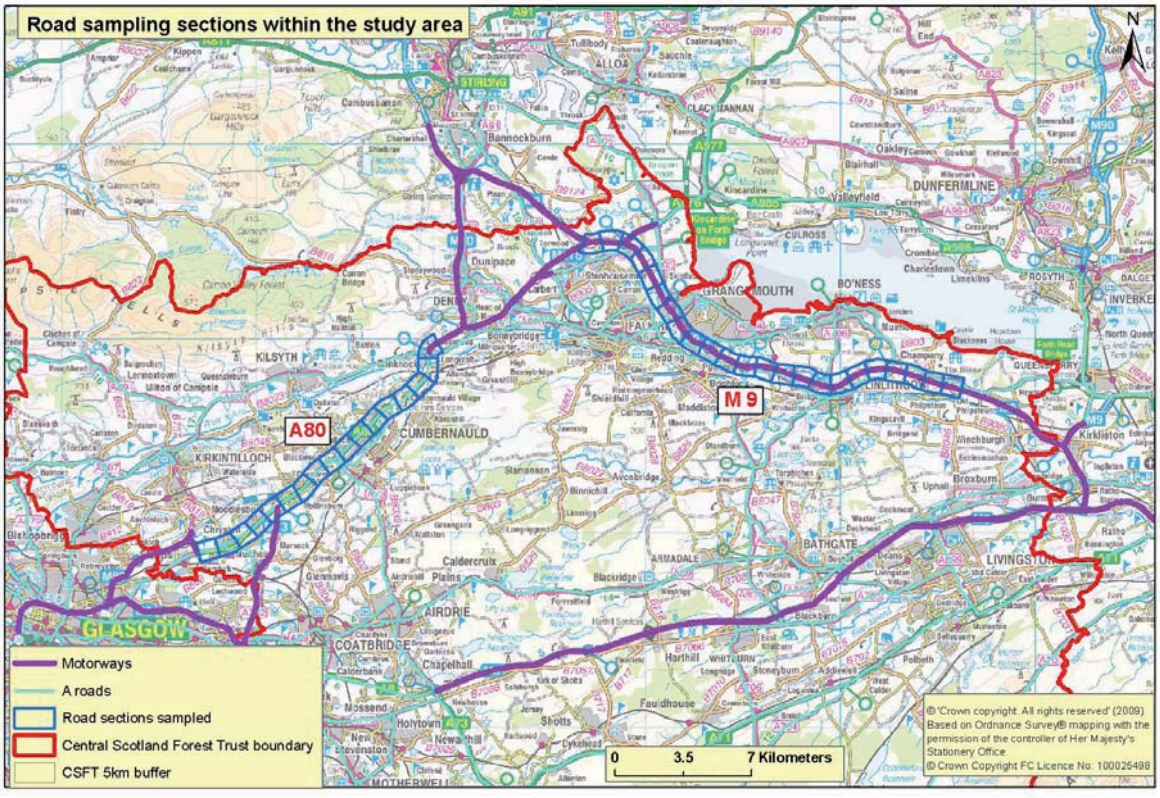


Figure 14- Road sample areas, A80 and M9 indicated by blue hatching, within the study area

Table 9 – Road sample data[8]

Landcover type	A80	M9
Open land	49.8%	72.1%
Woodland, scattered trees & scrub	18.4%	8.4%
Built environment	19.2%	13.9%
Marsh & wetland	0.2%	0.1%
Unclassified	1.0%	0.0%
Water	0.6%	2.8%
Gardens	10.8%	2.6%
Total	100.0%	100.0%
Topographical data		
Mean height (m)	9.7	35.7
Mean Slope (^{0})	3.1	1.9
Traffic data		
Deer vehicle collisions	21	30
Mean Traffic Volume (7 day average)	58646	37312
Mean Traffic Speed (MPH)	56.7	66.3

Traffic Analysis

Traffic volume and speed data were obtained from Transport Scotland. The traffic volume figures within Table D1 (Appendix D) represent the '7-day average' figure for each month over a period of 12 months. Traffic speed represents the average traffic speed of all vehicles in all lanes of each road per month. For more information on the data used and dealing with inconsistencies within the data see Appendix D.

Statistical analysis of DVC occurrence

Attributes of topography, landcover, traffic speed and traffic volume were studied in relation to DVC occurrence using Principle Component Analysis (PCA) to explore initial relationships. Exploration of all the A80 and M9 data together supported the summary

[8] Summary data for deer vehicle collisions (DVCs) in relation to traffic volumes (numbers of vehicles) and speeds (miles per hour), landcover composition, height (m), slope (degrees) within 500m on each side of the A80 and M9 sections in the study area. (Note: Mean traffic volume and speed for the A80 and M9 road was taken from 5 and 6 traffic counters respectively).

data (Table 9), which shows that the A80 sections have higher traffic numbers, more woodland and urban areas than the sections of the M9, which tend to have faster traffic and more open areas. It also indicated a clear grouping of data points by road types, indicating that the two sets of data should be treated separately.

The data for the two roads were therefore treated separately to investigate:

1. Which attributes predict the probability of a DVC (occurrence or absence), using a binomial regression.

M9 - Three attributes were statistically significant ($P < 0.05$), traffic volume and slope (positively correlated), and open ground (negatively correlated), indicating that the probability of a DVC occurring increases with higher traffic volumes, in areas with high average slope angle and less amounts of open ground than other areas.

A80 - No relationship was found between any of the attributes and DVC occurrence.

2. Which attributes explain the number of accidents, using a generalised linear model with a Poisson distribution.

A80 - There was a very weak (not statistically significant) relationship between woodland and DVC numbers, but there was very little variation in the data across the A80 section. The majority of sections had either 0, 1 or 2 DVCs, with one section having 6. This high occurrence may not be representative and could be classed as an abnormal data point or 'outlier'. However, an additional analysis with the outlier removed failed to improve model fit.

M9 - Two attributes were highly statistically significant, traffic volume (positively correlated, $P < 0.001$), and open ground (negatively correlated, $P < 0.01$), indicating that the probability of a DVC occurring increases with higher traffic volumes, in areas with less amounts of open ground than other areas.

These analyses suggest that, for this section of the M9, it may be possible to predict the probability of a DVC occurring and also where higher numbers may occur, using measures of traffic volume and landcover open ground amounts. Where traffic volumes increase, particularly in areas with low amounts of open ground, the likelihood of DVC's occurring will increase.

The difficulty in identifying a relationship between the number of DVCs ,traffic and environment data on the A80 may be due to the relatively low occurrence of DVCs within each 1km area. One aspect of road attributes not explored is the width of the roads, which is wider for the M9 than for the A80, resulting in greater amounts of traffic per lane and a longer exposure to collision for deer crossing the road.

2.3.2 Mapping Natural Heritage interactions in the case-study areas

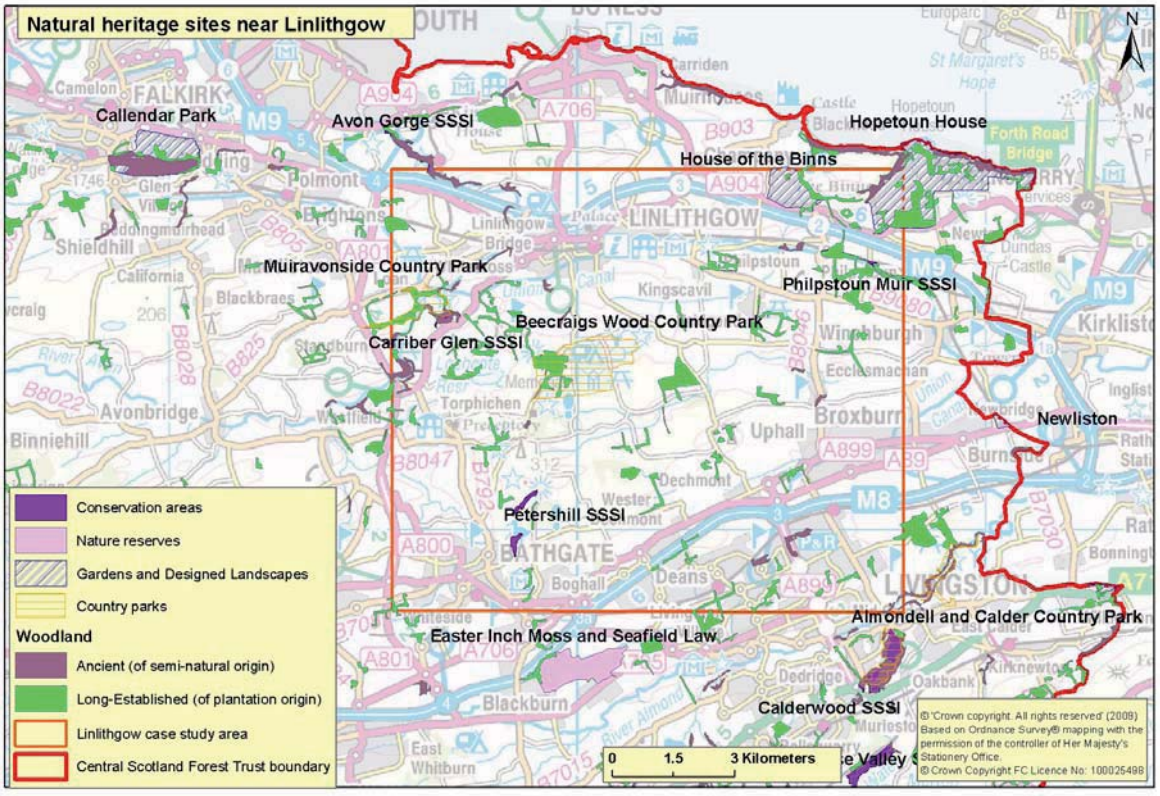


Figure 15 - Natural Heritage sites in and around the Linlithgow case-study area

Deer interact with Natural Heritage interests both positively (through, for example, disturbance and browsing woody plants off heathland) and negatively (through, for example, the prevention of natural regeneration through browsing). Mapping the location and distribution of land areas recognised for their Natural Heritage interest is therefore, an important dimension of understanding the character and distribution of people-deer interactions in the landscape. Figures 15 and 16 illustrate the distribution of land designated as a Site of Special Scientific Interest (SSSI), Local or National Nature Reserve (LNR or NNR), and Garden or Designated Landscape (GDL), along with 'Ancient' woodlands and Local Authority owned Country Parks. Both Figures show significant 'long-established' plantation woodland, along with limited 'Ancient' woodland and SSSI interests. Perhaps the most important area of designated woodland lies to the South of Wishaw, just outside the Ravenscraig case-study area, which demonstrates well that deer-people interactions are not constrained by boundaries. The mapping of the Natural Heritage spatially informs the Decision Support Framework by indicating areas of concern and identifying the organisations who share responsibility for their protection and management.

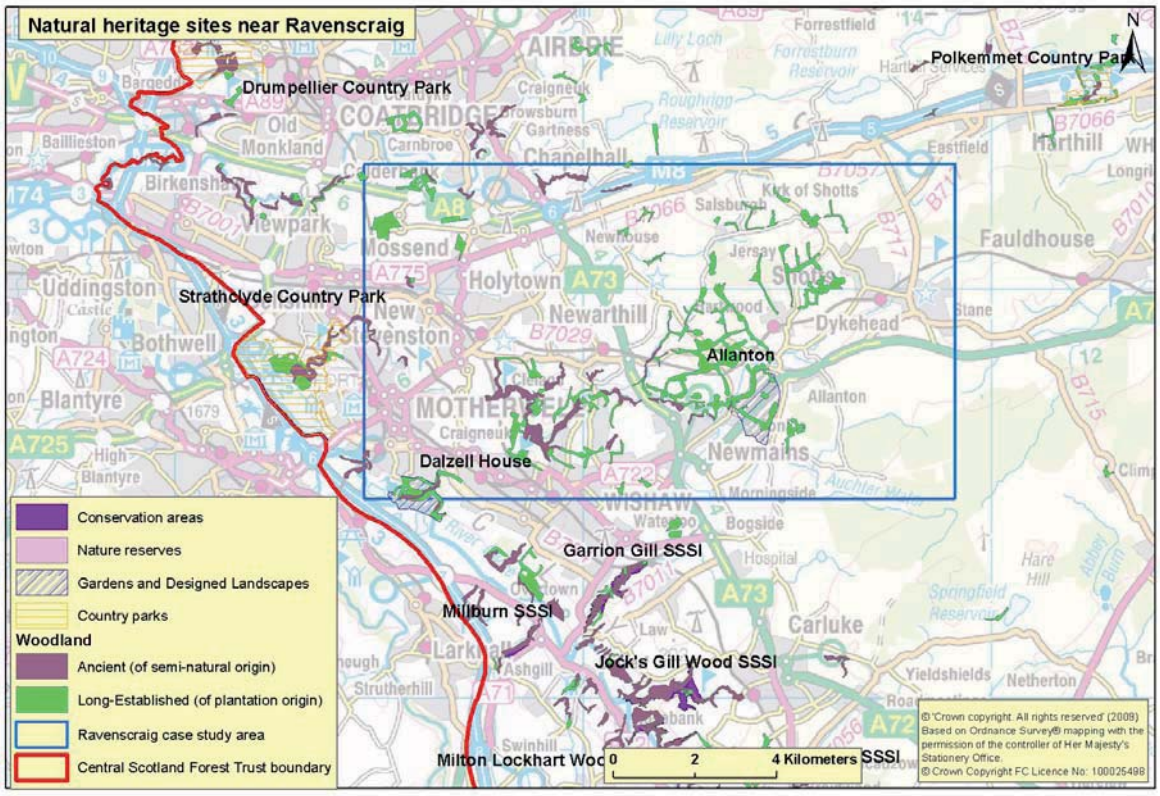


Figure 16 - Natural heritage sites in and around the Ravenscraig case-study area

2.3.3 Mapping landcover composition in the case study areas.

Landcover may affect people-deer interactions in a number of ways, with perhaps the most obvious and intuitive being that wooded areas provide key habitat for deer with the built environment providing a similar function for people. Such a basic assumption suggests a fundamental divide between people and deer, and that the interactions between them may increase where these landcover types (urban and wooded areas) are found in high (perhaps equally balanced) proportions. Landcover was simplified into three main types to illustrate the balance of urban and rural areas within the case study areas (Table 10 and Table 11). Both areas are shown to be dominated by open land (Ravenscraig 60.5%; Linlithgow 67.0%) with urban and woodland cover present in approximately equal amounts relative to each other (Ravenscraig 20.3% and 19.2% respectively; Linlithgow 17.4% and 15.7%). Landcover was extracted within a 1km radius based around the locations of 1) respondents who stated they did see deer, 2) respondents who stated they did not see deer and 3) deer positions from thermal imaging (Figure 17).

Given our basic assumption above we might expect those people who do see deer to be located within a landscape featuring higher proportions of wooded and urban landcover,

and consequently less open land (relative both to the average for the whole case-study area and to those who do not see deer). In fact, whilst this is true relative to the case-study area as a whole, the relationship does not hold relative to those who do not see deer. Instead, those who do not see deer are located in landscapes which, on average, have more (Ravenscraig) or as much (Linlithgow) wooded and urban landcover as those people who do see deer. This suggests a complex relationship between landcover and this specific deer-people interaction. Similar landcover analysis could be completed for other interactions.

That woodland provides key habitat for deer is borne out by the greatly increased woodland landcover, relative to the whole case-study area average, in which they were located via the thermal imaging surveys (see Tables 10 and 11), which also show a strong negative relationship between urban landcover and the sighting of deer via thermal imaging. Furthermore, although there were more deer sighted in the Ravenscraig case study area, this was not reflected by the number of people who stated they saw deer.

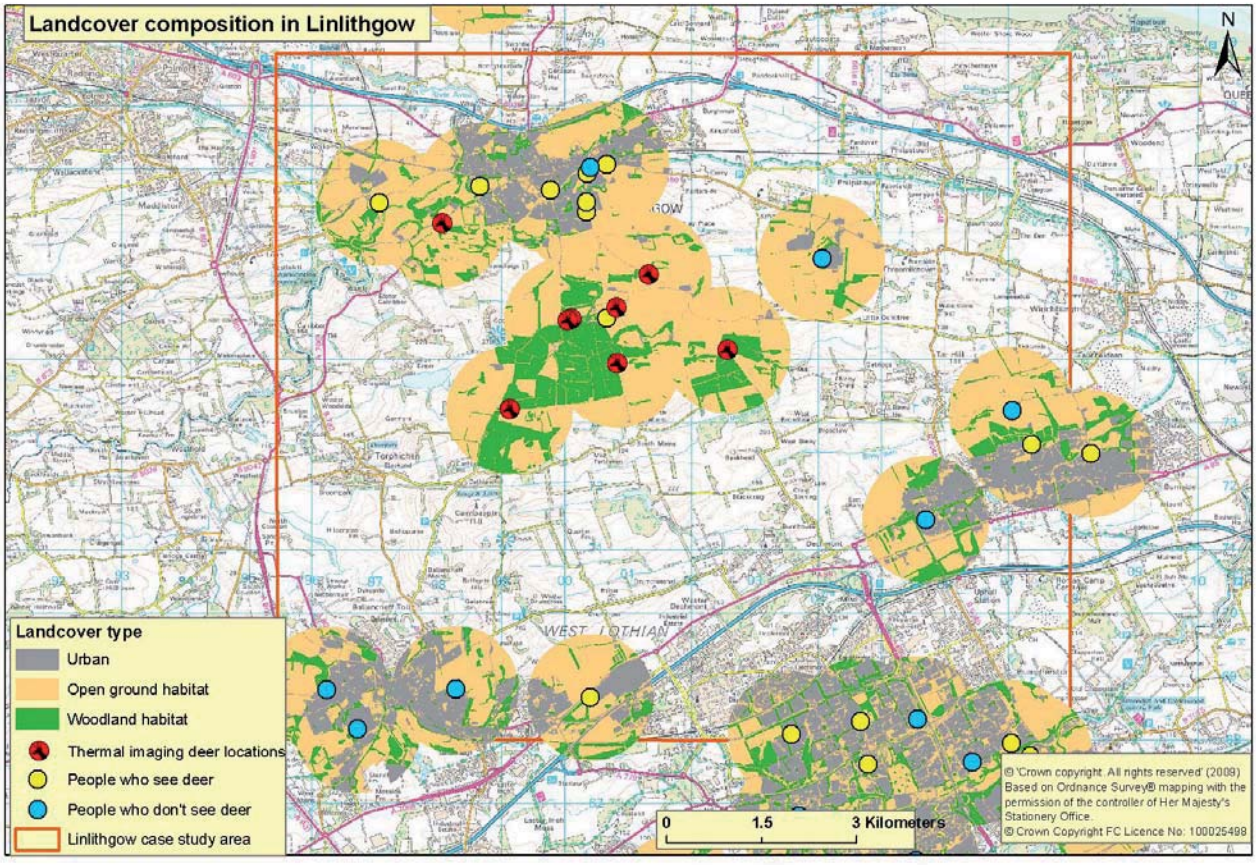


Figure 17 - Landcover composition in the Linlithgow case-study area
Landcover extraction within a 1km radius based around the locations of 1) respondents who stated they did see deer, 2) respondents who stated they did not see deer and 3) deer positions from thermal imaging

The analysis indicates that the Ravenscraig case study area has a larger proportion of urban landcover compared to that of the Linlithgow case study area. This was reflected by the thermal image deer sightings, in which 12.8% of the land within 1km of the deer was urban. However, despite the larger number of deer identified in the Ravenscraig area than in Linlithgow (See Section 2.4), fewer people reported they saw deer in the Ravenscraig area (33.5% vs. 31.1%).

The respondents who stated that they did not see deer live in areas that are more urban than those that do state they see deer, with the difference being greater in Ravenscraig, even though the deer were sighted in areas with a high urban component.

Table 10 – Summary percentage landcover types for the Ravenscraig case-study area

Ravenscraig				
Landcover type	Whole area	Do see deer	Don't see deer	Deer sighting
Urban	20.3%	31.1%	38.1%	12.8%
Open	60.5%	53.4%	46.2%	62.5%
Woodland	19.2%	15.5%	15.7%	24.7%

Table 11 - Summary percentage landcover types for the Linlithgow case study area

Linlithgow				
Landcover type	Whole area	Do see deer	Don't see deer	Deer sighting
Urban	17.4%	33.5%	36.2%	4.2%
Open	67.0%	49.0%	50.3%	68.3%
Woodland	15.7%	17.5%	13.5%	27.5%

These maps provide an important tool for communicating issues and priorities to stakeholders, and to facilitate the review of deer management and innovation of potential new strategies.

2.4 Thermal imaging

To date, relatively little attention has been focussed on assessing deer populations in peri-urban environments in the UK. Local surveys have provided information on distribution, revealing evidence of greater use of urban environments than hitherto realised (e.g. Rotherham 2000). There is also concern for the considerable damage deer can do in gardens (Coles 1997). However, it remains unclear how widespread deer are in urban environments and what numbers are involved. At the start of this study, there was little prior information on the numbers of deer in the central belt of Scotland. As a result, we undertook extensive surveys using thermal imaging. The principle objectives were to establish the distribution, to determine whether deer are widespread in the region or merely focussed in key areas, and the densities of deer present. We carried out an extensive survey in the two key study areas in the spring of 2008 and a more focussed survey in the spring of 2009.

We chose to survey the area using thermal imaging and to estimate densities using distance sampling. These methods have proved suitable for estimating deer densities in mixed woodland-rural landscapes elsewhere in the UK (Gill et al 1997; Mayle et al 1999) where other methods (such as direct counts or pellet counts) sometimes prove difficult. The method can provide information on deer presence, species composition, habitat use (at night), group sizes and population density. Accuracy is dependent on the number of observations obtained.

2.4.1 Survey methods

Assessing deer numbers requires surveying routes (either in a vehicle or on foot) using portable thermal imaging equipment, in our case a Pilkington Lite imager. When deer were encountered, information on deer group sizes, distance and bearings and GPS position were recorded. This data was then used to estimate density using distance sampling (Buckland et al 1997).

Survey routes were planned and marked on maps prior to each survey. As a general rule, it is recommended to survey approximately 2.5 km of transect route through woodlands and 1 km through fields per km^2 respectively, to ensure sufficient coverage of the survey area (Gill et al 1997). In the absence of prior information on deer distribution however, we chose to undertake an extensive survey at low sampling intensity in 2008, covering approximately 80 and 188 km^2 in Linlithgow and Ravenscraig respectively. It did not prove possible to survey all of the planned routes in 2008, however the majority of each study area was covered. The 2008 surveys yielded observations of only 3 groups of deer in Linlithgow and 17 in Ravenscraig, rather less than initially anticipated. As a result we chose to survey the areas again in 2009, but instead focussing on smaller areas, where deer had been seen (Figures 18 & 19). On

this occasion, we were able get close to the recommended sampling intensity in all areas except in the Heatherhead plantation (Table 12).

Table 12 - Thermal imaging survey effort

Study area	Year	Sub-area	Area (Km^2)		Total Transect Length (Km)		Sampling Intensity (Transect length/Area)	
			Forests	Open areas	Forests	Open areas	Forests	Open areas
Linlithgow	2008		8.00	72.00	10.7	78.0	1.34	1.08
	2009	Beecraigs	5.50	25.00	13.2	33.0	2.40	1.32
Ravenscraig	2008		18.00	170.00	19.2	60.9	1.07	0.36
	2009	Coltness	2.55	16.00	12.0	21.6	4.71	1.35
		Heatherhead	2.85	9.65	3.4	7.5	1.19	0.78
		Calderbank	1.25	8.65	2.5	9.0	2.00	1.04

2.4.2 Data analysis

Estimates of density were obtained using distance software (version 5.0 release 2). Estimates of density using this method assume that the probability of detecting animals can be estimated from the frequency distribution of distances to each group of animals actually observed during the survey. However this approach is dependent on an adequate sample of distances (>50 are recommended by Buckland et al 1997). Further, since detection rates vary in relation to habitat type, a separate detection function is usually needed for woodlands and open habitats. Since our total sample only comprised 30 observations, we used data from previously published surveys of roe deer (Gill et al 1997; Hemami et al 2007; Gill 2009 in prep) to fit a detection function. These surveys provided a sample of 1017 observations of roe deer groups from 21 sites in woodland habitats and 211 groups from 11 sites in open (field) habitats.

Data from both 2008 and 2009 were combined for analysis. Initially, estimates were obtained for each sub-area, however since density estimates did not differ significantly between the 3 Ravenscraig sub-areas, only a mean of these areas was estimated. Since all 4 sub-areas sampled in 2009 included all observations made in 2008, the densities and estimated population sizes refer to these sub-areas, not the entire study areas. The distribution of detection distances obtained in both woodlands and open areas ('fields') is shown in Figures 20 and 21.

2.4.3 Deer species and distribution

Of the 30 groups observed 90% (27) were identified as roe deer; the remainder were classed as 'unidentified'. The distribution of observations shows that deer have a tendency to be associated with woodland cover. Although more observations were made in open areas rather than woodlands, most of these were seen to be close to woodland cover. None were seen in areas far from woodland cover, nor in the most built-up areas.

Unfortunately it was not possible to obtain access to some of the forest blocks in Ravenscraig (Auchterhead OS 287 656, Heatherhead OS 284 660 and Ravenscraig plantation OS 278 657), so the status of deer in these areas are somewhat unclear.

2.4.4 Density estimates

The estimated densities of deer ranged from 0.8-3.3 Km^{-2} with significantly higher densities in Ravenscraig than Linlithgow (Table 13). The 95% confidence intervals are large, as a result (primarily) of the small number of observations. The low precision needs to be borne in mind when interpreting the estimates.

Although the use of detection data from other sites enabled us to obtain a density estimate for these two areas, the estimates could be biased if detection rates differ substantially from the average of 21 and 11 sites used for forest and field estimates respectively. The detection functions however reveal a reasonable match to the distribution of distances obtained, with the exception that the proportion of detections in woodlands in our 2 study areas declined more quickly beyond 25m than indicated by the detection functions. Further, access to some of the larger forest blocks proved to be difficult, and it is possible that vegetation on some of the former industrial sites offered more concealment than indicated by the extent of woodland marked on the OS map. This suggests that densities in the forests may have been underestimated. However the extent of woodland cover in both study areas is limited - just 18% in Linlithgow and 16% in Ravenscraig. Unless a large number of deer occur in the inaccessible woodland, estimates of numbers overall would be little affected.

Table 13 - Density Estimates

Study Area		Number of groups observed	Encounter rate (Groups per km transect)	Mean group size	Effective strip width (m)	Density (Deer Km^{-2})	95% Confidence interval	%cv	Estimated numbers
Linlithgow	Forests	2	0.141	1.0	92.8	0.8	0.3-2.2	55	4
	Open Areas	6	0.148	2.0	173.0	0.9	0.3-2.2	50	21
	Total								25
Ravenscraig	Forests	10	0.364	1.7	92.8	3.3	1.3-8.2	47	22
	Open Areas	12	0.198	2.4	173.0	1.4	0.6-3.0	41	47
	Total								69

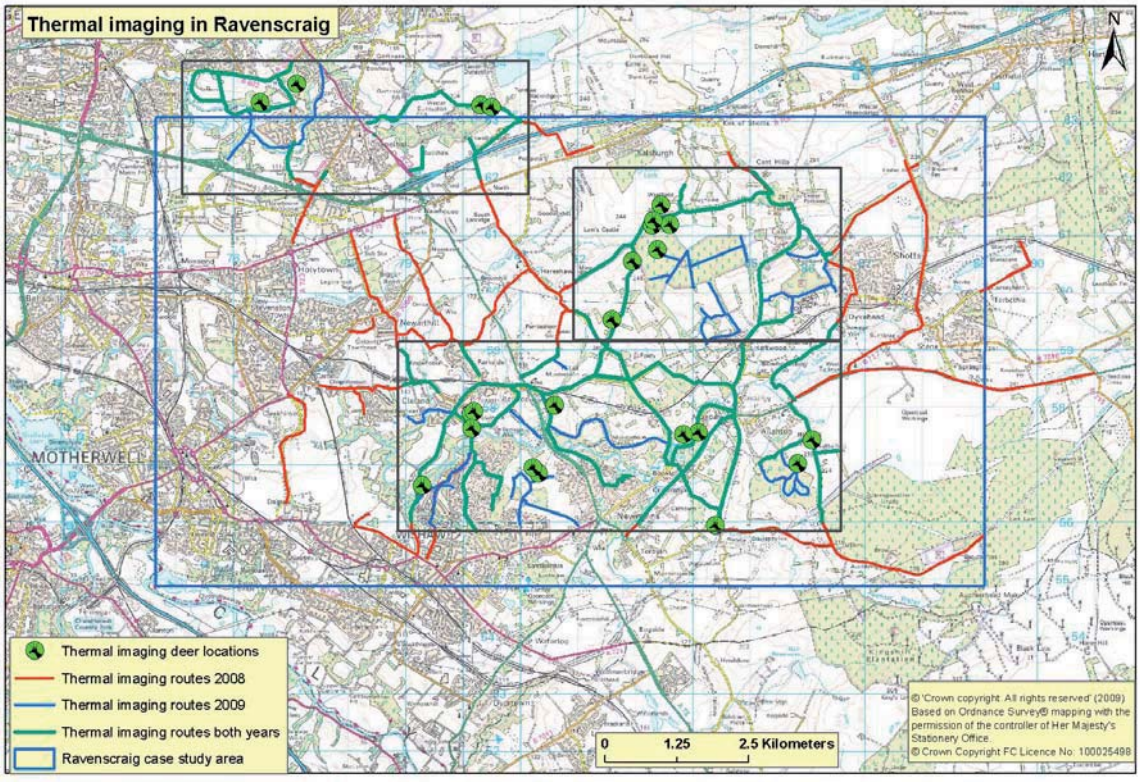


Figure 18 - Thermal imaging survey routes and sightings - Ravenscraig

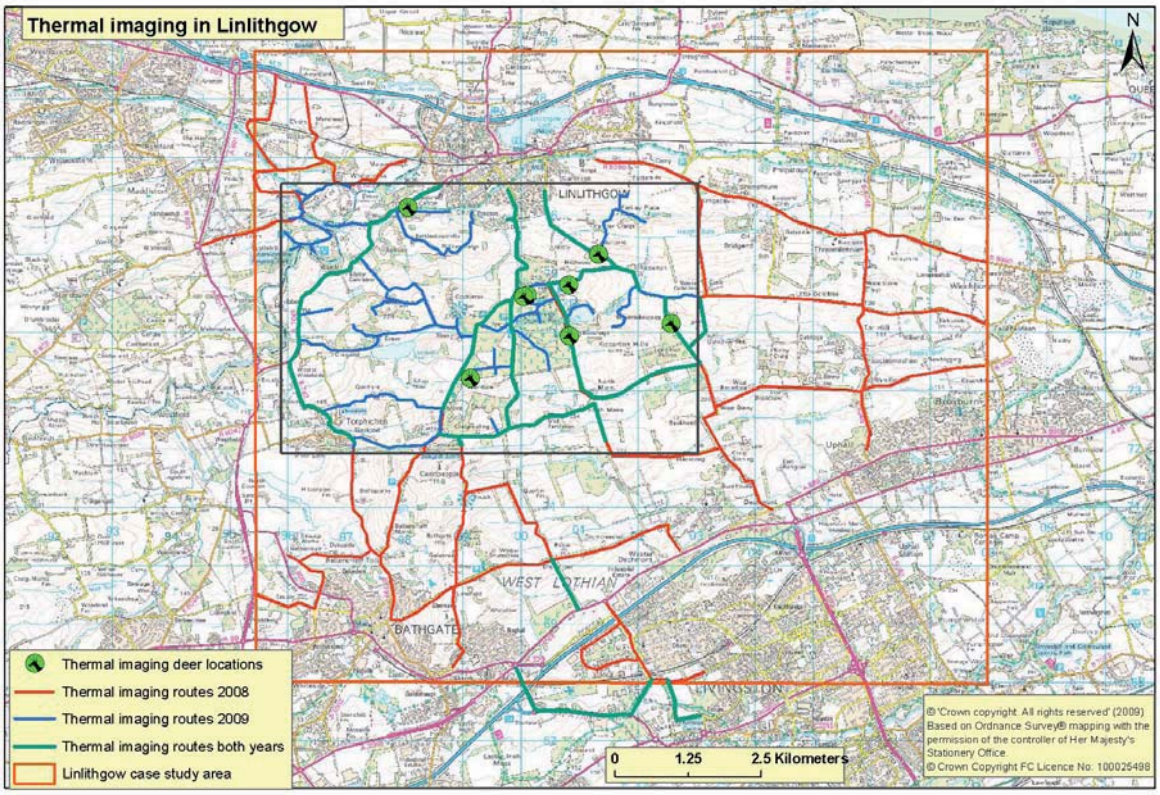


Figure 19 - Thermal imaging survey routes and sightings - Linlithgow

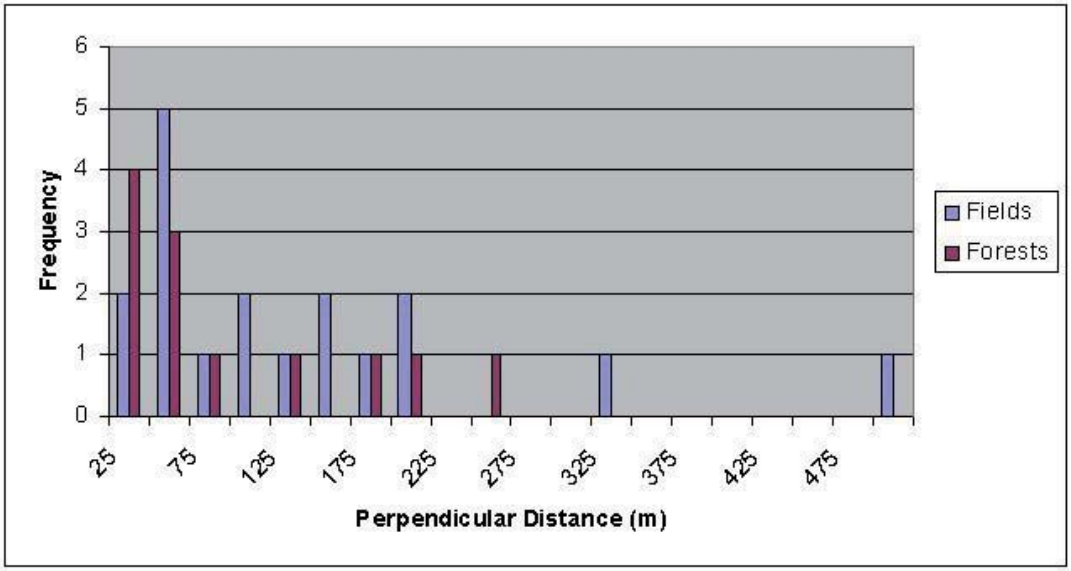


Figure 20 - The distribution of perpendicular distances obtained in forests in and open areas ('fields') in both study areas

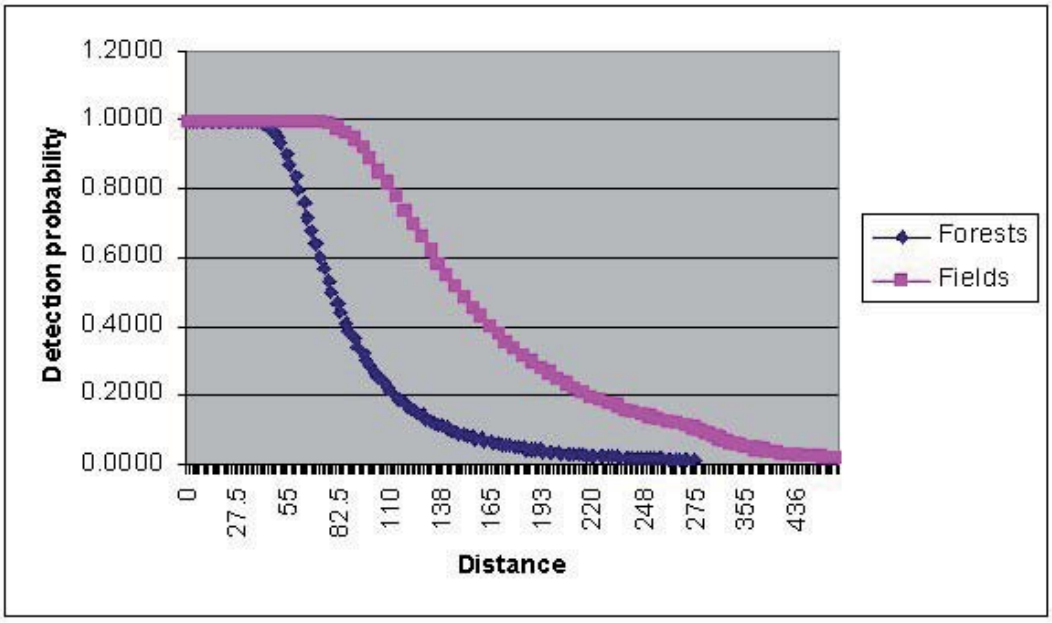


Figure 21 - Detection functions used to estimate density

3. Discussion & Synthesis (including decision framework)

3.1 Discussion

The research presented here is of interest and importance to policy and decision-makers, land and wildlife managers, researchers and members of the communities across peri-urban Scotland. It confirms some elements of 'received wisdom' regarding the issues surrounding wild deer in this environment, along with challenging others.

Our social research indicates that people-deer interactions (and hence value capture and impacts felt) are very limited in the peri-urban environment of central Scotland. This is mirrored and in part explained by the low numbers and densities of wild deer reported through the thermal imaging survey work undertaken. Spatial and statistical analysis reveals further that interactions are relatively sparsely distributed across the landscape, although in some instances clustered in specific locations.

These factors have a profound effect on the perceived need, and associated support, for deer management from local stakeholders, particularly when management is construed in terms of direct deer control. Where impacts are not felt and values are limited because of a restricted resource, the need for management, which may further restrict that resource, is not clear. One key finding of this research is, therefore, that there is a very clear need to establish appropriate reasons for deer management, and that these reasons must have a very strong evidence base familiar to local communities and managers. Currently the reasons and evidence are lacking.

Both local community members and deer/land managers demand clear reasons for direct management, including culling. For example '*I love shooting, however, ... I also don't feel that we should just go out shooting them just because they're there and because they* may *cause us a little bit of a problem'* (MG10). Perhaps the primary distinction is that managers are more familiar with the reasons for direct management of wild deer in rural areas.

Whilst interactions may be sparse, the research results presented in Section 2 illustrate that they are widespread, varied and complex. Wild deer are highly valued elements of the peri-urban environment, although the most important forms of value (seeing deer and sharing the environment with them) are the least tangible and perhaps least widely understood and acknowledged by those stakeholders and decisions makers traditionally

involved with deer. There is no reason to assume that these values are not equally important elsewhere (i.e. in rural areas), although they are perhaps paralleled or exceeded by other impacts and values of more substantive relevance in these areas. These findings compare closely with those of other published studies, particularly in the United States, where seeing and watching deer in the local area are often ranked as most important amongst the benefits obtained by communities (see for example, Shanahan, Siemer and Pleasant 2001; Lauber, Anthony and Knuth 2001).

This research project has also identified a considerable range of values associated with wild deer (both extrinsic and intrinsic), which again mirrors more rigorous studies of the range of values associable with wildlife more generally. Table 14 lists three typologies of wildlife values (extrinsic categories only) alongside those identified by research for this project. Of the major thematic categories common to other typologies, only religious/sacred and personal character-building/psychological categories of extrinsic value were not explicitly identified.

Table 14 - Categories of extrinsic wildlife value from existing typologies and this research

Kellert (1996)	Rolston (1994)	Dandy (2005)	This research
Utilitarian	Economic	Subsistence	Food source
Ecologistic–scientific	Scientific	Commercial	Commercial
Naturalistic	Biodiversity	Ecological	Ecological
Aesthetic	Aesthetic	Aesthetic	Aesthetic
Moralistic	Philosophical and religious	Sacred	Recreational
Symbolic	Cultural symbolization	Cultural	Cultural
Dominionistic	Recreational	Recreational	Existence
Humanistic	Character-building	Educational	Educational
Negativitstic	Historical	Political	Political
	Diversity-unity	Indirect Duty	
	Stability and spontaneity	Psychological	
	Dialectical		
	Life		
	Life support		

It is also clearly understood that wild deer have the potential to impact negatively upon communities and individuals in peri-urban Scotland, although currently those impacts are very limited. Those impacts considered most important and relevant to communities in the peri-urban environment (RTAs and deliberate acts of cruelty) are clearly distinct from those (such as forestry and agricultural crop damage) which long standing institutions and common practices have evolved to address and which traditional

stakeholders and decision-makers have previously had to consider. Again our research parallels other published studies which reveal that road-traffic accidents can be of very great importance to local communities (see Shanahan, Siemer & Pleasant 2001; Lauber, Anthony and Knuth 2001). Disease transmission, of medium concern to the research participants in our study, is of perhaps greater significance in published studies in the United States (where both Lyme and Chronic Wasting disease are important concerns, see for example Brown *et al*. 2005).

Whilst strong agreement is evident across community, manager and other organisational stakeholders as to the prioritisation of RTAs and welfare issues as of primary importance, there is an apparent discrepancy between the importance attached by different stakeholders to some impacts of lesser importance. The clearest examples here are damage caused by wild deer to private gardens and to other publicly important sites. The perception amongst some established stakeholders, strongly reflected in the popular media (*The Independent* 2004), is that these impacts are important, but this in clear and distinct contrast to our findings. This may be a reflection of the specific social groups which feed information in to these traditional stakeholders and the media, thus re-affirming that information must be sought from a wider base.

The social research conducted for this project also reveals much regarding the knowledge of and preferences for different management responses. In particular, it is clear that members of the local community and local deer/land managers tend to conceptualise management responses within the much wider and complicated context of human activity, and not as reactions to straight-forward and discrete impacts. The identification of the many and varied 'causes' of deer-people interactions, focusing often on anthropogenic phenomena such as urbanisation, chosen lifestyles and poor driving practices, seems to demand that, or, more positively, to provide a mandate for, policy and decision-makers encompass these into their processes.

Direct management via traditional methods such as fencing and culling is not, however, dismissed totally. Indeed, Section 2 indicates very high levels of support for fencing and the use of 'scarers' where they are deemed an appropriate and effective response to certain interactions. The low, but existing, level of support for culling is once again in line with other published studies. A number of studies in the United States have revealed that, whilst they are rarely the most preferred option, some minority support does exist for the use of lethal techniques to control deer amongst urban and sub-urban residents (see for example, Chase, Siemer, and Decker 1999; Lauber & Knuth 1998; Lauber and Knuth 2000). These studies also indicate that there are seemingly significant increases in acceptance following brief information provision describing and explaining the methods (Shanahan, Siemer & Pleasant 2001). Such support is apparently strongest where interactions between people and wild deer are common in the community. Commonly support for lethal control is strongly divided along gender

lines with males being more accepting of such techniques (Dougherty *et al.* 2003; Lauber *et al.* 2001; Kellert and Berry 1987), although no such division was apparent from the results of our study. In the UK very little research has been conducted public attitudes to lethal control other than in relation to 'invasive' species, where high levels of support were revealed in Scotland (Bremner & Park 2007). Studies, again in the United States, reveal high levels of support (majority) for control of deer reproduction and 'trap and remove' techniques (Chase, Siemer, and Decker 1999), which were not either options put forward by the research team, nor were they mentioned often by research participants. 'Sterilisation' was raised in just one focus-group by a member of the local community.

Employing spatial analysis techniques has enabled the research team to explore the geographical distribution of some people-deer interactions within the study area. Whilst the project team do not have access to the necessary data to populate a full exploration of interactions in this way, Figures 22 and 23 illustrate some of these. This spatial analysis can provide considerable benefit for stakeholders making decisions about the necessity, location and form of management in their area. Figure 22, for example, may lead a decision-maker to conclude that deer-people interactions are well developed and common in the area around Chapelhall in the North of the area as many residents there report seeing deer locally and a few RTAs have been reported there. The same decision-maker may identify Shotts, where residents report not seeing deer, as an appropriate location for significant community capacity building including, perhaps, guided walks around the local woodland where deer are known to be present.

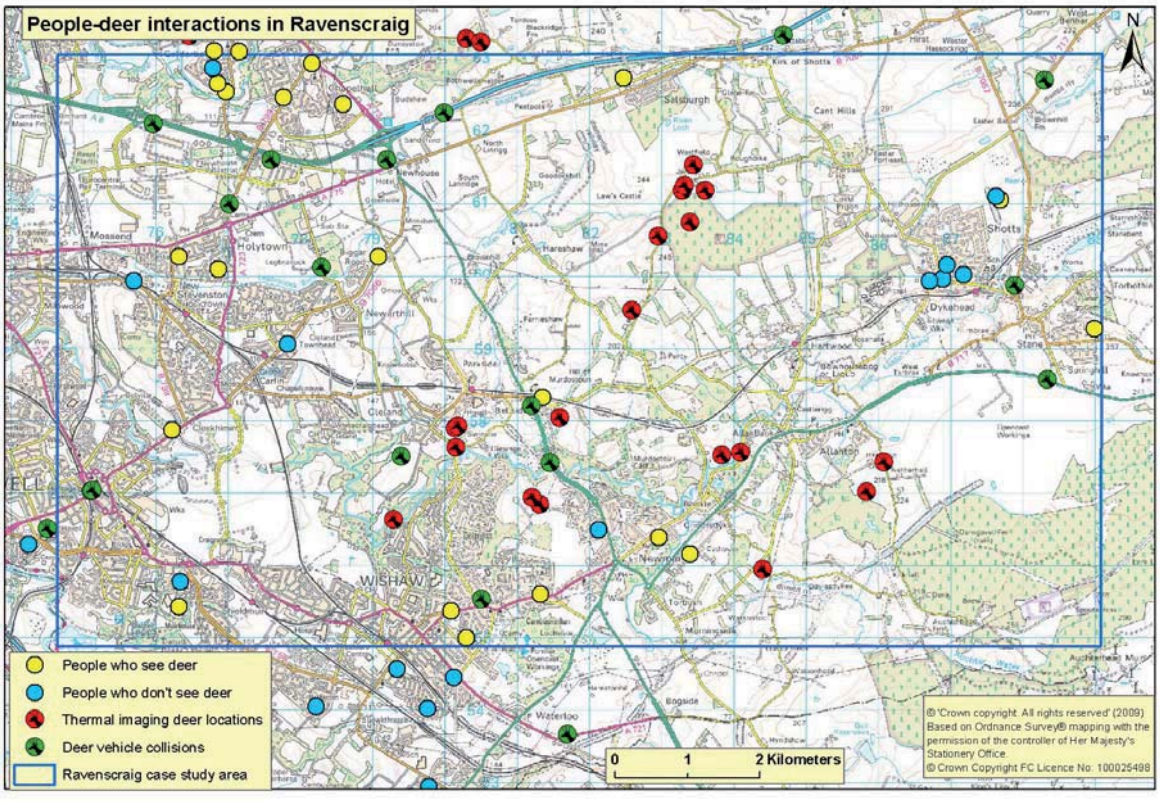


Figure 22- People-deer interactions - Ravenscraig

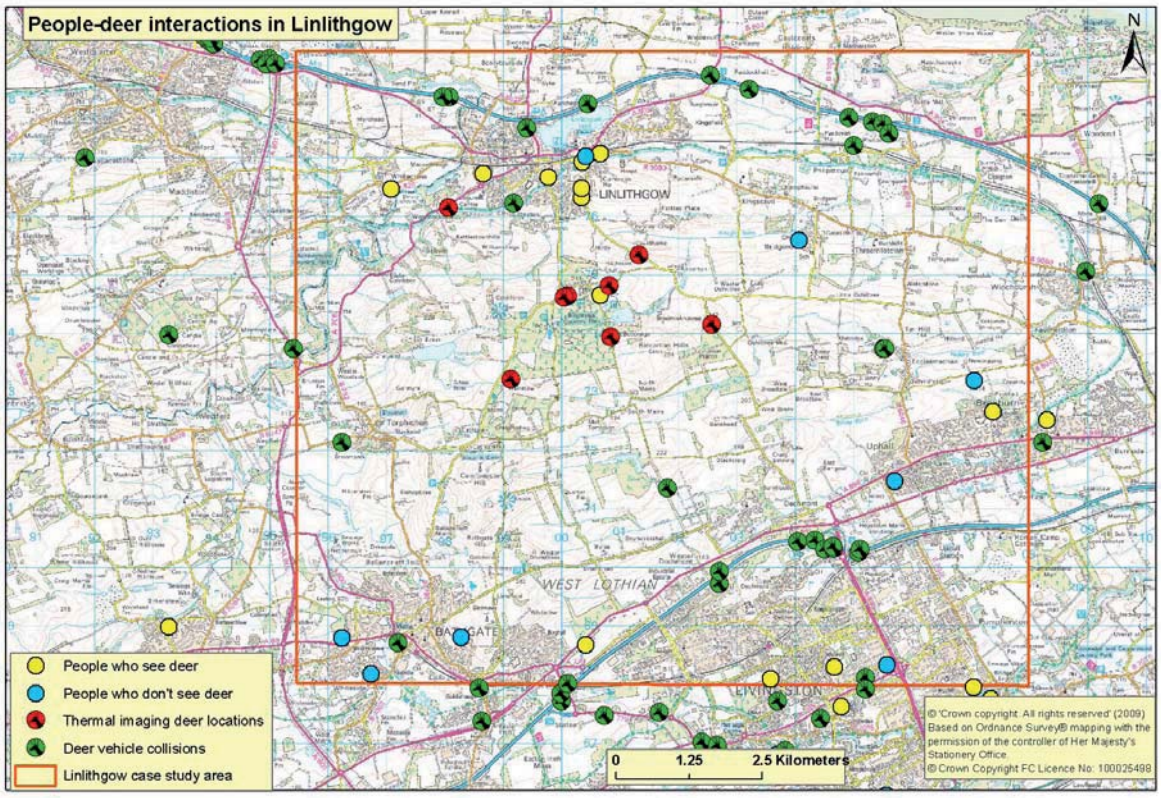


Figure 23 - People-deer interactions - Linlithgow

The data illustrated in Figure 23, may well lead an interested stakeholder to focus upon Livingston in an attempt to tackle the cluster of road-traffic accidents that surround it. Initial management responses might include seeking better knowledge regarding where the deer involved in RTAs are residing as they appear somewhat removed from the locations in which they are known to be present around Beecraigs Country park. Such spatial data and analysis could form the basis of a more nuanced approach to partnership formation and acceptance of responsibility for management.

The thermal imaging research indicated that most deer were located, as to be expected, in or around the larger woodland areas. Very few observations were made in more open areas. This is in apparent contrast to the RTA data, which reveals a more widespread distribution, including some in built-up areas. However it needs to be remembered that RTA data is accumulated over several years, in contrast the thermal imaging which is obtained over a few nights. Further, RTA's are likely to arise in response to disturbance or dispersal, so may reflect locations were deer can get to, but are beyond their normal patterns of habitat use.

The precision of density estimates can usually be improved by increasing sampling effort. However, this increases costs proportionally, and where densities are low it is unlikely that worthwhile improvements in precision can be achieved with limited

resources. If there is a need to obtain density estimates to support management in the future it may be worth considering alternative methods. Airborne thermal imaging may provide good estimates over inaccessible land, but further research is needed to verify accuracy, and it may prove expensive. Drive counts have been used in relatively open environments in the lowlands with reasonable success, but require the co-operation of a large number of volunteer observers to be effective. This however may be feasible if sufficient interest can be raised amongst local voluntary groups, and access agreements can be obtained from key landowners. Alternatively pellet counts can be considered, especially for the larger forest blocks (Swanson et al 2008).

The density estimates obtained in this study were lower than initially anticipated. However given the fact that there is relatively little information on deer densities in peri-urban habitats, it may well be that the higher contact rate between people and deer has gives an impression of higher deer numbers than more rural landscapes. A lower deer population also provides more scope to pursue management options to facilitate opportunities for wildlife observation than for control to limit impacts.

3.1.1 New Approaches to Management

That people-deer interactions in peri-urban Scotland are limited, complex and unfamiliar demands at least some innovation in approaches to management. First and foremost it is crucial for potential managers to be able to appropriately assess the overall balance between positive and negative interactions. Whilst it may be the case that some impacts, where serious, will over-ride all values, it appears this is unlikely to often be the case. This balance will, however, change over time. Literature suggests that it is crucial to understand what stage natural resource management issues are at before considering management responses (Raik, Siemer and Decker 2005). Currently interactions in the Central Belt are very limited, but it is important to recognise both that this could change (and be changed) and that it presents opportunities for managing deer-people interactions very effectively. A range of interventions at this stage could produce significant gains in terms of increased value capture and reduced impacts in the longer term. This illustrates the benefits of approaching 'deer management' as 'managing people-deer interactions' as the latter approach facilitates management actions to increase positive interactions along with controlling or reducing the negative ones.

Given the breath and complexity of interactions, a second key requirement is a broad suite of management options, with inbuilt flexibility and individual options linked directly to individual interactions. Literature and practice also suggest that one of the best responses to complexity and unfamiliarity in resource management issues is the adoption of partnership working arrangements (collaborative management) which, amongst the other things, facilitates knowledge and information exchange between stakeholders including local communities. Different stakeholders have different capacities to respond to the various management challenges faced. Some can provide

useful information, others resources and skills, and others still continuity and administration. A further management requirement is the need to link management options to the stakeholders which are able to effectively implement them with existing resources and skills.

3.2 Introducing the Decision Support Framework

Section 3.3 recommends a decision support framework through which interested stakeholders can assess the need for and potential form of, management of deer-people interactions in the peri-urban environment. The framework enables the user to identify the interactions relevant locally to their area of concern, list potential management responses, identify relevant stakeholders organisations to select management options and assume responsibility for them, and from a partnership to implement and monitor the chosen management options.

Interactions ⇒ Management Options ⇒ Stakeholders ⇒ Partnership

3.2.1 Phase one – Scoping

Table A enables the user to identify the people-deer interactions relevant to the local setting in which management is to be considered. It can be used either as a simple checklist to record presence or absence of interactions, or, where a deeper level of understanding of the local situation is required, as a template in which to score the importance and relevance of interactions locally- in 'consultation' with the data sources. Where there is no, or inadequate, knowledge pertaining to a particular interaction Table A facilitates the gathering of data and advice by identifying those stakeholder organisations most likely to be able to provide it.

Selection of an appropriate geographical area within which to consider the need for management is, of course, an important early step for interested stakeholders. Recommending precise parameters around this decision was not within the scope of the research project, however scoping the distribution and scale of interactions will very likely provide stakeholders with an insight in the appropriate scale of management.

3.2.2 Phase two – Solutions

Table B enables the user to identify the potential management options available as responses to the individual interactions to be managed in the local area. Management options are listed in likely order of preference for local stakeholders as established through this research, and should not be seen as mutually exclusive. Multiple management responses may well be appropriate. The user can then make an informed choice between the full range of management options.

3.2.3 Phase three – Involvement

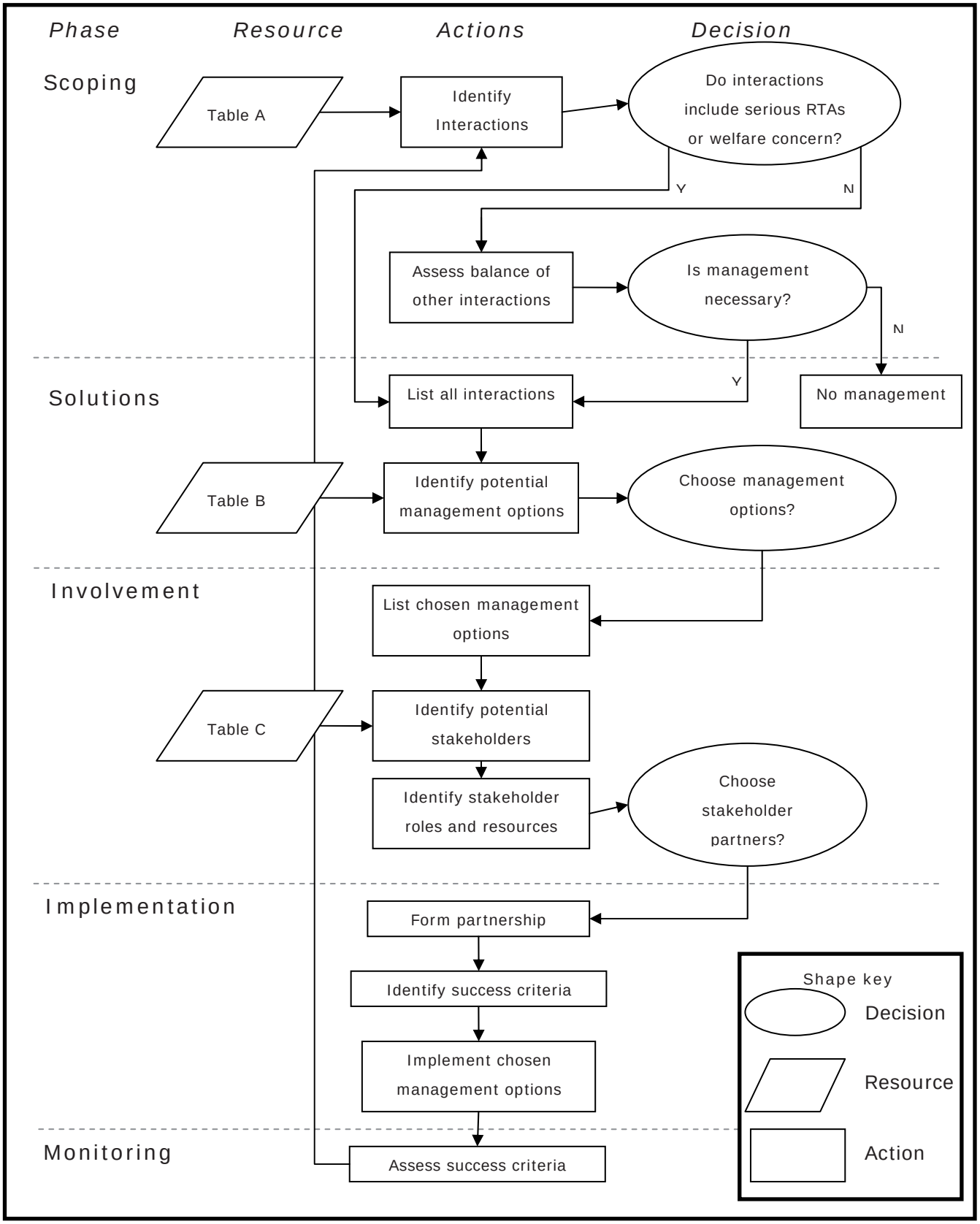
Table C enables the user to identify the potential stakeholders required to implement the chosen management options, along with their potential roles and responsibilities. In Table C stakeholder organisations are not necessarily listed in order of significance or importance for the implementation of each management option, and should not be considered mutually exclusive. Indeed in many cases several, if not all, of the identified stakeholders could be essential to the effective implementation of the management option. Once a list of potential stakeholders is available, negotiation between them can be initiated with regard to what capacity may exist in the relevant area for partnership working.

The potential roles and responsibilities of stakeholders can also be identified during this phase. These roles and responsibilities must be taken on by individual stakeholders following negotiation of the overall proposed management approach amongst all those potential involved.

3.2.4 Phases four and five – Implementation and Monitoring

The final two phases of the decision support framework are where management shifts from proposed to actual, with the formation of a partnership, the establishment of success criteria, and the implementation of the chosen management options. Time boundaries need to be agreed amongst partners within which progress will be assessed against the success criteria and information fed back into the first phase of the framework in order to reassess the need for (continued) management.

3.3 Decision Support Framework - Flow Diagram



3.4 Decision Support Framework - Tables

Table A. Phase 1 - Scoping Deer-people Interactions in the Peri-urban Environment – Checklist

Impact Type	Known or likely Serious Occurrence	Known Occurrence	No Occurrence	No / inadequate knowledge	Potential Data Sources
Road-traffic accidents					UK National Deer-vehicle Collisions Project Transport Scotland Local Authority Scottish Society for the Prevention of Cruelty to Animals Deer Commission for Scotland
Acts of cruelty towards deer					Scottish Society for the Prevention of Cruelty to Animals Police Constabulary Local community Deer Commission for Scotland
Woodland damage – Natural Heritage					Scottish Natural Heritage Forestry Commission, Scotland Local woodland bodies (e.g. CSFT) Deer Commission for Scotland
Woodland damage – Forestry crop					Forestry Commission, Scotland Private woodland owners & forestry companies Deer Commission for Scotland
Agricultural or commercial horticultural damage					National Farmers Union, Scotland Local farmers & growers Deer Commission for Scotland
Private garden damage					Local community
Intake of toxins by deer					Scottish Environment Protection Agency Local Authority
Disease transmission					Health Protection Agency, Scotland Veterinarian organisations & individuals Deer Commission for Scotland
Damage to other					Local Authority

publicly important sites					Public and private site owners & managers
Value Type	Known or likely High Value Capture	Known Value Capture	No Value Capture	Potential Value / No	Data Sources
Cultural value					Local community Deer Commission for Scotland
Ecological services					Scottish Natural Heritage Forestry Commission, Scotland Deer Commission for Scotland
Seeing deer (aesthetic value)					Local community British Deer Society Deer Commission for Scotland
Economic value 1 – through recreational stalking					British Deer Society British Association for Shooting and Conservation Deer Commission for Scotland
Economic value 2 – as a 'tourist' attraction					Visit Scotland Deer Commission for Scotland
Venison consumption					Local deer managers Local community Scottish Game Dealers and Processors Association Deer Commission for Scotland

Table B – Phase 2 – Identifying Solutions

Impact Type	Potential Management Responses
Road-traffic accidents	Fencing 'Scarers' Introduce speed limits On-site driver information & signage Roadside vegetation management (if applicable) Road layout change Community capacity building Culling
Acts of cruelty towards deer	Additional policing Community capacity building Culling
Woodland damage – Natural Heritage	Fencing Policy or planning change

	Culling
Woodland damage – Forestry crop	Fencing Tree / crop protection Additional planting (to account for loss) Compensation Re-site crop Culling
Agricultural or commercial horticultural damage	Fencing Crop protection Compensation Culling
Private garden damage	Fencing Culling
Intake of toxins by deer	Fencing Remediation of contaminated land Culling
Disease transmission	Provision of information on tick avoidance Culling
Damage to other 'special' sites	Fencing Culling
Value Type	Potential Management Responses
Cultural value	Provision of information to local communities
Ecological services	
Seeing deer (aesthetic value)	Facilitate viewing opportunities Provision of information to local communities
Economic value 1 – through recreational stalking	Promote stalking opportunities
Economic value 2 – as a 'tourist' attraction	Promote presence of deer in Central Belt
Venison consumption	Promote locally produced venison Increase stalking opportunities

Table C – Phase 3 – Identifying Potential Stakeholders and Roles

Management option	Stakeholders	Potential Roles and Responsibilities
Fencing	Forestry Commission, Scotland	Information, grants and resources
	Deer Commission for Scotland	Information and resources
	Landowners	Permission needed
'Scarers'	Deer Commission for Scotland	Information
Introduce speed limits	Transport Scotland	Information and legislative power
	Local Authority	Information and legislative power
On-site driver information & signage	Transport Scotland	Information and resources
	Local Authority	Information and resources
Roadside vegetation management	Transport Scotland	Information and resources
	Local Authority	Information and resources
	Landowners	Permission needed
Road layout change	Transport Scotland	Information and legislative power
	Local Authority	Information and legislative power
	Local community	Popular consent needed
Community capacity building	*All*	Provision of information; Resources;
Culling	Local community	Popular consent needed
	Landowners	Permission needed and resources.
	Forestry Commission, Scotland	Information and resources
	Deer Commission for Scotland	Information and resources
Additional policing	Local police constabulary	Information and resources
Policy or planning change	*All government bodies*	Information and legislative / planning power
Tree / crop protection	Forestry Commission, Scotland	Information and resources
	Deer Commission for Scotland	Information and resources
	National Farmer's Union	Information and resources
	Local farmers and growers	Resources
Additional planting	Forestry Commission, Scotland	Information, grants and resources
	Local forestry bodies	Information and resources
Compensation	Legal professionals	Litigation
Re-site crop	Local farmers and growers	Resources
Remediation of contaminated land	Scottish Environmental Protection Agency	Information and resources
	Forest Research	Information
Provision of information on tick avoidance	Forestry Commission, Scotland	Information
	Health Protection Agency	Information
	Veterinarian organisations and individuals	Information

4. Conclusions & Recommendations

The research conducted for this project supports a number of conclusions that will be of interest to stakeholders in the issues surrounding wild deer in peri-urban Scotland. Deer-people interactions in this environment are many, varied, complex and widely distributed. They can be both positive and negative. Having said this, these same interactions are not, in the 'Central Belt' at least, strong – that is, they are not in any way a prominent feature of most people's everyday lives. The interaction between people and deer in peri-urban areas can, and often does, bring 'new' stakeholders into the arena of deer management, most prominently perhaps Local Authorities and the peri-urban 'public'. In these areas Local Authorities are significant landowners, possess substantial resources and commonly have close links to the communities they serve. In many instances this results in Local Authorities being expected and able to play a more prominent role in managing the issues relating to deer, whilst being at the forefront of concerns that any management is appropriate and acceptable to communities. This is not a traditional role played by many Local Authorities, and thus it is not often an established priority for them.

Seeing deer and sharing the environment with deer are clearly highly valued by community members in peri-urban Scotland. These experiences are valued largely as they provide a link to a 'natural' world, although the elusive nature of deer and their perceived rarity combine to restrict the amount of this value captured by communities. Other values, particularly economic and ecological ones, are considered far less important and relevant to peri-urban communities. This research suggests that there is a significant need to pro-actively manage deer-people interactions so as to capture more value, thus broadening the traditional concept of deer management considerably.

The peri-urban communities of the 'Central Belt' register very little negative impact upon themselves by wild deer. Considered of far greater significance are the potential negative impacts upon the welfare of deer living in the peri-urban environment. Of particular concern is the vulnerability of deer, and indeed other animals, to deliberate acts of cruelty, and there exists a strong demand for management action to address this. The occurrence of road-traffic accidents involving deer is considered serious and management responses required, however, this impact is not widely perceived as occurring in the peri-urban communities of the 'Central Belt'.

Strong and clear preferences in relation to the management of wild deer are illustrated in this research. First and foremost, the combination of limited value capture and minimal impacts felt leads community members to question strongly the need for management in the peri-urban environment. From this it can be concluded that if

reasons for management do exist they must be clearly and effectively articulated to all stakeholders, including the local community.

In terms of management options, fencing and 'scarers' are widely perceived as the most preferred option by local communities, along with changing human activities (such as driving practices or urbanisation). Culling is generally considered a legitimate 'last resort' in response to serious impacts, so long as stringent conditions are met. There is, in fact, no evidence that these preferences are any different in strength or type from community members living in other environments, and this comparison is beyond the scope of this project.

Employing a spatial approach has allowed an exploration of the complex nature of people-deer interactions and has highlighted that management decisions are likely to be site-specific. Whilst measures to manage the land and traffic volume on the M9 may influence the number of deer vehicle collisions on the M9, it may not be effective on the A80. Opportunities to allow people to see deer in their local area may also have to approached differently as our research shows that, even though deer may be close to urban areas, some communities apparently do not see them. Of course, management for any area needs to take account of a range of factors, including the protection of natural heritage. Further work is required to quantify deer numbers and the areas they are found within peri-urban areas to allow management strategies to be undertaken to enhance the positive elements of people-deer relationships and to identify areas where deer could potentially have negative effects, i.e. near roads with particular characteristics, within natural heritage sites.

This research indicates that some innovation is needed in the established processes and practices used to manage deer. As the human 'drivers' of deer-people interactions are so prominent and varied in the peri-urban environment, it demands a broadening of focus away from being primarily upon managing deer *per se*, towards managing the 'people-deer interactions' more holistically. This shift facilitates the spread of 'responsibility' for management actions away from landowners, rangers and stalkers alone to a range of stakeholders able to provide information and resources in various forms. Interactions must be used to identify management options and these, in turn, will identify stakeholders. The Decision Support Framework is a means by which the interactions between managers and stakeholders might be structured.

Recommendations

This research leads the project team to make the following recommendations regarding the management of deer in the peri-urban environment and related research needs.

Management recommendations

1. Future debate regarding issues related to wild deer and their management in the peri-urban environment should be framed in the broad terms presented by this research. With the increasing interaction of people and deer in the peri-urban environment and the associated risk of increased conflict between stakeholders with contrasting perspectives, there is a pressing need to encompass both positive and negative interactions between people and deer. This should facilitate input from all stakeholders and allow interested parties to reach a more balanced view of the costs and benefits associated with the presence of wild deer in this environment.

2. Future effort should be directed towards 'managing people-deer interactions' rather than 'deer management' *per se*. Such an approach should facilitate broad partnerships where responsibility for action is shared, and enable innovative management solutions to be implemented including, where necessary, affecting changes in the behaviour of people and communities.

3. The Decision Support Framework presented within this report should be developed, and piloted in selected areas. The Framework provides an opportunity to explore new approaches to the management of the issues relating to wild deer. Pilot studies would facilitate further clarification of which stakeholders may assume responsibility for management actions in a variety of settings. Pilot studies would also provide the opportunity to move further towards a fully spatially integrated Decision Support Framework.

4. Knowledge and information relating to the interaction of people and deer should be more systematically gathered, monitored and shared between stakeholding organisations and individuals. This is necessary both between stakeholders with differing perspectives, skills and knowledge, and amongst similar stakeholders which share issues and perspectives but may have different experiences of addressing them.

5. The interaction of deer and people needs to be more appropriately encompassed within planning processes and policy development, particularly those relating to house building, transport infrastructure and community capacity building. This should facilitate advanced recognition of the potential for increased value capture, and limiting impacts felt, by stakeholders. Such an approach has the potential to reduce the overall costs incurred during the management of wild deer and associated issues.

Research recommendations

Research should be conducted to further understanding of:

1. How the Decision Support Framework can be used to effectively manage deer-people interactions in the peri-urban environment.
2. The differences and similarities in the relative importance and relevance of the values and impacts associated with wild deer by different 'publics', such as across 'urban' and 'rural' locations.
3. The occurrence of and motivations for acts of cruelty against wildlife including deer, and identify possible management solutions.
4. The character, strength and variation of the 'existence' value of wildlife, including deer.
5. The character and variation of the 'cultural' value of wildlife in Scotland, and its connections to individual species.
6. The differences and similarities between the ecology of wild deer in urban, peri-urban and rural landscapes.
7. The number and spatial distribution of deer within the peri-urban environment to better understand the habitats they use and how they move through other habitats.
8. The complexities underpinning the causes of road-traffic accidents involving deer, and a more nuanced understanding of their impacts in various circumstances and settings.
9. The welfare impact upon wild deer of inhabitation of contaminated land and the intake of toxins.
10. How the values and impacts associated with wild deer are communicated between stakeholders within and without decision- and policy-making processes, to ensure that appropriate consideration is given to each and their spatial distribution properly understood.

Appendix A – Details of Social Research Events

Focus-groups

7 focus-groups were conducted with members of the local communities and 3 with local deer and land managers were conducted in order to gain data relating to their attitudes, opinions and preferences regarding the values, impacts and management of wild deer in the local area. Table A1 lists where and when each focus group was held.

Table A1: Date and Location of Focus-groups

Group	Case Study Area	Participants	Location	Date
CG1	Ravenscraig	Community Members	Allanton Community Centre, ML7 5AX	28th July 2008
CG2	Ravenscraig	Community Members	Allanton Community Centre, ML7 5AX	28th October 2008
CG3	Ravenscraig	Community Members	Salsburgh Community Centre, ML7 4AH	28th October 2008
CG4	Ravenscraig	Community Members	New Stevenston Community Centre, ML1 4AD	29th October 2008
CG5	Ravenscraig	Community Members	New Stevenston Community Centre, ML1 4AD	29th October 2008
CG6	Ravenscraig	Community Members	Wishaw – Volunteer Centre North Lanarkshire	30th October 2008
CG7	Linlithgow	Community Members	Linlithgow - Springfield Community Education Centre, EH49 7SN	30th October 2008
MG8	Ravenscraig	Managers	Hamilton – Forestry Commission, Central Scotland Conservancy Office, ML3 0QA	5th March 2009
MG9	Ravenscraig	Managers	Hamilton – Forestry Commission, Central Scotland Conservancy Office, ML3 0QA	5th March 2009
MG10	Linlithgow	Managers	Roslyn - Forest Research's Northern Research Station, EH25 9SY	5th March 2009

Questionnaire and focus group invitation distribution

Table A2: Organisations contacted to recruit focus-group participants and distribute survey.

	Ravenscraig	Linlithgow
1	Adult Guitar Lessons	Adidas Soccer Scotland
2	Adult Pottery Class	Almond Valley Heritage Trust
3	Allanton Tenants & Residents Association	Armadale Bowling Club
4	Audrey Clark School of Dance	Bathgate Bowling Club
5	Bellshill and Mossend bowling Club	Bathgate Golf Club
6	Bellshill Chess Club	Beat Feet Dance Company
7	Beltane Outdoor Bowling Club	Bellsquarry Community Council
8	Calderbank Bowling Club	Blackbelt Academy Master Sutherlands
9	Calderbank Conservation Society	Bridgend and District Golf Club
10	Carriden House Conservation Group	Bridgend Community Council
11	Chapelhall Tenants & Residents Association	British Trust for Conservation Volunteers
12	Coltness Memorial Church	Broadmeadow Livery Stables
13	Colville Park Golf Club	Broxburn Athletics Social Club
14	Colville Park Social & Recreational Club	Broxburn Ballet School
15	Creative Writing Classes (North Lanarkshire Council)	Broxburn Bowling Club
16	Dance UK	Dance World
17	Hamilton Radio Modellers Club	Deans Bowling Club
18	Hibernian Social and Recreation Club	Fauldhouse Cricket Club
19	Holytown Bowling Club	Glenmavis Bowling Club
20	Karate Marshall Arts Instruction	Grange Equestrian Centre
21	Lanarkshire Forest Education Initiative	Linlithgow Residents and Tenants Association
22	Lanarkshire Indoor Bowling Club	Linlithgow Bowling Club
23	Learning Photography (North Lanarkshire Council)	Linlithgow Bridge Tenants and Residents Association
24	McGorry School of Irish Dancing	Linlithgow Community Council
25	Microlight Scotland Flying School	Linlithgow Rose FC Social Club
26	Mossend Bowling Club	Linlithgow Rugby Football Club
27	Scottish Amateur Rowing Association	Little Boghead Village Nature Park
28	Newarthill Bowling Club	Livingston Chess Club
29	Newmains Bowling Club	Livingston Rugby Club
30	Newmains Federation of Tenants & Residents Associations	Lodge St. Andrew Social Club
31	Our Lady's Opera	Lord Bruce Social Club

32	Ramblers- Biggar Group	Low Port Centre (Activity Centre)
33	Ramblers- Clyde Valley Group	Mosswood Community Education Centre
34	Ramblers- S Lanark Older Walkers (SLOW)	Myra Mackie School of Dance
35	Ramblers- Strathaven local Group	Philpstoun and District Bowling Club
36	Salsa Classes (North Lanarkshire Council)	Pumpherston Golf Club
37	Scottish Aeromodellers Association	Ramblers- Linlithgow Group
38	Scottish Countryside Rangers Association	Ramblers- Livingston Group
39	Scottish Soft Tennis Association	Scottish Auto Cycle Union
40	Shotts Golf Club	Scottish Field Archery Association
41	Shotts Ironworks Bowling Club	Seafield Bowling Club
42	Shotts Karate Club	SwimEasy
43	Shotts Thistle AFC	The Cricket Club
44	Smarter Salsburgh	Uphall Golf Club
45	South Airdrie Group for the Environment	Uphall Station Bowling Club
46	The Kings (Church group)	West Lothian Canoe Club
47	The Valerie Brown School of Dance and Drama	West Lothian Citizens' Panel
48	Torbothie Quoiting Club	West Lothian County Cricket Association
49	Up Yer Pole	West Lothian Dance Academy
50	Whitburn Bowling Club	West Lothian Golf Club
51	Wishaw Bowling Club	West Lothian Indoor Bowling Club
52	Wishaw Golf Club	West Lothian Sub Aqua Club
53		Winchburgh Bowling Club

Focus-group Structure

Focus-group discussions were semi-structured via the provision of brief elements of information relating to the values, impacts and management of wild deer in Scotland through the use of MS Powerpoint. The first slide introduced the idea that increasingly wildlife can be found and seen in some peri-urban and urban[9] areas. Slide 2 identified some of the potential 'values' associated with wild deer that might be held by community members. These were the aesthetic (i.e. visual attractiveness; beauty), cultural (e.g. symbolic of the Scottish nation), economic (e.g. revenue gained through tourism, venison and sport hunting) and environmental (e.g. keystone browsing species) values. Slide 3 identified the potential 'impacts' that wild deer may have upon the interests of local communities including damage to local trees, woodlands, gardens and 'special sites' (such as cemeteries), along with their involvement in road-traffic accidents. Also discussed via this slide were the various impacts upon the welfare of deer that can occur (including deliberate acts of cruelty). The fourth slide focused upon the various

[9] The term 'peri-urban' was considered unnecessarily jargonistic and complex for the discussion groups and may simply have triggered debate and confusion around its definition. Consequently, after a brief explanation by the lead researcher at the beginning of the discussion group, discussions used the term 'urban' only.

management options available to land managers when faced with deer impacts. These were fencing and culling, along with the use of 'scarers' (i.e. those devices designed to affect deer behaviour to avoid impacts including sound and light emitting devices). Further to this researchers also identified the option of making changes to things other than the deer directly in order to minimise or reduce impacts. The two most commonly utilised explanatory examples of this given during the groups were the introduction of speed limits on roads with deer-vehicle collision problems, and an increase in wildlife police constables within the local police force to deal with incidences of welfare crime. The final slide attempted to summarise the values and impacts associated with wild deer as discussed by the group into a set of priorities. The objective of this slide was to obtain a ranking of priorities in response to the question 'Which of these would be your highest priority if wild deer became common in your local area?'.

Stakeholder Workshop

A Stakeholder Workshop was held in Forest Research's Northern Research Station on the 6th April 2009. The workshop allowed the project team to get feedback on some preliminary results from a range of stakeholders and to assist development of the 'responsibility framework'. Table A3 lists stakeholders that attended the workshop.

Table A3: Stakeholder Workshop attendance.

Stakeholder Organisation
British Association of Shooting and Conservation
British Deer Society
Central Scotland Forest Trust
Deer Commission Scotland
Forest Enterprise
Forestry Commission
Scottish Natural Heritage
Scottish Rural Property and Business Association
Scottish Society for the Prevention of Cruelty to Animals
Transport Scotland
West Lothian Council

Appendix B - References

Bremner, A. & K. Park 2007 'Public attitudes to the management of invasive non-native species in Scotland'. *Biological Conservation*, Vol. 139, pp.306–314.

Brown, J. B. (1999) 'The Use of Focus Groups in Clinical Research', in B. Crabtree & W. Miller, *Doing Qualitative Research* (2nd Edition) London: Sage Publications, pp. 109-124.

Brown, TL., JE. Shanahan, DJ. Decker, JT. Major, WF. Siemer, and PD. Curtis. (2005) *Response of Hunters and the General Public to the Discovery of Chronic Wasting Disease in Deer in Oneida County, New York*. HDRU Series No. 05-8. Department of Natural Resources, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

Buckland, S.T. Anderson, D.R., Burnham, K.P. and Laake J.L. (1993) *Distance sampling – estimating the abundance of Biological populations* Chapman and Hall, London.

Burnham, P., K Gilland, W. Grant & Z. Layton-Henry (2004) *Research Methods in Politics*. Basingstoke: Palgrave MacMillan. pp. 105-113.

Chase, Lisa C., William F. Siemer, and Daniel J. Decker (1999) *Deer Management in the Village of Cayuga Heights, New York: Preliminary Situation Analysis from a Survey of Residents*. HDRU Series No. 99-1. Department of Natural Resources, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

Coles, C. (1997) Gardens and Deer – a guide to damage limitation. Swan Hill Press, Shrewsbury.

Dandy, N (2005) *Wildlife Values in International Conservation Policy*, unpublished PhD thesis, University of Leicester.

Dougherty, E., D. Fulton (2003) 'The Influence of Gender on the Relationship Between Wildlife Value Orientations, Beliefs, and the Acceptability of Lethal Deer Control in Cuyahoga Valley National Park'. *Society and Natural Resources*, Vol. 16, pp.603–623.

EEA (European Environment Agency) (1999) *Environmental Indicators: typology and overview*. Technical Report 25.

Gill R.M.A. (2009) 'The effects of varying deer density on natural regeneration in woodlands in lowland Britain Forestry' (submitted).

Gill, R.M.A. and V. Beardall (2001) 'The Impact of Deer on Woodlands: the effects of browsing and seed dispersal on vegetation structure and composition', *Forestry*, Vol.74, No.3, pp.209-218.

Gill R.M.A., Thomas, M.L. and Stocker, D. (1997). 'The use of portable thermal imaging for estimating deer population density in forest habitats.' *Journal of Applied Ecology*, 34 1273-1286.

Hemami, M.R., Watkinson, A. Gill, R.M.A., Dolman, P. (2007) 'Estimating abundance of introduced Chinese muntjac Muntiacus reevesi and native roe deer Capreolus capreolus using portable thermal imaging.' *Mammal Review* 37 246-254.

The Independent (2004) Bambi in the back garden: deer are the new urban invaders. Monday, 16 August.

Kellert, S. (1996) *The Value of Life: Biological Diversity and Human Society*. Washington, DC: Island Press/Shearwater Books.

Kellert, S. R., and J. K. Berry. 1987. 'Attitudes, knowledge, and behaviors toward wildlife as affected by gender'. *Wildl. Soc. Bull.* 15:363–371.

Kierdorf, U., Kierdorf, H., Sedlacek, F. and Fejerskov, O. 1996., 'Structural Changes in Fluorosed Dental Enamel of Red Deer (*Cervus elaphus L.*) From A Region With Severe Environmental Pollution by Fluorides', *Journal of Anatomy*, 188, 183-195

Kierdorf, H., Kierdorf, U. and Boyde, A. 2000., 'Structure and Mineralisation Density of Antler and Pedicle bone in Red Deer (Cervus elaphus L.) Exposed to Different Levels of Environmental Fluoride: A Quantitative Backscattered electron Imaging Study', *Journal of Anatomy*, 196, 71-83

Lauber, T.B., ML. Anthony and BA. Knuth (2001) 'Gender and Ethical Judgments About Suburban Deer Management'. *Society and Natural Resources*, Vol. 14, pp. 571–583.

Lauber, T.B. and B.A. Knuth. (1998). *Suburban residents' attitudes towards contraception and other deer management techniques*. HDRU Series Report No. 98-8. Department of Natural Resources, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

Lauber T.B. and B.A. Knuth (2000) *Tailoring Communication about Suburban Deer Management to Stakeholders' Concerns*. HDRU Series No 00-8. Department of Natural Resources, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

Mayle, B. Peace, A. Gill, R. (1999) *How Many Deer? A guide to estimating deer population size*. Forestry Commission field book 18. Forestry Commission, Edinburgh. 96p

Miles, MB., and AM. Huberman (1994) *Qualitative Data Analysis: an expanded sourcebook*. (2nd Edition) Sage Publications: London.

Pokorny, B. 2000., 'Roe Deer *Capreolus capreolus* as an accumulative bioindicator of heavy metals in Slovenia', *Web Ecology*, 1, 54-62

Putman, R. J. and N. Moore (1998) 'Impact of deer in lowland Britain on agriculture, forestry and conservation habitats'. *Mammal Review*. 28: 141-164.

Raik, DB., WF. Siemer and DJ. Decker (2005) 'Intervention and Capacity Considerations in Community-Based Deer Management: The Stakeholders' Perspective', *Human Dimensions of Wildlife*, Vol. 10, pp. 259–272.

Robson, C. (2002) *Real World Research* (2nd Edition) Oxford: Blackwell Publishing, pp. 284-289

Rolston, H. III (1994) *Conserving Natural Value*. New York: Columbia University Press

Rotherham, I. (2000) 'Urban Deer – a south Yorkshire case study'. Ministry of Defence Deer Management Annual Symposium, 10 June 2000, Bovington.

Scottish Executive (2007) *Environment & Health in Scotland: a new approach*. Discussion Paper.

Shanahan, JE, WF. Siemer & AF. Pleasant (2001) *Community Attitudes About Deer Management In the Village of Cayuga Heights, New York*. HDRU Series No. 01- 7. Department of Natural Resources, NYS College of Agriculture and Life Sciences, Cornell University, Ithaca, NY.

Swanson G. Campbell, D. and Armstrong, H. (2008) *Estimating deer abundance in woodlands: the combination plot technique*. Forestry Commission, Bulletin 128.

Wilson, C. J. (2003) *Current and Future Deer Management Options: Report on behalf of DEFRA European Wildlife Division*. Department of the Environment, Food & Rural Affairs / Rural Development Service.

Appendix C – Steering Group Membership

The steering group included stakeholder organisations in order to provide advice and guidance on the research throughout the project.

Members of the Steering Group

Emilie Wadsworth	Central Scotland Forest Trust
Alastair MacGugan	Deer Commission for Scotland
Davie Black	Scottish Environment Link / Ramblers' Association
Mike Flynn	Scottish Society for the Prevention of Cruelty to Animals
Angus Corby	Transport Scotland

Appendix D – Datasets used

Datasets used

The following data sets were used to build the land cover used in the analysis and were assembled in 10 metre resolution raster grids.

- Ordnance Survey MasterMap
- Land Cover Scotland (LCS88)
- National Inventory of Woods and Trees (NIWT)
- Scottish Semi Natural Woodland Inventory (SSNWI)
- Phase 1 habitat data
- Forestry Commission subcompartment database
- Woodland Grant Scheme 3 (WGS3)
- Scottish Forestry Grant Scheme (SFGS)
- Scottish Ancient Woodland from the Scottish Inventory of Ancient and Long-established Woodland Sites (v3) and the Scottish Inventory of Semi-natural Woodlands (v3)
- Ordnance Survey 50 metre resolution Digital Elevation Model (DEM)
- Designated areas: Natura 2000 Special Areas of Conservation (SAC), Special Site of Scientific Interest (SSSI)
- Ordnance Survey® Strategi ® infrastructure data for roads and rail

Traffic data

Table D1 gives data files obtained from Transport Scotland used to calculate traffic volume and traffic speed data for use within the principle component analysis.

Table D1: Data Files used to calculate traffic volume and speed of 1km road Segments

Road	Km Section	Data File	Road Junctions Represented	Time of Data Used (volume)	Time of Data Used (speed)
A80	1-2	JTC00150	/	Jan '08- Dec '08	Jan '08- Dec '08
A80	3-5	JTC00267	/	Jan '08- Dec '08	Jan '08- Dec '08

A80	6-9	JTC00266	/	Jan '08- Dec '08	Jan '08- Dec '08
A80	10-13	JTC00265	/	Jan '08- Dec '08	Jan '08- Dec '08
A80	14-17	JTC00264	/	Jan '08- Dec '08	Jan '08- Dec '08
M9	1-3	JTC00456, JTC00457	7-8	Jan '08- Dec '08	Jan '08- Dec '08
M9	4-7	NTC00807	6-7	Jan '08- Dec '08	Jan '08- Dec '08
M9	8-10	JTC00460	5-6	Jan '08- Dec '08	Jan '08- Dec '08
M9	11-12	JTC00461	4-5	Jan '08- Dec '08	Jan '08- Dec '08
M9	13-19	JTC08237	3-4	Mar '07- Feb '08	
M9	20-23	JTC00014	3-2	Mar '07- Feb '08	

Note: Traffic volume was calculated as the average '7- day average' figure for each month over a period of 12 months. Traffic speed was calculated as the average traffic speed by any vehicle per month. Occasionally data sets had missing values for some days during a month. These months were subsequently divided by the number of days with available data. For NTC00807 traffic volume data was provided for the south lane only, therefore for each month's average '7 day average' was doubled to 'correct' for the missing north lane data. Two data files were used to represent junctions 7-8 on the M9 road as both data files were appropriate to use for these junctions.

Deer Vehicle Collisions (DVC's)

DVC's datasets were obtained from Jochen Langbein, head of the National Deer Vehicle Collisions Project, and from Mike Flynn at the SSPCA. These data were used to generate maps highlighting DVC location.

Thermal Imaging

The following data sets were used to generate polylines and create maps indicating the routes undertaken during the thermal imaging surveys.

- Ordnance Survey MasterMap
- Ordnance Survey® Strategi ® infrastructure data for roads and rail

Appendix E – Data Table for A80 and M9

Data extraction results for the 1km segments adjacent to the A80 and M9 roads and used in the principle component analysis.

Table E1: A80 Table of Results

Segment Number	1	2	3	4	5	6	7	8	9
DVC/km (A80)	1	0	1	1	2	1	0	1	2
Traffic Volume (per 1000 vehicles)	52.9	52.9	45.3	45.3	45.3	74.7	74.7	74.7	74.7
Mean Traffic Speed (mph)	30.7	30.7	56.7	56.7	56.7	59.8	59.8	59.8	59.8
DEM mean (m)	7.3	4.4	8.0	5.7	4.9	7.8	6.0	7.0	5.8
Slope Mean (°)	2.1	1.9	3.5	2.2	1.6	2.2	2.7	2.1	2.0
% Open Land	69.0	43.9	61.5	51.9	60.1	74.7	58.8	26.8	38.4
% Woodland, Scattered trees & scrub	22.3	11.3	16.6	3.2	15.7	9.3	11.6	13.7	32.8
% Urban	6.4	22.3	11.5	24.2	13.3	12.4	18.1	30.1	22.5
% Marsh & Wetland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Unclassified	0.0	0.0	0.0	0.1	4.7	0.0	0.0	0.0	0.0
% Water	0.1	0.0	1.1	0.0	0.5	0.7	1.1	0.4	1.4
% Gardens	2.1	22.4	9.5	20.3	5.6	2.8	10.4	29.0	4.8

Segment Number	10	11	12	13	14	15	16	17
DVC/km (A80)	1	2	0	2	1	0	6	0
Traffic Volume (per 1000 vehicles	49.8	49.8	49.8	49.8	64.4	64.4	64.4	64.4
Mean Traffic Speed (mph)	64.6	64.6	64.6	64.6	58.8	58.8	58.8	58.8
DEM mean (m)	10.3	16.3	18.8	16.0	11.1	10.9	11.8	11.7
Slope Mean (°)	3.3	5.1	5.8	3.7	3.2	4.4	3.5	3.1
% Open Land	45.9	27.2	34.4	45.2	41.1	49.0	55.4	62.4
% Woodland, Scattered trees & scrub	19.2	38.6	21.8	21.1	20.8	23.9	21.0	10.6
% Urban	19.3	21.6	24.1	24.3	25.6	20.8	14.8	15.4
% Marsh & Wetland	0.3	0.0	0.2	1.6	0.2	0.5	0.0	0.2

% Unclassified	0.0	0.0	0.0	0.0	12.2	0.0	0.0	0.0
% Water	0.3	0.0	0.2	0.0	0.2	1.4	3.3	0.3
% Gardens	15.1	12.5	19.4	7.8	0.0	4.4	5.4	11.4

Table E2: M9 Table of Results

Segment Number	1	2	3	4	5	6	7	8	9	10	11	12
DVC/km (M9)	1s	5	3	0	0	0	0	2	0	2	5	3
Traffic Volume (per 1000 vehicles)	48.5	48.5	48.5	36.5	36.5	36.5	36.5	32.4	32.4	32.4	42.2	42.2
Mean Traffic Speed (mph)	64.7	64.7	64.7	66.8	66.8	66.8	66.8	67.0	67.0	67.0	66.6	66.6
DEM mean (m)	23.2	20.1	10.9	5.5	2.2	1.3	3.9	6.4	10.9	26.0	40.6	49.8
Slope Mean (^{o})	0.6	0.5	0.8	0.3	0.2	0.2	0.2	0.2	1.5	3.0	4.2	2.8
% Open Land	83.5	70.8	78.1	92.6	90.1	68.9	62.1	53.5	55.8	57.3	40.7	73.8
% Woodland, Scattered trees & scrub	7.5	21.9	10.5	1.3	1.3	8.7	10.2	6.0	4.4	7.5	19.9	14.5
% Urban	8.0	6.5	11.9	5.5	6.7	10.4	25.9	29.6	26.4	22.1	18.3	10.3
% Marsh & Wetland	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	1.0	0.0
% Unclassified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Water	0.0	0.0	0.0	0.0	0.5	9.7	0.7	0.2	0.8	0.4	3.7	1.3
% Gardens	0.8	0.7	0.0	0.1	1.5	2.0	1.1	11.4	11.9	12.7	16.3	0.0

Segment Number	13	14	15	16	17	18	19	20	21	22	23
DVC/km (M9)	0	0	1	0	1	0	0	2	0	2	3
Traffic Volume (per 1000 vehicles)	30.3	30.3	30.3	30.3	30.3	30.3	30.3	43.4	43.4	43.4	43.4
Mean Traffic Speed (mph)	68.7	68.7	68.7	68.7	68.7	68.7	68.7	67.2	67.2	67.2	67.2
DEM mean (m)	49.8	39.0	39.6	46.2	60.5	63.7	72.9	68.1	62.5	58.8	59.8

Slope Mean (°)	4.1	4.2	4.5	2.5	2.8	2.4	1.7	0.8	1.2	1.8	2.8
% Open Land	74.5	72.9	78.5	60.7	41.6	57.0	94.6	90.2	92.2	88.7	81.4
% Woodland, Scattered trees & scrub	15.6	15.8	9.2	2.6	3.6	20.6	1.2	2.3	3.7	1.3	4.2
% Urban	7.7	7.4	7.6	36.6	24.6	14.3	4.1	7.3	3.7	9.8	14.8
% Marsh & Wetland	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Unclassified	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
% Water	1.7	2.4	4.1	0.2	30.1	8.1	0.0	0.0	0.0	0.0	0.0
% Gardens	0.3	0.0	0.6	0.0	0.0	0.0	0.0	0.2	0.3	0.3	0.0

Appendix F – Acknowledgements

The project team would like to thank the following for their assistance in completing this research project:

The Steering Group:

- Emilie Wadsworth — Central Scotland Forest Trust
- Alastair MacGugan — Deer Commission for Scotland
- Davie Black — Scottish Environment Link / Ramblers Association
- Mike Flynn — Scottish Society for the Prevention of Cruelty to Animals
- Angus Corby — Transport Scotland

and:

- Andy Peace — Forest Research
- Jochen Langbein — National Deer-vehicle Collisions Project
- Tommy McGrory — Forestry Commission, Central Scotland Conservancy
- Allan Craig — Forestry Commission, Central Scotland Conservancy
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- Michal Petr — Forest Research

Appendix G – Deer in the peri-urban environment