Deer-vehicle collisions in Scotland: data collection and collation to end 2015
Commissioned Report No. 950

Deer-vehicle collisions in Scotland: data collection and collation to end 2015

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COMMISSIONED REPORT

Summary

Deer-vehicle collision in Scotland: data collection and collation to end 2015

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Keywords
Deer; deer-vehicle collision; DVC; road safety; animal road casualties.

Background
Over the past five decades wild deer in Scotland have increased in range and numbers by close to 50%, and total annual volumes of car traffic have more than doubled, combining to make deer-vehicle collisions (DVCs) an increasingly common occurrence throughout the country. Following an initial assessment from 2003 to 2005, from 2008 onwards the Deer Commission for Scotland (since incorporated within Scottish Natural Heritage) commissioned a number of consecutive projects to monitor trends and changes in distribution of DVCs based on a more streamlined data collection regime. This report presents findings from the latest three year data collection project for January 2013 to December 2015, and comparisons with results from earlier years. The prime purpose of the work is to provide further information to SNH, Transport Scotland, Trunk Road Operating Companies, local authorities and deer managers to help prioritise allocation of resources and action to reduce risks to public safety and safeguard deer welfare.

Deer-vehicle collisions (DVCs) throughout the report is used as a broad term to describe any incidents where it may be concluded that a collision of a road vehicle with a deer occurred; as evident either from live injured or dead deer casualties found at the roadside, or from reported road traffic collisions in which deer were implicated. It is important to note that, as there is no legal requirement for DVCs to be recorded or reported to any authority (except for accidents involving human injury), the numbers of records obtained represent merely an annual sample of all DVCs that actually occur.

Main findings
- During this latest continuation project in excess of 4600 new records of DVCs for the period January 2013 to December 2015 have been accrued and mapped, which represents an increase of 10% on the previous three year period.
- The SNH DVC database compiled now includes over 12,500 mapped incident records for the period 2008 to 2015. Of these more than 10,500 relate to the four most consistent core sample categories (Scottish SPCA, Trunk Road Operating Companies, Forestry Commission wildlife rangers, and human injury DVCs attended by police).
Total numbers of records from the core sources for 2012 to 2015 (5999) have increased by 35% compared to 2008 – 2011 (4495). Greatest levels of increase have occurred particularly in Aberdeenshire, Fife and The Central Belt.

The largest increase in annual numbers of reported DVCs ever since 2009 has been in SSPCA records, and is likely to reflect the overall expansion in range of deer especially in the Scottish Lowlands and urban fringes over recent years.

After many decades of steady growth, traffic volumes across Scotland peaked during 2007 followed by a downward trend to 2011, and a return in 2013 to 2015 to levels only marginally higher than the previous 2007 traffic peak. This suggests that the persistent increasing trend in reported DVCs since 2008 cannot be attributed to changes in traffic alone, but more likely reflects expansion in ranges and numbers of deer populations.

Analysis of diurnal patterns of DVCs in all seasons shows an early morning peak in incidents between 06:00 – 09:00 hrs, and an even higher peak from early evening through to midnight (18:00 to 24:00). The major seasonal peak in DVCs throughout Scotland occurs during May & June on all road types but is most pronounced on motorways. A secondary autumn peak is most noticeable in northern Scotland and those other areas where red and fallow rather than roe deer presence predominates.

Significant samples of records have been obtained from right across all mainland local authorities via Scottish SPCA, and from all trunk road operating companies. Information on DVCs for recent years does remains lacking to date for the three Scottish Island authorities. Another key gap in relation to data collection continues to be incomplete national coverage for all police regions on human injury accidents in which deer are implicated.

The primary objective for the project has been monitoring trends in DVC numbers, distribution and hotspots. Estimation of the true overall toll of DVCs across Scotland was neither a specific project objective, nor are the sampling regime and records obtained well suited to such extrapolation. However, based on the sample data available at very least 4000 but likely closer to 9000 DVCs may be estimated to occur in Scotland per year.

Basic analysis of DVC data undertaken to date does not fully consider differences in traffic flows between roads, and as such hotspots identified indicate more so the relatively level of risk to deer, rather than risk of DVC per driver or driven mile. It is suggested that future DVC monitoring work should also include: further analysis of frequency of DVCs reported per km per year for all trunk route sections >500 meters in lengths in order to develop DVC risk maps, assessment of how DVC risks relate to patterns of road accidents from others causes, and evaluation of all past DVC data by habitat type and other road characteristics.

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Table of Contents

1. **INTRODUCTION**
   1.1 Past DVC assessments  
   1.2 Continuation project 2013 – 2015  
   1.2.1 Purpose  
   1.2.2 Terms of Reference  
   1.2.3 Final Report  

2. **DATA COLLECTION REGIME AND PROCESSING**
   2.1 Core data sources  
   2.1.1 Trunk Road Operating Companies  
   2.1.2 Scottish SPCA  
   2.1.3 Forestry Commission wildlife rangers  
   2.1.4 Police and Road Safety Teams RTC records  
   2.2 Supplementary data sources  
   2.2.1 General public entries at online report form  
   2.2.2 Individual ‘Deer-knowledgeable’ contributors  
   2.2.3 Local Authority road cleansing departments  
   2.3 Data quality and processing  

3. **RESULTS**
   3.1 Change in volume of available reports by source type and year  
   3.1.1 Core sources  
   3.1.2 Supplementary sources  
   3.2 Overview of countrywide distribution of DVC records from core sources  
   3.3 Numbers and distribution of DVCs on the Scottish Trunk Road Network  
   3.3.1 Change in overall volume of TROC reports and break down by region  
   3.3.2 DVC distribution and changes in relative hotspots within the trunk network  
   3.3.3 Proposed future re-assessment of DVCs rate per km per year and traffic flow  
   3.4 Numbers and trends of DVC recorded by Unitary Council areas  
   3.4.1 Observed changes based on Scottish SPCA (plus FC ranger) records  
   3.4.2 Combined records from all core sources by LA areas on trun and non-trunk roads  
   3.5 Human injury (ST19) collisions and damage-only DVC attended by police  
   3.5.1 Numbers of reported personal injury accidents in which deer implicated  
   3.5.2 Estimating actual numbers of deer related PIAs in Scotland per year  
   3.5.3 Proportion of reported PIA and damage-only DVCs on trunk and non-trunk roads  
   3.5.4 Distribution and continued value of collection PIA information  
   3.6 DVC frequency in relation to Time of day and Season  
   3.6.1 Diurnal patterns of DVC occurrence  
   3.6.2 Seasonal patterns of DVC occurrence by road type and region  
   3.7 DVC reports with reliable detail of deer species  
   3.8 Estimation of actual annual number of toll DVCs in Scotland  
   3.8.1 Past estimates  
   3.8.2 Updated broad ranging estimates  
   3.8.3 Proposed alternative independent assessment of national DVC tolls  

4. **DISCUSSION AND CONCLUSIONS**
   4.1 Progress of data collection and collation  
   4.2 Basic analysis of trends and distribution of DVC occurrence  
   4.2.1 Trends  

Page

1  
1  
1  
1  
1  
2  
2  
3  
3  
3  
4  
4  
4  
5  
5  
6  
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20  
21  
22  
23  
24  
24  
25  
26  
27  
27  
27  
28  
29  
29  
29  

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.2.2 Diurnal and seasonal distribution and species involved</td>
<td>30</td>
</tr>
<tr>
<td>4.2.3 National estimates</td>
<td>31</td>
</tr>
<tr>
<td>4.3 Recommendations for future monitoring and further analysis</td>
<td>31</td>
</tr>
<tr>
<td>4.3.1 Improvements of data coverage and consistency</td>
<td>31</td>
</tr>
<tr>
<td>4.3.2 Additional evaluation of existing and future data</td>
<td>32</td>
</tr>
<tr>
<td>5. REFERENCES</td>
<td>33</td>
</tr>
<tr>
<td>ANNEX 1: ADDITIONAL FULL PAGE MAPS</td>
<td>34</td>
</tr>
<tr>
<td>Figure</td>
<td>Description</td>
</tr>
<tr>
<td>--------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Figure 1</td>
<td>DVC records provided to the present and past studies by the four core sources.</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Locations of all mapped DVC reports obtained for 2008 to 2015 from Trunk Road Operating Companies shown overlaid on those from Scottish SPCA and FC Rangers</td>
</tr>
<tr>
<td>Figure 3a &amp; 3b</td>
<td>Overview of distribution and frequency per 4 km by 4 km OS tetrad for data from all core sources combined for a) January 2008 to December 2011, and b) January 2012 to December 2015.</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Reported Trunk Road DVCs by year and region 2008 to 2015</td>
</tr>
<tr>
<td>Figure 5 a &amp; 5b</td>
<td>Distribution and frequency per 2 km OS tetrad of DVCs reported from the core sources along the northern half of the Scottish trunk road network in two consecutive 4-year data collection periods.</td>
</tr>
<tr>
<td>Figure 6 a &amp; 6b</td>
<td>Distribution and frequency per 2 km OS tetrad of DVCs reported from the core sources along the southern half of the Scottish trunk road network in two consecutive 4-year data collection periods.</td>
</tr>
<tr>
<td>Figure 7</td>
<td>Example output from proposed future analysis highlighting</td>
</tr>
<tr>
<td>Figure 8</td>
<td>Distribution of available records of DVCs leading to human injury for period 2008 to 2015, plus available damage-only incidents for 2001 to 2015.</td>
</tr>
<tr>
<td>Figure 9</td>
<td>Relative frequency of DVC occurrence by time of the day based on DVC incidents attended by police</td>
</tr>
<tr>
<td>Figure 10</td>
<td>Relative frequency of DVC occurrence by differing time periods of the day and broken down by season</td>
</tr>
<tr>
<td>Figure 11 a&amp;b</td>
<td>DVC frequency maps for trunk roads in South West Scotland during 2008 to 2011 and 2012 to 2015</td>
</tr>
<tr>
<td>Figure 12 a&amp;b</td>
<td>DVC frequency map for trunk roads in South East Scotland during 2008 to 2011 and 2012 to 2015</td>
</tr>
<tr>
<td>Figure 13 a&amp;b</td>
<td>DVC frequency map for trunk roads in North West Scotland during 2008 to 2011 and 2012 to 2015.</td>
</tr>
<tr>
<td>Figure 14 a&amp;b</td>
<td>DVC frequency map for trunk roads in North East Scotland during 2008 to 2011 and 2012 to 2015.</td>
</tr>
<tr>
<td>Figure 15 a&amp;b</td>
<td>DVC frequency map for trunk roads in the Central Belt during 2008 to 2011 and 2012 to 2015.</td>
</tr>
</tbody>
</table>
List of Tables

Table 1a & 1b. Number of DVC reports obtained by year with sufficient detail for mapping from among the four core data source categories. ................................................. 5

Table 2. Numbers of DVC reports available in database with sufficient detail for mapping from various supplementary source categories. ..................................................... 7

Table 3. Number of DVC reports logged by Operating companies and DBFOs on trunk roads in differing sectors of the Transport Scotland trunk road network by year.................11

Table 4. Example data extracts for selected specific trunk routes and time periods ........ 15

Table 5. Totals numbers of DVC related incidents recorded by Scottish SPCA and FC wildlife rangers broken down by Council administrative boundaries and comparing two consecutive 4-year data collection periods. ................................................................. 18

Table 6. Numbers of DVC records from all four core source types combined for trunk and non-trunk roads by Local Authority ........................................................................ 19

Table 7. Available police records on personal injury DVCs broken down by the eight former legacy forces now incorporated within Police Scotland. ........................................... 20

Table 8. Breakdown of records of personal injury and where available damage-only road traffic collisions attended by police, in relation to occurrence on trunk and non-trunk roads. ................................................................................................. 22

Table 9. Numbers of DVC records from ‘deer-knowledgeable contributors’ with species detail, broken down by Council administrative boundaries. ........................................... 26

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The assistance of staff from all of the Scottish Trunk Road Operating Companies and DBFOs, Scottish SPCA, Forestry Commission, Council Road Safety teams, Transport Scotland and Police Scotland, as well as numerous individuals who have provided records to the study over many years is gratefully acknowledged. Many thanks are due also to Sinclair Coghill (Project officer at SNH for this contract), as well as members of the steering group Jamie Hammond, Donald Fraser and Angus Corby for assistance throughout the study, including helpful comments on earlier draft of this report.
1. INTRODUCTION

In Scotland, as in the rest of the UK and many other European countries, the numbers and distribution of wild deer have increased significantly over recent decades. Whereas all deer species found in Scotland have expanded their range to some extent over the past thirty years, roe deer in particular have become well established in the urban fringe of many major towns and have spread also into parks and other green spaces close to the centre of cities such Glasgow, Aberdeen and Edinburgh (e.g. see Dandy et al 2009). This expansion of deer ranges has concurred with a period of rapid growth also of road traffic throughout Scotland, and has led to deer-vehicle collisions becoming increasingly common.

Deer-vehicle collisions, hereafter referred to as DVCs, is a broad term used to describe any incidents where it may be concluded that a collision of a road vehicle with a deer occurred; as evident either from live injured or dead deer casualties found at the roadside, or from reported road traffic collisions in which deer were implicated as an object or hazard in the carriageway (e.g. deer colliding with road vehicle, or deer presence causing drivers to swerve).

1.1 Past DVC assessments

Following an earlier investigation [funded via the Scottish Executive] to gather and collate available records of DVCs for 2003 to 2005 from a very wide range of potential sources (Langbein and Putman, 2006), from 2008 onwards the Deer Commission for Scotland (since incorporated within Scottish Natural Heritage) commissioned a number of subsequent studies to update and monitor trends and changes in distribution of DVCs based on a more streamlined data collection regime. For the period 2008 to 2012 this research was commissioned by SNH via the Deer Initiative Ltd., with majority of work in turn subcontracted to Langbein Wildlife Associates (LWA). Findings based on data collection to end 2010 and to end 2012 respectively are reported in Langbein (2011) & (2013).

1.2 Continuation project 2013 – 2015

1.2.1 Purpose

SNH commissioned LWA in September 2013 to source and collate further data on numbers and distribution of DVCs for the period January 2013 to December 2015. The prime purpose is to provide further information to SNH, Transport Scotland (TS), Trunk Road Operating Companies (TROCs), local authorities and local deer managers to help prioritise allocation of resources and action to reduce risks to public safety and safeguard deer welfare.

1.2.2 Terms of Reference

Data collection and collation should encompass:

- Use of contacts established in previous projects to collect data on DVCs in Scotland, specifically, Trunk Road Operating Companies (TROCs), SSPCA, Forestry Commission and Police or Council Road safety teams ST19 (human injury road accident) reports.
- Collection of additional data via Deer Aware online reporting form and the OhDeer mobile phone App from a variety of known individuals and the general public.
- Collation and cleansing of the data received, grid referenced as accurately as is practicable, in a format compatible with previous data for upload on SNH GIS system.
- Provision of data extraction and analysis on an ad-hoc basis where enquires or concerns about DVCs for localised road sections are raised.
Outputs required:

- GIS format data delivered at six monthly intervals in September and March from March 2014 to March 2016.
- Provision of an annual report, providing basic analysis of this data and broken down into results for TROCs and council areas with main hotspots identified for each.

1.2.3 Final Report

Following preparation of annual interim reports in line with the above, in this end of contract report data from the most recent four years are reviewed mainly by comparison with those for the previous four years collected in a directly comparable fashion since 2008. Evidence for broad trends in scale and distribution of DVCs over the past eight years are investigated, and mapped to enable identification of any prominent changes in DVC occurrence in different parts of the trunk road network and within specific local authority administrative boundaries. Proposals for future refinements of monitoring and suggestions for further more in depth analysis that lie outside the scope of the present contract are discussed.

During this latest continuation of the DVC monitoring project in excess of 4600 new records of DVCs for the period January 2013 to December 2015 have been accrued and mapped, which represents an increase of 10% on the previous three year period.

It is important to note, however, that as there is no obligation on the public to report nor for organisations to record DVCs (except for RTAs involving human injury), the numbers of records obtained represent merely an annual sample of all DVCs that actually occur. Nevertheless, as data collection for the present contract has used a closely comparable sampling regime to that employed for the previous five years, the information gathered do provide indicators of changes in scale and relative distribution of DVC occurrence across Scotland over this period, and helps to identify areas of highest or increasing incidence within differing regions.
2. DATA COLLECTION REGIME AND PROCESSING

The earlier studies in Scotland showed that complete and representative countrywide recording of even the majority of DVC incidents would not be likely to be achievable without very substantial input of resources (Langbein & Putman, 2006). Akin to the later DVC projects undertaken on behalf of SNH from 2008 to 2012, the primary focus during the 2013 to 2015 contract has therefore been to continue regular annual collection of records from the same four principle data types, that together form the ‘core sources’ of the sampling regime (see 2.1).

Data from a number of supplementary data sources (see 2.2), which have been less consistently available and/or do not provide widespread coverage across Scotland, have been collected and collated on a more ad hoc basis, if and when thought valuable to help inform particular questions not well covered by data from the core sources alone.

2.1 Core data sources

2.1.1 Trunk Road Operating Companies

Records obtained via TROCs of incidents involving injured deer or requests to clear deer carcasses from the road or verges present the by far largest accessible source of information on DVCs that occur on the Scottish trunk road network. Data gathering here encompasses requests for relevant information from each of the 4 major TROCs who manage the NW, NE, SW and SE trunk units on behalf of Transport Scotland, as well as all additional DBFO companies (currently 6) that maintain smaller distinct sections, in order to provide comparable coverage of DVC data collection across the entire Scottish trunk network made up of motorways and strategic A-roads. An up to date map showing the full extent of the trunk network and the various TrOC and DBFO sub-divisions is available online via Transport Scotland [map link].

While the private companies that manage different parts of the network on behalf of TS have changed a number of times since 2008, a request is sent annually or six-monthly to all the operating companies to provide records of all deer road casualty or collision incidents. A standard template of ‘ideal’ data submissions is provided with these requests, and although not yet taken up in all cases, helps to standardise inputs received; including as a minimum the date, road number and location of any live or dead deer road casualty logged by them, plus additional details about the incident or information on the deer species involved when known.

2.1.2 Scottish SPCA

The Scottish Society for the Prevention of Cruelty to Animals (SSPCA) are the major single organisation that tend to be called upon by the public or police in incidence involving live injured deer including deer road casualties. Other smaller animal welfare organisations, wildlife rangers or individual deer managers between them will also deal with many further localised requests to attend to deer casualties, but from which records are much more difficult to obtain in a systematic manner for all of Scotland. Annual information from SSPCA on the other hand provides a very wide spread and comparable data source across years, and sampling of deer road casualties on any part of the Scottish road network, including unclassified minor as well as local and major roads. The vast majority of SSPCA DVC records relate to incidents where deer have been injured but not killed outright, and attendance is requested on welfare grounds. SSPCA in general do not attend to dead animals, and hence only a small proportion relate to calls about dead deer that are subsequently passed on to other agencies.
The full data on ‘deer’ incident logs provided annually by SSPCA generally includes as many reports about non-road related incidents (e.g. dog attacks, fence entanglements, alleged ‘abandoned’ fawns etc.) as road related ones. Only unique incidents mentioning e.g. RTA, collision with a vehicle, injured deer by roadside, or other word strings indicative of a DVC having taken place are then extracted and retained by us for the DVC database.

2.1.3 Forestry Commission wildlife rangers

In parts of Scotland where there are substantial areas of FC woodland, their wildlife rangers will often be among the first points of call when a deer is injured on a road running close to their land. DVC casualties attended by the rangers tend to be logged under ‘RTA’ or ‘RTC’ in their national cull database. These records provide only a comparatively small and geographically more restricted annual data set. They have been retained as a regular annual data source for the project, firstly i. as they help to supplement SSPCA records for more remote areas, where FC rangers rather than the former may be the most common organisation called on by police or public to attend to live deer road casualties, and ii. as they are among the best data sources that can provide reliable information also on the deer species involved in the majority of reports.

2.1.4 Police and Road Safety Teams RTC records

Records of road traffic collisions attended by police can potentially provide information on the most serious DVCs, i.e. those involving personal injury accidents (PIA). PIAs and also damage-only DVC incidents when attended by police, are in addition among the few data that reliably record information on the time of day of actual incidents (i.e. rather of when a deer casualty is seen and reported), as well as other aspects such as accident severity. Information on any RTCs attended by police mentioning deer (or stag) in the accident description have been sought annually either direct from the 8 former legacy forces (incorporated within Police Scotland from 2013), or else via Regional Council Road Safety teams that in some cases further process such accident data. However, as involvement of ‘deer’ is not a separate category in the ST19 police forms used for compilation of official human injury accident statistics by DfT, these records have only been obtainable to date for around half of the 8 legacy police force areas in most years. Nevertheless, gathering of these police data has continued to be attempted as far as possible, even though to date this still does not provide a complete countrywide sample of such incidents.

2.2 Supplementary data sources

In addition to data collection from the four core source categories discussed above that form the central part of long term monitoring of DVCs across Scotland commissioned by SNH since 2008, on average a further 200 or so records per data year have been accrued from various other sources. Amongst other these include:

2.2.1 General public entries at online report form

On-line reporting by interested members of the public in earlier years was hosted on the deercollisions.co.uk web-site (that served also the parallel DVC project for England and Wales administered via the Deer Initiative), and since 2009 has been transferred to the Deeraware.com site. It provides facility for members of the public to record DVCs they have seen or been involved with throughout the UK. However, overall input has never been extensive (with usually fewer than 50 records for Scotland submitted by the public per year). Level of such reporting tends also to be largely media dependant, with short peaks or localised reporting when seasonal deer-aware campaigns have taken place or DVCs have otherwise featured in the local or national media. As such they can provide additional information of interest, but cannot readily be included in analysis of wider trends and distribution of DVC occurrence.
2.2.2 Individual ‘Deer-knowledgeable’ contributors

SNH deer officers and a number of other private deer managers, stalkers or naturalists known to the project team have been encouraged also to submit records (via the online report form) of any deer road casualties seen while travelling. These additional records, whilst again not a systematic or regular source of data, are of value firstly, i) to add to the overall volume of reports with reliable information on deer species by region, and ii) to offer a potential means of estimating the sampling intensity achieved by TROCs, on basis of evaluating the proportion of reports recorded on trunk roads by these other contributors that are indeed also later reported within TROC data.

2.2.3 Local Authority road cleansing departments

From earlier DVC collection studies (Langbein & Putman, 2006) it was apparent that only a minority of Local Authority roads departments would be able to provide useable records of sufficient quality. Comparable and sufficiently detailed information on deer road casualty carcass uplifts to enable mapping (and consequently allow potential duplication with other sources to be identified) would however be unlikely to be obtainable in the majority of areas. It was therefore decided not to actively seek such information for the present project. Any such data provided via some LAs since 2008 has nevertheless been retained in case of possible later use. For example, in event that any localised queries or need for DVC risk assessments for specific routes arise.

2.3 Data quality and processing

In case of DVC records obtained from TROCs, FC and Road Safety teams the great majority (> 90%) tend to be provided either with Ordnance Survey grid references allocated at source; or else with other details, such as Marker post or trunk road section references, that enable allocation of map references to a reasonable level of accuracy (mostly better than to the nearest 1 or 2 kilometres).

Scottish SPCA records tend to be more variable in the detail provided. Although a high proportion of those attributable to DVCs tend to give full postcodes of incident locations (c.60%) which enable ready conversion to map references, around 25% require estimation of geographical locations based on only shorter ‘postcode locale’ information together with at times limited location details. A further 10 to 15 % of SSPCA records each year that indicate a DVC appears to have taken place, tend to have insufficient detail to allow allocation of map references to a reasonable degree of accuracy, and are excluded from the database on which further analyses and comparisons between areas are based.

Data from the other ‘supplementary’ sources have also been mapped as far as possible. However, for the majority of comparisons across years and between differing parts of Scotland, these other data are generally excluded, and drawn on only for assessment for specific issues; e.g. where they can add information on involvement of different deer species, or assessment of the sampling intensity achieved by the core sources.

For purpose of the basic analysis presented in this report, all mapped records for 2008 to 2015 were uploaded to a GIS, and then assessed foremost, a) in relation to the most recent (2016) version of the TS trunk network shapefile, b) OS grid squares overlays of variable sizes to provide an indication of hotspots, and c) the geographical boundaries of the 29 Scottish mainland unitary local authorities (“Councils”). Although some DVCs are also known to occur within the 3 Island Council authorities, none have tended to be captured since 2008 by our more restricted sampling regime, and to address that gap in coverage some separate enquiries may be required in future.
3. RESULTS

3.1 Change in volume of available reports by source type and year

3.1.1 Core sources

Despite focus on collection of data from a more limited set of only the most consistent data sources, the mean annual samples of records obtained per complete data year from these ‘core’ sources have grown steadily. They now exceed average annual volume of data obtained even during the earlier 2003 to 2005 DVC research (Langbein & Putman, 2006) when based on much wider range of Scottish data sources. This increase has been achieved partly through a substantial improvement from 2008 onwards in the number, data quality and countrywide coverage of information obtained via Trunk road companies (TROCs) and the Scottish SPCA.

Table 1a & 1b. Number of DVC reports obtained by year including sufficient detail for mapping from among the four core data source categories.

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<th>RS-RTC</th>
<th>SSPCA</th>
<th>D-FC</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>489</td>
<td>88</td>
<td>319</td>
<td>62</td>
<td>958</td>
</tr>
<tr>
<td>2009</td>
<td>677</td>
<td>75</td>
<td>291</td>
<td>101</td>
<td>1144</td>
</tr>
<tr>
<td>2010</td>
<td>722</td>
<td>64</td>
<td>349</td>
<td>68</td>
<td>1203</td>
</tr>
<tr>
<td>2011</td>
<td>608</td>
<td>72</td>
<td>418</td>
<td>92</td>
<td>1190</td>
</tr>
<tr>
<td>2012</td>
<td>749</td>
<td>74</td>
<td>666</td>
<td>72</td>
<td>1561</td>
</tr>
<tr>
<td>2013</td>
<td>644</td>
<td>65</td>
<td>698</td>
<td>72</td>
<td>1479</td>
</tr>
<tr>
<td>2014</td>
<td>692</td>
<td>38</td>
<td>509</td>
<td>76</td>
<td>1315</td>
</tr>
<tr>
<td>2015</td>
<td>668</td>
<td>29</td>
<td>883</td>
<td>64</td>
<td>1644</td>
</tr>
<tr>
<td>Total</td>
<td>5249</td>
<td>505</td>
<td>4133</td>
<td>607</td>
<td>10494</td>
</tr>
</tbody>
</table>

Table 1a & b provide a breakdown of records obtained from among the four core sources categories by year during the past 8 years, and are compared also to those obtained from the same sources during the earlier DVC projects. It is clear from this in the first instance that the average annual volume of records obtained from among these core data sources has more than doubled since 2008, even when compared to the most intensive data collection period from 2003 to 2005. However, as data before 2008 were collected in a different and more variable, the figures from 2008 onwards are the most directly comparable data in terms of both coverage across Scotland and consistency of approach to collection across years.
As illustrated further by Figure 1 below, the greatest increase in annual numbers of reported DVCs has occurred in SSPCA records. Data from SSPCA have increased year on year since 2009, with just one exception (2014) before another large increase in data for 2015. It is likely that better recording and extraction from improved computer storage of call logs may have contributed to the large increase post 2011. However, it has been notable in the full sets of ‘deer’ related SSPCA incident calls provided to the project, that not only numbers of DVC related incidents, but also total volume of incidents regarding deer in injured in other ways has continued to rise substantially over the more recent years; together with DVC records both are likely to reflect the overall expansion in range of deer and especially so in the Scottish Lowlands and urban fringe over recent years.

![Chart showing change in numbers of DVC records obtained PER YEAR from among the four core data sources](image)

Figure 1. DVC records provided to the present and past studies by the four core sources: Trunk Operating companies (TrOC), Scottish SPCA (SSPCA), Road safety teams (RS-RTC) and Forestry Commission rangers (D-FC).

Numbers of reports received from trunk ROCs and FC rangers did increase significantly from 2008 to 2009, but have remained relatively stable since. A reduction in TROC records in one year (2013) is largely attributable to a break in recording by one trunk unit (SW) in spring of that year during change over in contracts between operating companies. Overall total numbers of TROCs reports have otherwise been relatively stable at from 650 to 750 deer casualty reports per year. In case of reported human injury and damage-only DVCs attended by police, input has been lacking for several regions and or study years, and total size of this sample has also declined further due to reduced ability in the three most recent years of road safety teams any longer to provide information on damage-only incidents attended by police.

3.1.2 Supplementary sources

A summary of numbers of additional DVC records from various supplementary sources available in the full database of mapped records for 2008 to 2011 and 2012 to 2015, is shown in Table 2. These sources do not form part of the main sampling regime, as they cannot provide consistent input across years or representative sampling across all of Scotland. They are nevertheless available to be drawn upon to provide some insights to specific questions not well addressed base on core data alone.
Data were available from selected local authority road departments and police control rooms up until 2010 (mainly from a separate short term contract), but collection was then discontinued, not least because of limited geographical coverage overall, as well as low data quality making identification of potential duplication with reports from core sources almost impossible.

Table 2. Numbers of DVC reports available in database with sufficient detail for mapping from various supplementary source categories.

<table>
<thead>
<tr>
<th>Year</th>
<th>DCS Carcass Searches</th>
<th>D-knowledge Other</th>
<th>General Public</th>
<th>Police Control</th>
<th>Council uplifts</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-2011</td>
<td>209</td>
<td>35</td>
<td>13</td>
<td>361</td>
<td>335</td>
<td>953</td>
</tr>
<tr>
<td>2012-2015</td>
<td>0</td>
<td>143</td>
<td>103</td>
<td>0</td>
<td>0</td>
<td>246</td>
</tr>
</tbody>
</table>

Deer Commission roadside carcass search data were available from a special project up until March 2011, aimed at estimation of minimum actual level of deer casualty numbers for selected trunk routes in the Highlands when not reliant solely on reporting by TrOCs (for results see Langbein, 2011). Limited numbers of more ad-hoc deer casualty sightings obtained from a number of ‘deer-knowledgeable’ contributors (including SHN staff) and general public are available for more recent years, which can also usefully inform particular questions; e.g. likely levels of sampling achieved by TROCs alone for specific routes, and often provide deer species information that is lacking among the core data.

3.2 Overview of countrywide distribution of DVC records from core sources

Figure 2 provides a Scotland-wide overview of the distribution of all DVC locations reported over the eight year period 2008 to 2015 by TROCs, SSPCA and FC, with those obtained from TROCs for the trunk road network shown overlaid on data from the latter two.

This illustrates the very widespread combined input from among these three sources. In addition it shows that, although unsurprisingly SSPCA records are most widespread in areas of highest human population and densest road networks (and consequently greater likelihood an injured deer at the roadside will be reported), they do provide good sampling from throughout Scotland. Furthermore, especially in the less densely populated areas of the country, where SSPCA may not be the first point of contact for injured deer call-outs, records are supplemented by extra records obtained via FC wildlife rangers (see also 2.1.3 above).

Only a low proportion of records from SSPCA & FC (~ 5 to 15% respectively) relate to trunk roads, with the bulk of records from these sources recorded on local authority roads (non-trunk A-roads, B-roads and other more minor public roads). Records of human-injury and other DVCs attended by police available in only some regions, are not included but discussed separately later (and see Figure 7).
Figure 2. Locations of all mapped DVC reports obtained for 2008 to 2015 from Trunk Road Operating Companies (blue) shown overlaid on those from Scottish SPCA (red) and FC Rangers (light blue).

Figure 3a and Figure 3b overleaf show the data from all core sources combined, replotted to provide an overview of the frequency of records per 4 km by 4 km Ordnance Survey grid square. The two maps provide a comparison between the first four years (2008 to 2011) and most recent four complete data years (2012 to 2015) since comparable sampling began in 2008. Only grid squares for which at least some records are available are shown, divided into categories with just 1 or 2 records per square (grey) up to maximum 21-80 per 4km by 4km square (maroon).

It is apparent that the overall pattern is broadly similar for data from these two independent periods. Total numbers of core records during 2012 to 2015 (5999) have however increased by 35% compared to 2008 – 2011 (4495). Greatest levels of increase appear to have occurred in Aberdeenshire, Fife and The Central Belt, though also along A9 north of Inverness. These changes are explored in greater detail in the following sections, reviewing data broken down by Trunk road units and Unitary Council administrative areas.
Figure 3 a & 3 b. Overview of distribution and frequency per 4 km by 4 km OS tetrad for data from all core sources combined for a) January 2008 to December 2011, and b) January 2012 to December 2015.
3.3 Numbers and distribution of DVCs on the Scottish Trunk Road Network

The Scottish trunk road network alone, composed of motorways and major strategic A-roads, makes up 6% of the total Scottish road network, but carries 39% of all traffic and 63% of heavy goods vehicles (Transport Scotland, 2013). Earlier studies have shown that the total number of reported DVCs across Scotland mirrored closely differences in traffic volumes carried on different roads types (Langbein & Putman, 2006; and see section 3.5 this report). Major roads (all trunk and non-trunk A-roads plus motorways) contributed over 75% of all DVC reports despite representing only around 20% of the total road network in that earlier study. A major part of the present study has therefore been focussed on monitoring of DVCs along the TS trunk road network, not merely because of the importance of those strategic roads, but also as it presents opportunity for widespread data collection in a relatively standardised manner.

3.3.1 Change in overall volume of TROC reports and break down by region

An overview of numbers of DVCs reported by the various operating companies on the Scottish trunk road network is provided in Figure 4. Additional detail of figures are shown in Table 3, including records added during the present contract for 2013 to 2015.

![Figure 4. Reported Trunk Road DVCs by year and region 2008 to 2015*](image)

*Note – In 2013 only part-year data available for South West region – see Table 2*

Figure 4 shows that following a substantial increase in records in 2009 across all four network regions (possibly attributable to improved reporting following our initial request for more standardised data in 2008) network wide DVC reports have remained relatively stable. More fluctuation is however notable within the different regions.

In case of NE Unit average annual number of TrOC DVCs recorded during the three years of the present continuation study (2013 to 2015) have risen by 26% compared to the average for the previous three years (2010 to 2012). A more modest increase by 11 to 13 % has been recorded over the same period in SE and NW region.
By contrast a 45% reduction has been noted in SW Unit. Part of the latter is down to a 3-month gap in data logs for this unit in 2013. However, numbers in later years have also remained much lower for this unit than pre 2013.

Table 3. Number of DVC reports logged by Operating companies and DBFOs on trunk roads in differing sectors of the Transport Scotland trunk road network by year.

<table>
<thead>
<tr>
<th>Year</th>
<th>SW Unit</th>
<th>SE Unit</th>
<th>NW Unit</th>
<th>NE Unit</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>120</td>
<td>78</td>
<td>175</td>
<td>116</td>
<td>489</td>
</tr>
<tr>
<td>2009</td>
<td>207</td>
<td>124</td>
<td>196</td>
<td>150</td>
<td>677</td>
</tr>
<tr>
<td>2010</td>
<td>219</td>
<td>105</td>
<td>260</td>
<td>138</td>
<td>722</td>
</tr>
<tr>
<td>2011</td>
<td>191</td>
<td>97</td>
<td>195</td>
<td>125</td>
<td>608</td>
</tr>
<tr>
<td>2012</td>
<td>268</td>
<td>184</td>
<td>176</td>
<td>122</td>
<td>750</td>
</tr>
<tr>
<td>2013</td>
<td>103</td>
<td>121</td>
<td>263</td>
<td>157</td>
<td>644</td>
</tr>
<tr>
<td>2014</td>
<td>137</td>
<td>175</td>
<td>206</td>
<td>174</td>
<td>692</td>
</tr>
<tr>
<td>2015</td>
<td>134</td>
<td>142</td>
<td>237</td>
<td>155</td>
<td>668</td>
</tr>
<tr>
<td>Total</td>
<td>1379</td>
<td>1026</td>
<td>1708</td>
<td>1137</td>
<td>5250</td>
</tr>
</tbody>
</table>

Note: SW Unit figures include also M74_A74M & M77_GSO & M8_A725 DBFOs data; SE Unit figure incl. M80 DBFO, M77_GSO & M8_A725, & Forth Bridges; NE Unit figures incl. Aberdeen Road Ltd.; SW data 2013: 9month data only (data gap Apr-Jun, when avg. 105 records logged in past years)

The reasons for noticeable peaks in returns also for some other individual years (e.g. NW 2010 and 2013) remain unclear at present. Factors such as differences between years in winter weather (snow cover reducing observations of road kill on verges) may possibly contribute. However, others factors such as transfer between operating companies that may handle and log call-outs slightly differently, expansion of the trunk network through new built roads, and return to growth in road traffic that had stagnated from 2007 to 2011 may all contribute to fluctuations between individual years.

The TrOCs contracted by Transport Scotland to maintain the main NW and SW trunk units from early 2013 transferred from Transerv to BearScotland; and from Amey to Transerv, respectively. In addition during early 2014 SE Unit maintenance has now transferred from BearScotland to Amey. New DBFOs have also been established during the period of the present contract, including Aberdeen Roads Ltd and Forth Bridges unit. In theory these changes should not necessarily affect overall numbers of records obtained by the project, as all the OCs now have systems in place to record incidents such as removal of animal carcasses and others debris.

It is likely that some improvement in general awareness of deer and of the DVC project among TrOC staff may have contributed in some way to increases in records now received in most areas. On the other hand, reasons for the fall off in records in SW Unit only for the past two years compared to pre 2013 remain unclear. The manner and consistency across different trunk ROCs as to whether deer carcasses are removed and recorded mostly just when cleared from carriageways and hard shoulders (where they constitute greatest continuing hazard) or also when found on the verges, has been raised as an issue to be looked into by Transport Scotland, so as to ensure any significant differences in approach to dealing with animal carcass uplifts are identified.
3.3.2 DVC distribution and changes in relative hotspots within the trunk network

In order to provide basic overviews of the distribution, relative frequency and changes in DVC hotspots over recent years, a series of grid based maps for different parts of the network are provided below (Figure 5 and 6).

These overview maps have been prepared by first identifying all DVC records – based on core source records only - mapped within a corridor of up to 250 metres to either side of the trunk road GIS shape file (2015 version). This analysis ‘corridor’ was chosen as although the majority of TROC records are provided with grid references allocated at source, the level of accuracy of such mapping does not always place the records precisely on the line of the road. Whilst near 85% were captured when using a narrower GIS analysis buffer of 150 m to either side of the trunk network, this increased to over 95% of all TROC records when extended to 250 metres. Using such as buffer provides a simpler way of treating and minimising exclusion of data reported as on the network, than making artificial correction to the reported location to move each onto the GIS line of the road.

The data captured along the trunk network in this way (for all of the 8 data years combined) are predominantly those from TROC records (4867), but those from SSPCA (754), RS-RTC (215) and FC (153) have also been retained if reported as occurring on the trunk roads, and not identified as likely duplicates. [Among a total of 1181 records for the trunk network reported by the latter three sources, only 85 (7.2%) were identified as likely / potential duplicates with incidents logged on the same day by TROCs within no more than 4 km].

This data set was then analysed to determine the frequency of DVC reports per cell of a 2 km by 2 km OS grid overlaid on the network, for two different periods of the study. Figures 5 and 6 provide overviews of the resulting frequency maps for the Northern and Southern half of the trunk network. In each case findings for the first four years (2008 to 2011) and the most recent four complete data years (2012 to 2015) are presented alongside, to help assess gross changes in distribution of relative hotspots over that time. The same mapping used for these overview maps, is shown at greater size in a series of additional maps broken down into 4 smaller regions of the trunk road network (ANNEX 1).

Among all those grid cells shown on these maps with at least some DVCs records, only the top 1% with highest frequency of records are shown in black (>15 to 52 reports over 4 years). These black cells together with the next highest category (red = > 8 records) made up from 4.5% of all mapped grid cells (2008 – 2011) rising to 6.9% (2012 – 2015 maps). Between them the black and red categories thus provide a good initial indication of the main clusters or DVC ‘hotspots’ within different part of the network; and also how these have changed between maps for the first and last four years of data collection.

General inspection of Figures 5 and 6, show that the pattern of DVCs across the network are broadly similar in both periods. However, with an overall increase of over 20% of reported DVCs during the most recent compared to the earlier four year period, many clusters of hotspots are more pronounced in the later period.
Figure 5 a & 5 b. Distribution and frequency per 2 km OS tetrad of DVCs reported from the core sources along the northern half of the Scottish trunk road network in two consecutive 4-year data collection periods. Comparing (a) January 2008 to December 2011 and (b) January 2012 to December 2015. Although grid squares are used for ease of presentation, only data from records logged within 250m to either side of the trunk shape file were included for analysis (see text).
Figure 6 a & 6 b. Distribution and frequency per 2 km OS tetrad of DVCs reported from the core sources along the southern half of the Scottish trunk road network in two consecutive 4-year data collection periods. Comparing (a) January 2008 to December 2011 and (b) January 2012 to December 2015. Although grid squares are used for ease of presentation, only data from records logged within 250m to either side of the trunk shape file were included for analysis (see text).
In areas where one or more hotspots are noted, data along that route or any specific areas can then readily be drawn out from either the grid based shape file or underlying full base data within the GIS. By way of example, a number of extracts for the sections with relatively high DVC incidence in either period are shown in Table 4. For example drawing out data for the A9 Dornoch to Helmsdale, extract of reported incidents can be seen to have almost doubled over this period, whereas in case of the A835 a reduction by 27% has occurred. Alternatively, in areas around trunk road interchanges with several routes in close proximity in the same grid square, GIS data extraction can readily instead be used to capture all trunk incidents within a circle of set radius around that interchange, as per the sample extract for the M73 / M8 interchange in Table 4.

Table 4. Example data extracts for selected specific trunk routes and time periods

<table>
<thead>
<tr>
<th>Trunk Route Section</th>
<th>length (km)</th>
<th>2008 to 2011</th>
<th>2012 to 2015</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>A9 Dornoch Firth to Helmsdale</td>
<td>50</td>
<td>54</td>
<td>107</td>
<td>+ 98%</td>
</tr>
<tr>
<td>A835 Loch Glascarnoch to Ullapool</td>
<td>30</td>
<td>45</td>
<td>33</td>
<td>- 27%</td>
</tr>
<tr>
<td>A9 Perth to Dunkeld</td>
<td>25</td>
<td>65</td>
<td>41</td>
<td>- 37%</td>
</tr>
<tr>
<td>All trunk sections within 5km radius of M73 / M8 Balgeddie Interchange</td>
<td>29</td>
<td>134</td>
<td>176</td>
<td>+ 31%</td>
</tr>
</tbody>
</table>

For purpose of basic analysis in the present report the project steering group requested to stick for now with grid based presentation of data as that in the previous (2011) project report. However, it is planned that these data will be re-analysed in greater depth in future, possible along lines outlined in 3.3.3 below, to ascribe a DVC frequency per km per year to all sub-sections of the network; and adjusted also for traffic flow for longer routes, to produce maps of the relative DVC-risk throughout the trunk network.

3.3.3 Proposed future re-assessment of DVCs rate per km per year and traffic flow

Assessment of hotspots and relative ‘risk’ of DVCs for different parts of the trunk road network in a systematic manner is complicated by numerous influencing factors on DVC frequency (not least differences in traffic volume, as well as single and multi-lane trunk road sections). To help assess relative frequency of DVCs along different parts of the trunk network, in our previous DVC studies for Scotland, Ordnance survey grids of variable size were overlaid on the network to determine numbers of DVCs per e.g. 2 km by 2 km OS grid cells, and similar mapping was again requested for the present end of contract report.

Use of such an arbitrary grid overlaid on a linear network, however, has the drawback that the actual length of trunk road falling within particular cells will vary depending on whether the road runs centrally through a square or merely for a very short section; in addition in some cases grid squares will contain sections from just one but in others more than one trunk road, not least around road junctions and hence widely differing levels of traffic. To explore alternative improved methods for more systematic evaluation and presentation of relative DVC rates per km along specific road sections of the trunk network, some preliminary GIS work was also undertaken based on allocation of all trunk road DVC records to one of the over 4500 different administrative road ‘sections’ that make up the GIS trunk network shape file as employed by Transport Scotland and their managing agents. The eventual aim of this being to produce a system for more ready identification of meaningful sections with highest reported rates of DVCs, which account for differences in road length
and could eventually also be adjusted for differences in traffic volume. A sample map of the type of output envisaged at present is shown in Figure 7. However, methodology for such analysis and presentation remains to be refined and firmed up, for possible use in future DVC monitoring work.

![Location of DVCs reported by Trunk Operating companies 2008 to 2013](image)

**Figure 7.** Example output from proposed future analysis, in this case highlighting only those trunk road sections in the Perth – Stirling – Dunfermline area with average annual rates of DVC equal or higher than 2 DVC km⁻¹ yr⁻¹ (based on 2008 to 2013 data).

### 3.4 Numbers and trends of DVC recorded by Unitary Council areas

#### 3.4.1 Observed changes based on Scottish SPCA (plus FC ranger) records

Whereas distributional changes in DVCs discussed in the previous section were confined to incidents reported on Scottish trunk roads (motorways and major strategic A roads managed by Transport Scotland), records provided by SSPCA (supplemented where available by records from FC wildlife rangers) offer an insight to occurrence of DVCs across the entire Scottish road network. Although a small proportion of DVC reports from SSPCA & FC (~ 5% to 15%) also relate to incidents on trunk roads, the great bulk of records from these sources are recorded on non-trunk roads managed by the local (Council) highways authorities (i.e. non-trunk A-roads, B-roads, C-roads and also all other more minor public roads).
Scottish SPCA logs of requests to attend to live deer injured on roads rose steadily year on year from 2008/9 through 2011, with an even greater increase (58%) in 2012. Following a smaller increase in 2013, a drop by 30% in 2014 may be partly due to lesser level of incident description in the information received to help identify road traffic and non-road related deer incidents. More comprehensive detail in 2015 by contrast have enabled us to identify close to 1/3 (883) of over 2400 deer related incident logs received overall from SPCA as being road casualty related. While it is clear that a major increase in DVC related call-outs to SPCA has occurred over recent years, the trends are liable to be affected to some extent by manner of recording calls at the switchboard, and in particular whether deer killed outright in collisions (not requiring action by SPCA) have always been included in past data received in different years.

Forestry Commission ranger records (FC) of deer casualties were retained as part of the main sampling scheme for the present project, partly in case SPCA records alone would not sample incidents in some of the more remote local authority regions adequately; not least if FC rather than SPCA were the most common organisation called to deer casualties in some such areas. With the significant rise in numbers and distribution of SPCA records obtained since 2008, samples of SPCA records however greatly exceed those obtained via FC in nearly all Local authority areas, with possible exception of Argyll & Bute and parts of Highland Region in some years. As Nevertheless, as FC records only rarely duplicate incidents obtained via SPCA, and are also the only one among our four primary data sources consistently able to provide reliable information on the species of deer involved in individual incidents, they continue to be retained here as part of main regular DVC sampling regime.

Table 5 provides a breakdown of SSPCA and FC DVC records obtained for within the boundaries of each of 29 Scottish Unitary Local Authorities (Council or City Council areas) since 2008. At least some SSPCA records are now available for all of these mainland unitary Councils. DVCs are also known to occur within the 3 Island Council authorities, but none have tended to be captured by our SSPCA and other core samples since 2008, and separate enquiries may be needed in future to fill that gap.

The Local Authority where consistently the highest levels of SSPCA (+FC) reports have been recorded is Aberdeenshire Council, followed by Fife, and - unsurprisingly given its relatively large size - Highland Council. The Table highlights also that despite their comparatively small size, Aberdeen City and Glasgow City rank within the top ten Councils with most call-outs to deer injured in traffic collisions on council roads. In this context it should be noted that of the above Highland, Fife, North Lanarkshire and Glasgow City are also, along with Edinburgh City, the five local authorities with the highest total volumes of traffic volumes.

The figures in Table 5 also confirm the very widespread sampling of DVC incidents achieved right across Scotland based on SSPCA reports over recent years. There may well nevertheless be some extent of relative over-sampling of urban and more populous areas, where the SSPCA may be more likely to be called upon by the public as well as police than in more remote areas. However, the very wide distribution of the DVC incidents handled by SSPCA does underline that these records do indeed provide very good sampling across all Council regions and road types.

Table 5 also provides council by council comparisons of the extent of change in average annual numbers of records obtained during data collection for the four years from 2008 to 2011 against those for 2012 to 2015. It demonstrates a very clear if variable increasing trend of DVCs in most parts of the country over the past eight years, which is unlikely to be attributable to wholly or even mostly to improved recording alone. Within the great majority of Council areas DVC incidents handled by SSPCA have more than doubled since 2012,
compared to the previous four project years. Perhaps most notable are increases by over 2.5-fold in North Lanarkshire and South Lanarkshire, as well as similar rises in Aberdeenshire and Fife.

Table 5. Totals numbers of DVC related incidents recorded by Scottish SPCA and FC wildlife rangers broken down by Council administrative boundaries and comparing two consecutive 4-year data collection periods.

<table>
<thead>
<tr>
<th>Unitary Council</th>
<th>2008 to 2011</th>
<th></th>
<th></th>
<th></th>
<th>2012 to 2015</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSPCA D-FC</td>
<td>Total</td>
<td>mean</td>
<td>Change</td>
<td>SSPCA D-FC</td>
<td>Total</td>
<td>mean</td>
<td>Change</td>
<td></td>
</tr>
<tr>
<td>ABERDEENSHIRE</td>
<td>166</td>
<td>25</td>
<td>191</td>
<td>48</td>
<td>432</td>
<td>25</td>
<td>457</td>
<td>114</td>
<td>x2.4</td>
</tr>
<tr>
<td>FIFE</td>
<td>115</td>
<td>5</td>
<td>120</td>
<td>30</td>
<td>282</td>
<td>3</td>
<td>285</td>
<td>71</td>
<td>x2.4</td>
</tr>
<tr>
<td>HIGHLAND</td>
<td>84</td>
<td>85</td>
<td>169</td>
<td>42</td>
<td>178</td>
<td>61</td>
<td>239</td>
<td>60</td>
<td>x1.4</td>
</tr>
<tr>
<td>NORTH_LANARKSHIRE</td>
<td>80</td>
<td>80</td>
<td>20</td>
<td>20</td>
<td>204</td>
<td>204</td>
<td>51</td>
<td>x2.6</td>
<td></td>
</tr>
<tr>
<td>ARGYLL &amp; BUTE</td>
<td>24</td>
<td>110</td>
<td>134</td>
<td>34</td>
<td>64</td>
<td>105</td>
<td>169</td>
<td>42</td>
<td>x1.3</td>
</tr>
<tr>
<td>PERTH &amp; KINROSS</td>
<td>83</td>
<td>1</td>
<td>84</td>
<td>21</td>
<td>167</td>
<td>1</td>
<td>168</td>
<td>42</td>
<td>x2</td>
</tr>
<tr>
<td>ABERDEEN_CITY</td>
<td>74</td>
<td>74</td>
<td>19</td>
<td>19</td>
<td>126</td>
<td>126</td>
<td>32</td>
<td>x1.7</td>
<td></td>
</tr>
<tr>
<td>GLASGOW_CITY</td>
<td>53</td>
<td>53</td>
<td>13</td>
<td>13</td>
<td>112</td>
<td>112</td>
<td>28</td>
<td>x2.1</td>
<td></td>
</tr>
<tr>
<td>DUMFRIES &amp; GALLOWAY</td>
<td>23</td>
<td>37</td>
<td>60</td>
<td>15</td>
<td>64</td>
<td>41</td>
<td>105</td>
<td>26</td>
<td>x1.8</td>
</tr>
<tr>
<td>SCOTTISH_BORDERS</td>
<td>49</td>
<td>3</td>
<td>52</td>
<td>13</td>
<td>101</td>
<td>1</td>
<td>102</td>
<td>26</td>
<td>x2</td>
</tr>
<tr>
<td>STIRLING</td>
<td>44</td>
<td>16</td>
<td>60</td>
<td>15</td>
<td>78</td>
<td>20</td>
<td>98</td>
<td>25</td>
<td>x1.6</td>
</tr>
<tr>
<td>SOUTH_LANARKSHIRE</td>
<td>35</td>
<td>1</td>
<td>36</td>
<td>9</td>
<td>93</td>
<td>3</td>
<td>96</td>
<td>24</td>
<td>x2.7</td>
</tr>
<tr>
<td>EAST_LOTHIAN</td>
<td>38</td>
<td>38</td>
<td>10</td>
<td>10</td>
<td>88</td>
<td>88</td>
<td>22</td>
<td>x2.3</td>
<td></td>
</tr>
<tr>
<td>MORAY</td>
<td>32</td>
<td>32</td>
<td>64</td>
<td>16</td>
<td>75</td>
<td>10</td>
<td>85</td>
<td>21</td>
<td>x1.3</td>
</tr>
<tr>
<td>ANGUS</td>
<td>38</td>
<td>2</td>
<td>40</td>
<td>10</td>
<td>83</td>
<td>1</td>
<td>84</td>
<td>21</td>
<td>x2.1</td>
</tr>
<tr>
<td>FALKIRK</td>
<td>30</td>
<td>30</td>
<td>8</td>
<td>8</td>
<td>70</td>
<td>1</td>
<td>71</td>
<td>18</td>
<td>x2.4</td>
</tr>
<tr>
<td>EAST_DUNBARTONSHIRE</td>
<td>57</td>
<td>57</td>
<td>14</td>
<td>14</td>
<td>67</td>
<td>67</td>
<td>17</td>
<td>x1.2</td>
<td></td>
</tr>
<tr>
<td>MIDLOTHIAN</td>
<td>49</td>
<td>49</td>
<td>12</td>
<td>12</td>
<td>67</td>
<td>67</td>
<td>17</td>
<td>x1.4</td>
<td></td>
</tr>
<tr>
<td>WEST_LOTHIAN</td>
<td>32</td>
<td>1</td>
<td>33</td>
<td>8</td>
<td>65</td>
<td>1</td>
<td>66</td>
<td>17</td>
<td>x2</td>
</tr>
<tr>
<td>CITY_OF_EDINBURGH</td>
<td>23</td>
<td>23</td>
<td>6</td>
<td>6</td>
<td>48</td>
<td>48</td>
<td>12</td>
<td>x2.1</td>
<td></td>
</tr>
<tr>
<td>NORTH_AYRSHIRE</td>
<td>14</td>
<td>1</td>
<td>15</td>
<td>4</td>
<td>40</td>
<td>4</td>
<td>44</td>
<td>11</td>
<td>x2.9</td>
</tr>
<tr>
<td>RENFREWSHIRE</td>
<td>26</td>
<td>26</td>
<td>7</td>
<td>7</td>
<td>41</td>
<td>41</td>
<td>10</td>
<td>x1.6</td>
<td></td>
</tr>
<tr>
<td>CLACKMANNANSHEIRE</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>31</td>
<td>1</td>
<td>32</td>
<td>8</td>
<td>x5.3</td>
</tr>
<tr>
<td>EAST_RENFREWSHIRE</td>
<td>9</td>
<td>9</td>
<td>2</td>
<td>2</td>
<td>28</td>
<td>28</td>
<td>7</td>
<td>x3.1</td>
<td></td>
</tr>
<tr>
<td>SOUTH_AYRSHIRE</td>
<td>9</td>
<td>2</td>
<td>11</td>
<td>3</td>
<td>28</td>
<td>28</td>
<td>7</td>
<td>x2.5</td>
<td></td>
</tr>
<tr>
<td>DUNDEE_CITY</td>
<td>13</td>
<td>13</td>
<td>3</td>
<td>3</td>
<td>27</td>
<td>27</td>
<td>7</td>
<td>x2.1</td>
<td></td>
</tr>
<tr>
<td>EAST_AYRSHIRE</td>
<td>10</td>
<td>10</td>
<td>3</td>
<td>3</td>
<td>23</td>
<td>4</td>
<td>27</td>
<td>7</td>
<td>x2.7</td>
</tr>
<tr>
<td>INVERclyde</td>
<td>7</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>21</td>
<td>21</td>
<td>5</td>
<td>x3.9</td>
<td></td>
</tr>
<tr>
<td>WEST_DUNBARTONSHIRE</td>
<td>12</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>19</td>
<td>19</td>
<td>5</td>
<td>x1.6</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1235</strong></td>
<td><strong>321</strong></td>
<td><strong>1556</strong></td>
<td><strong>389</strong></td>
<td><strong>2722</strong></td>
<td><strong>282</strong></td>
<td><strong>3004</strong></td>
<td><strong>751</strong></td>
<td>x1.9</td>
</tr>
</tbody>
</table>

3.4.2 Combined records from all core sources by LA areas on trunk and non-trunk roads

Whereas Table 5 is restricted to data from the SSPCA (supplemented by some for FC) of which over 85% relate to non-trunk roads, in Table 6 below data from all of our core sources (including Trunk Road Operating Companies) for the most recent four years are re-examined by Council administrative boundaries. This shows the combined sample of all mapped records from core sources available per council area, as well as the percentage of these that relate to incidents along trunk and non-trunk roads. (The portion allocated to trunk roads, as
discussed in section 3.3 above, are all those mapped within a corridor of up to 250 metres to either side of the trunk road shape file).

Table 6. Numbers of DVC records from all four core source types combined for trunk and non-trunk roads by Local Authority

<table>
<thead>
<tr>
<th>Unitary Council area</th>
<th>DVC reports from all Core Sources 2012 to 2015</th>
<th>Of which on Trunk roads</th>
<th>Of which on Non-Trunk roads</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total :</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aberdeenshire</td>
<td>548</td>
<td>117 (21%)</td>
<td>431 (79%)</td>
</tr>
<tr>
<td>Fife</td>
<td>545</td>
<td>262 (48%)</td>
<td>283 (52%)</td>
</tr>
<tr>
<td>Highland</td>
<td>887</td>
<td>644 (73%)</td>
<td>243 (27%)</td>
</tr>
<tr>
<td>NORTH_LANARKSHIRE</td>
<td>361</td>
<td>148 (41%)</td>
<td>213 (59%)</td>
</tr>
<tr>
<td>PERTH_AND_KINROSS</td>
<td>558</td>
<td>416 (75%)</td>
<td>142 (25%)</td>
</tr>
<tr>
<td>ABERDEEN_CITY</td>
<td>144</td>
<td>31 (22%)</td>
<td>113 (78%)</td>
</tr>
<tr>
<td>Angus</td>
<td>175</td>
<td>63 (36%)</td>
<td>112 (64%)</td>
</tr>
<tr>
<td>ARGYLL_AND_BUTE</td>
<td>315</td>
<td>214 (68%)</td>
<td>101 (32%)</td>
</tr>
<tr>
<td>DUMFRIES_AND_GALLOWAY</td>
<td>242</td>
<td>151 (62%)</td>
<td>91 (38%)</td>
</tr>
<tr>
<td>SCOTTISH_BORDERS</td>
<td>169</td>
<td>83 (49%)</td>
<td>86 (51%)</td>
</tr>
<tr>
<td>GLASGOW_CITY</td>
<td>280</td>
<td>195 (70%)</td>
<td>85 (30%)</td>
</tr>
<tr>
<td>Stirling</td>
<td>234</td>
<td>152 (65%)</td>
<td>82 (35%)</td>
</tr>
<tr>
<td>EAST_LOTHIAN</td>
<td>207</td>
<td>128 (62%)</td>
<td>79 (38%)</td>
</tr>
<tr>
<td>Moray</td>
<td>104</td>
<td>27 (26%)</td>
<td>77 (74%)</td>
</tr>
<tr>
<td>SOUTH_LANARKSHIRE</td>
<td>195</td>
<td>122 (63%)</td>
<td>73 (37%)</td>
</tr>
<tr>
<td>EAST_DUNBARTONSHIRE</td>
<td>67</td>
<td>0 (0%)</td>
<td>67 (100%)</td>
</tr>
<tr>
<td>WEST_LOTHIAN</td>
<td>92</td>
<td>29 (32%)</td>
<td>63 (68%)</td>
</tr>
<tr>
<td>Midlothian</td>
<td>91</td>
<td>31 (34%)</td>
<td>60 (66%)</td>
</tr>
<tr>
<td>Falkirk</td>
<td>170</td>
<td>114 (67%)</td>
<td>56 (33%)</td>
</tr>
<tr>
<td>CITY_OF_EDINBURGH</td>
<td>87</td>
<td>52 (60%)</td>
<td>35 (40%)</td>
</tr>
<tr>
<td>RENFREWSHIRE</td>
<td>104</td>
<td>71 (68%)</td>
<td>33 (32%)</td>
</tr>
<tr>
<td>CLACKMANNANSHIRE</td>
<td>33</td>
<td>1 (3%)</td>
<td>32 (97%)</td>
</tr>
<tr>
<td>NORTH_AYRSHIRE</td>
<td>98</td>
<td>72 (73%)</td>
<td>26 (27%)</td>
</tr>
<tr>
<td>EAST_AYRSHIRE</td>
<td>46</td>
<td>22 (48%)</td>
<td>24 (52%)</td>
</tr>
<tr>
<td>SOUTH_AYRSHIRE</td>
<td>71</td>
<td>48 (68%)</td>
<td>23 (32%)</td>
</tr>
<tr>
<td>DUNDEE_CITY</td>
<td>33</td>
<td>12 (36%)</td>
<td>21 (64%)</td>
</tr>
<tr>
<td>EAST_RENFREWSHIRE</td>
<td>50</td>
<td>31 (62%)</td>
<td>19 (38%)</td>
</tr>
<tr>
<td>INVERCLYDE</td>
<td>40</td>
<td>23 (58%)</td>
<td>17 (43%)</td>
</tr>
<tr>
<td>WEST_DUNBARTONSHIRE</td>
<td>36</td>
<td>23 (64%)</td>
<td>13 (36%)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5982</strong></td>
<td><strong>3282</strong> (55%)</td>
<td><strong>2700</strong> (45%)</td>
</tr>
</tbody>
</table>

While Table 6 is presented here for completeness, to give the fuller picture for each Council area, in interpreting the figures shown it is important to note that:

i. the proportion of the total road network made up of trunk roads will vary greatly between differing Council administrative boundaries, and

ii. the proportion of the (unknown) true total of actual DVC incidents that occur which are captured by our core samples is likely to be rather better for trunk roads than for the non-trunk roads.
This arises as among data received for trunk roads via TROCs a high proportion will relate to requests to clear dead deer from carriageways. By contrast, SSPCA and FC records, which make up the bulk of our information for non-trunk roads, in over 90% of cases will relate to requests to assist with ‘live’ injured deer on welfare grounds, as SSPCA will generally not attend to deer killed outright. The true proportion of DVC incidents occurring on non-trunk roads is therefore likely to exceed the minimum figures shown in Table 6.

3.5 Human injury (ST19) collisions and damage-only DVC attended by police

3.5.1 Numbers of reported personal injury accidents in which deer implicated

Consistent extraction throughout Scotland of police records of personal human injury road traffic collisions (PIA) in which deer were implicated has continued to prove difficult. Annual requests for such data had been made to the 8 former Scottish ‘legacy’ police forces prior to their merger into the single Police Scotland force during 2010. It had been hoped that following formation of Police Scotland such extraction would become simpler and more consistent. However to date availability of comparable data on Road traffic collisions in which deer have been implicated are still only available for all of the 2008 – 2015 project period in case of 2 of the legacy forces (Northern and Fife) and in case of a third (Central) for the Falkirk Council area only. These most consistent data have been much aided by regular provision and extraction by Highland, Fife and Falkirk Council Road Safety officers from their processed RTC records in which deer or stag are mentioned, broken down by severity (slight, serious, fatal), and including when available also details of damage-only incidents attended by police. In these areas too however, damage-only incidents are generally no longer obtainable after 2014.

Information on reported PIAs with ‘deer’ has been possible to obtain from a slightly wider range (5 of 8) of the former legacy forces for the past three years (2012 to 2015), aided by data drawn together recently for us by Transport Scotland. While they too have not been able to obtain this past information via Police Scotland (mainly as they extra detail needed to identify ‘deer’ incidents does not form part of the official national statistics), it is likely more complete extraction of such PIA records across all of Scotland should be possible in future.

Data on PIAs in which deer have been implicated, for those legacy forces and years where at least some such records have been possible to obtain, are summarised in Table 7.

Table 7. Available police records on personal injury DVCs broken down by the eight former legacy forces (now incorporated within Police Scotland).

<table>
<thead>
<tr>
<th>Year</th>
<th>Central</th>
<th>Fife</th>
<th>Grampian</th>
<th>Lothian &amp; Borders</th>
<th>Northern</th>
<th>Tayside</th>
<th>Strathclyde</th>
<th>Dumfries &amp; Galloway</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>7</td>
<td>3</td>
<td>7</td>
<td>nd</td>
<td>13</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2009</td>
<td>0*</td>
<td>3</td>
<td>8</td>
<td>nd</td>
<td>9</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2010</td>
<td>1*</td>
<td>2</td>
<td>3</td>
<td>nd</td>
<td>9</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2011</td>
<td>1*</td>
<td>5</td>
<td>6</td>
<td>nd</td>
<td>10</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2012</td>
<td>4*</td>
<td>4</td>
<td>6</td>
<td>nd</td>
<td>7</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2013</td>
<td>3</td>
<td>0</td>
<td>nd</td>
<td>4</td>
<td>14</td>
<td>9</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2014</td>
<td>2</td>
<td>1</td>
<td>nd</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>nd</td>
<td>nd</td>
</tr>
<tr>
<td>2015</td>
<td>2</td>
<td>1</td>
<td>nd</td>
<td>5</td>
<td>8</td>
<td>6</td>
<td>nd</td>
<td>nd</td>
</tr>
</tbody>
</table>

Total 20 19 30 12 76 16 nd nd

(* 2009 - 2012 Central Police records for Falkirk council only; nd - no data available/ provided)
In case of Highland Region, where consistent information is available for the 8 main study years – deer PIAs have averaged 10 per year from 2008 to 2013 (and same also for earlier years 2003 to 2007), but have reduced to 6 and 8 in 2014 and 2015 respectively. These incidents have included at least one or two KSI incidents in most years. For Fife – a much smaller local authority, deer related PIAs have averaged 2.5 per year; and over the shorter span of years for which data are available for Grampian and Tayside an average of 6 and 5 PIAs with deer per year were reported respectively.

Review of available accident descriptions for PIA records in which deer are believed to have been implicated, indicate that close to 60% involve swerving or other manoeuvres in attempts to avoid deer on the road before hitting another vehicle or object. Mention that as deer has actually been hit by the vehicle is only apparent in about 35% of cases, although from the short text descriptions it is not always entirely clear whether or not a deer was also hit or not.

3.5.2 Estimating actual numbers of deer related PIAs in Scotland per year

Based on the limited PIA data available (Table 7), together with assumption that average figures from those police forces with data are representative of the rest of the country, we may estimate that at least near 40 or more PIA records would be forthcoming if similar data were available for all eight legacy forces. This is a somewhat lower estimate than the 65 to 70 proposed previously (Langbein, 2011) based on available data for earlier years since 2003. While this may reflect a downward trend in injury DVCs (as is the case for PIAs from all causes on the road network over the past decade), figures for deer accidents must be interpreted cautiously in view of the quite small samples involved.

Furthermore, although above estimate of 40 ‘reported’ deer related PIA per year in Scotland over recent years, derived through assessment of ST19 data, must be seen as only a very conservative estimate of actual numbers of human injury accidents and casualties in which deer are implicated. Thus, at a UK wide level, during 2010 there were a total of 208,648 casualties of all severities among 154,414 injury accidents reported (via ST19 forms) by police in Britain (DfT, 2011). However, estimates from the National Travel Survey suggest ST19 figures are likely to represent less than one third of all injury road accidents and casualties. Thus, according to DfT:

“STATS19 remains the most detailed, complete and reliable single source of information on road casualties covering the whole of Great Britain. However, it has long been known that police data does not provide a complete record of all injury accidents and resulting casualties. Our best current estimate derived from the NTS data is that the total number of road casualties in Great Britain annually, including those not reported to the police, is within the range 660 thousand to 800 thousand with a central estimate of 730 thousand. This is based on data for the seven year period 2004 to 2010.” (DfT, 2011)

On the basis of the range of these higher NTS estimates, it is likely that the true annual number of deer related accidents leading to human injuries may exceed 120 per year across Scotland.

This would be a rather higher estimate than those put forward in our previous study reports (Langbein, 2011) when NTS figures were not yet available. Nevertheless these estimates do not seem unrealistic in the context of published figures on other countries. For example in Germany (ADAC, 2009), total number of all DVCs have been assessed at around 220,000 per year (DJV, 2011), and the number of injury accidents reported to police with the causation factor “wild game animal on the road” have consistently exceeded 2700 over the last five years, of which close to 80% (c.2200) annually are believed to result from collisions
with roe, red and fallow deer (DJV, 2010; 2011). Which translates into c. 1% of all DVCs leading to human injury. If applying that 1% figure to the above estimates of 40 reported but likely 120 actual DVCs with human injury would suggest the Scotland-wide annual toll of all DVCs in the range of 4000 to 12,000.

3.5.3 Proportion of reported PIA and damage-only DVCs on trunk and non-trunk roads

Over the past 7 to 8 years, two Council Road Safety teams (Highland and Fife) have also been able to provide us with information on a sample of over 300 damage-only road traffic collisions attended by police in which deer were implicated in some way. The proportion of damage-only accidents that are reported and attended by police is highly variable between years and regions, and extraction of such data for us has also reduced in recent years, due to less detailed recording of such incidents at police level. However, those past records available on damage-only DVCs, are nevertheless valuable as, together with those for PIA incidents, they can provide some useful insights into the likely proportion of all DVCs that occur on trunk and non-trunk roads, as well as the diurnal patterns of DVCs.

Table 8. Breakdown of records of personal injury and where available damage-only road traffic collisions attended by police, in relation to occurrence on trunk and non-trunk roads. (damage-only records available for Highland and Fife only; others restricted to PIA incidents)

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>Total average annual traffic volume (in million vehicle kms)</th>
<th>Available records of DVCs attended by police</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trunk Non-trunk Total</td>
<td>% traffic on trunk</td>
</tr>
<tr>
<td>Highland</td>
<td>1528 1114 2642</td>
<td>58%</td>
</tr>
<tr>
<td>Angus + Perth &amp; Kinross</td>
<td>1649 1641 3290</td>
<td>50%</td>
</tr>
<tr>
<td>Aberdeenshire + City of Aberdeen</td>
<td>1125 2864 3989</td>
<td>28%</td>
</tr>
<tr>
<td>Fife</td>
<td>820 1981 2801</td>
<td>29%</td>
</tr>
<tr>
<td>Combined</td>
<td>5122 7600 12722</td>
<td>40%</td>
</tr>
</tbody>
</table>

In Table 8 PIA and damage-only records for those Council areas where samples of significant size are available to us, are broken down into the proportion that occurred on trunk road and non-trunk roads. Also shown are the average annual total traffic volumes by local authority for these two broad road types, to assess the extent to which spread of DVCs among road types reflects the total traffic carried by each. It is clear from this that while overall road length made up by trunk roads countrywide is only about 6%, they carry in case of the sample of Council areas used in Table 8, 40 % of average annual traffic volume (based on 2012 TS statistics).

DVC incidents attended by police are probably the most representative of all our data samples in terms of distribution across road types. Figures in the table show that overall the proportion of DVCs recorded on trunk roads, does in fact very closely reflect the distribution of total traffic volumes.
3.5.4 Distribution and continued value of collection PIA information

A map showing the distribution of all currently available PIA DVC records available to us for the period 2008 to 2015 in provided in Figure 8. The PIAs (red circles) are overlaid also on any mapped damage-only records (as well as PIAs from earlier years) available in the fuller DVC database for 2001 to 2015. Note that as per Table 7 information on PIAs in the Dumfries and Galloway and Strathclyde areas are not currently available to us.

![Map showing the distribution of available records of DVCs leading to human injury](image)

*Figure 8. Distribution of available records of DVCs leading to human injury for period 2008 to 2015 (red circles), plus damage-only incident for throughout 2001 to 2015. (Note - police data on PIAs unavailable for any recent years for Strathclyde and Dumfries & Galloway)*

In order to obtain more complete coverage across Scotland of these small but important data sets from view of Road Safety evaluations, a number of discussions were initiated during 2014 via contact with Traffic Scotland, Police Scotland and Road Safety GB. Some progress in this regard was made via contact with Traffic Scotland Statistics section, who themselves had been trying to consolidate additional RTC data (over and above those published in standard DfT STATS19 reporting) for the various legacy police forces. However, they too have experienced difficulties to date in obtaining such information for past years for all of the 8 legacy police forces. In addition, various confidentiality issues relating to passing information to third parties on incident descriptions remain to be resolved, and have at times
restricted availability of these records to the project. Nevertheless, recent progress on this
with assistance of Transport Scotland, makes better availability of at least PIA incidents
involving deer more likely in future.

3.6 DVC frequency in relation to Time of day and Season

3.6.1 Diurnal patterns of DVC occurrence

Diurnal variation in traffic flows and how that relates to diurnal variation in deer activity period
may lead to certain times when DVC are most likely to occur. In order to investigate the
distribution of DVC occurrence in relation to the time of day, it is important to focus on those
records for which we may be most confident that times of actual incidents have been
recorded accurately; that is, as for many deer road casualties the time when most deer are
found may be biased towards the early hours of the morning simply as road kills may be
more easily spotted then by greater numbers of drivers.

The data least likely to be affected by any such possible observer bias are records obtained
for human injury as well as damage-only DVCs at which police attended, which are then
generally recorded most accurately with respect to time of actual incident and location.
Overall we are able to draw on around 500 such incidents from the last 8 project years (as
outlined Table 8 above), as well as a further 400 from earlier DVC projects in Scotland; as
there was no significant difference in the diurnal patterns emerging between data for the
earlier and later years, data for all 2001 to 2015 were pooled for this assessment.

The overall diurnal distribution of 969 DVCs attended by police in Scotland for which
accurate incident times are available is presented in Figure 9. Incident times have been
allocated to one of eight different 3-hour periods.

![DVC occurrence by time of day](image)

**Figure 9. Relative frequency of DVC occurrence by time periods of the day (based only on
DVC incidents attended by police and hence most reliable actual incident times (n = 969).**

The same data are presented broken down for four different ‘seasons’ in Figure 10, as
follows (Winter: Dec-Feb; Spring: Mar-May; Summer: Jun-Aug; Autumn: Sep-Nov). A
broadly similar diurnal pattern is apparent in each of these seasons, with an early morning
peak in incidents between 0600 – 0900 hrs, as well as an even higher peak early evening through to midnight.

As may be expected as a result of shorter daylight, the evening peak occurs earliest during winter and latest during summer. In general the periods of highest incidence of DVCs in Scotland may be identified as from early evening until midnight (1800-2400) followed by early morning (0600-0900).

![DVC occurrence by time of day and season](image)

Figure 10. Relative frequency of DVC occurrence by differing time periods of the day and broken down by season (based only on DVC incidents attended by police and hence including reliable incident times (n = 969).

### 3.6.2 Seasonal patterns of DVC occurrence by road type and region

The seasonal patterns of DVC occurrence were analysed and discussed in some detail in the previous contract report based on data for 2003 to 2010, for differing road types as well as different regions within Scotland (see Langbein 2011, section 5.3), and are not re-examined in detail here.

In summary a major peak in DVCs occurs during May & June on all road types throughout Scotland. This peak is most pronounced by far for motorways where over 60% of annual incident occur during May and June, followed by A-class trunk roads (35%). In case of other A-roads and all smaller roads a regular spring peak is still apparent but here makes up only 25%. The patterns with just a single noticeable peak remain the same for most of Scotland, with exception of North West Scotland, where a significant proportion of incidents involve larger deer species (red, sika and fallow); whereas in other regions roe deer incidents tend to predominate (see also 3.7).
3.7 DVC reports with reliable detail of deer species

The species of deer involved is reported in only a minority of DVC reports obtained for the present project. For our by far largest data samples (TROCs and SSPCA) incidents tend to be first logged when a request to attend to an animal carcass from a road is received from the public, police or another organisation, and will generally then simply be referenced as ‘deer’ with detail of the species of deer rarely reported or recorded. Indeed even for those occasion where deer species is provided, the reliability of that identification would be unknown.

Table 9. Numbers of DVC records from ‘deer-knowledgeable contributors’ with species detail, broken down by Council administrative boundaries.

<table>
<thead>
<tr>
<th>Local Authority</th>
<th>ROE</th>
<th>%</th>
<th>RED</th>
<th>%</th>
<th>SIKA</th>
<th>%</th>
<th>FALLOW</th>
<th>%</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIGHLAND</td>
<td>142</td>
<td>36%</td>
<td>234</td>
<td>60%</td>
<td>14</td>
<td>4%</td>
<td></td>
<td></td>
<td>390</td>
</tr>
<tr>
<td>ARGYLL_AND_BUTE</td>
<td>145</td>
<td>55%</td>
<td>117</td>
<td>44%</td>
<td>3</td>
<td>1%</td>
<td></td>
<td></td>
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</tr>
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<td>5</td>
<td>42%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>STIRLING</td>
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<td>23%</td>
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<td></td>
<td></td>
<td></td>
<td>39</td>
</tr>
<tr>
<td>PERTH_AND_KINROSS</td>
<td>22</td>
<td>33%</td>
<td>8</td>
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<td></td>
<td></td>
<td>37</td>
<td>55%</td>
<td>67</td>
</tr>
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<td>94%</td>
<td>3</td>
<td>6%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td>DUMFRIES_AND_GALLOWAY</td>
<td>66</td>
<td>89%</td>
<td>2</td>
<td>3%</td>
<td></td>
<td></td>
<td>6</td>
<td>8%</td>
<td>74</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>ANGUS</td>
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<td>100%</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td>7</td>
</tr>
<tr>
<td>CLACKMANNANSHEIRE</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>EAST_AYRSHIRE</td>
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<td>100%</td>
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<td></td>
<td></td>
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<td></td>
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<td>2</td>
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<tr>
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<td></td>
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<tr>
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<td>8</td>
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<td></td>
<td>2</td>
</tr>
<tr>
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</tr>
<tr>
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<td>1</td>
<td>100%</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>MORAY</td>
<td>62</td>
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<td></td>
<td></td>
<td></td>
<td>62</td>
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<tr>
<td>NORTH_LANARKSHIRE</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>RENFREWSHIRE</td>
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<td>100%</td>
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<td></td>
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<td></td>
<td></td>
<td>2</td>
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<tr>
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<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>SOUTH_LANARKSHIRE</td>
<td>9</td>
<td>100%</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>WEST_DUNBARTONSHIRE</td>
<td>1</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>WEST_LOTHIAN</td>
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<tr>
<td><strong>Total</strong></td>
<td>580</td>
<td>57%</td>
<td>370</td>
<td>36%</td>
<td>17</td>
<td>2%</td>
<td>51</td>
<td>5%</td>
<td>1018</td>
</tr>
</tbody>
</table>

Some of our smaller sources categories that do provide reliable species detail for a high proportion of records, include in particular i. FC wildlife rangers, ii. a number of deer-knowledgeable contributors (including SNH deer officers, and some estate deer managers) who submit sightings of deer road casualties on-line, and iii) a dedicated road side carcass search project which was administered by SNH for a number of specific A-class trunk roads in Highlands region up until March 2011.

For the eight year period January 2008 to December 2015, a total of 1018 DVC records with species detail are available to us from such ‘deer-knowledgeable’ contributors. A breakdown of these records by local authority is provided in Table 9, to provide an indication of the share of all DVCs made up by differing deer species.

Figures in Table 9 indicate that red deer are regularly involved in a significant proportion of reported DVCs in only five council areas, especially Highland and Argyll and Bute; with sika also reported in a small proportion if DVCs in these council areas. Fallow DVC reports
available mostly relate to Dumfries and Galloway (especially A701 near St Anne’s) and Perth & Kinross (esp. A9 Dunkeld to Blair Atholl). For the majority of other Council areas however roe deer are the only species reported, although in many cases numbers of species-specific reports remain very low.

If it is felt important to improve information on the extent of involvement of different deer species, encouraging greater input of deer road casualty sightings from more members of lowland as well as upland DMGs may be the most productive way to achieve this.

### 3.8 Estimation of actual annual number of toll DVCs in Scotland

The primary purpose of the present contract has been the continued collation of countrywide samples of DVCs, in order to provide further information to SNH, Transport Scotland (TS), Trunk Road Operating Companies (TROCs), local authorities and local deer managers to help prioritise allocation of resources and action to reduce risks to public safety and safeguard deer welfare. Estimation of the true actual numbers of DVCs that occur nationally across Scotland was not a specific project objective. However, the question of the overall toll is often raised by the media and others. Such estimation remains extremely difficult, as whilst the various different Scotland-wide sample data obtained from TROCs, SSPCA, FC rangers and Police human injury records can each provide indices of change across years, the proportion of all actual incidents sampled by each of these sources remain unknown.

#### 3.8.1 Past estimates

Past estimates proposed on the basis of the 2003 to 2005 study suggested that the total number of DVCs in Scotland is likely to lie in excess of 7000 and possibly as high as 12,000 per annum (Langbein & Putman, 2006). These estimates were derived foremost from extrapolations based on numbers of PIA (human injury) DVCs and the ‘estimated’ proportion (c.1%) these tend to represent of total numbers based on other studies in the UK and Europe (Langbein, 2007; ADAC, 2009; DJV 2011). Revised estimates based on more recent information on PIAs reported to police and estimates of actual numbers these represent (as discussed further in section 3.5.2) permit also only very broad ranging estimates, that true totals of all DVCs (including any deer casualties, without or with damage to vehicles) in Scotland are likely to lie between 4000 to 12,000 per year.

Alternatively results from an earlier assessment by the Deer Commission for Scotland (based on a series of roadside verge carcass searches for 3 different substantial sections of A-class trunk routes in the Highlands between 2003 to 2010), determined that TROCs records on their own at best made up 64%, 57% and 24% of minimum actual numbers of deer road casualty carcasses found on those three routes respectively (see Langbein, 2011). On that basis it was estimated that overall TROCs records are unlikely on average to record more than 50% of the true number of DVCs on such trunk roads. Using that sampling intensity it was suggested at the time that actual numbers of trunk road DVCs were likely to lie in the region of 1500 per year, leading to minimum estimates of 4500 for the Scottish road network as a whole. Given that even the carcass searches would be unlikely to provide a full picture (as some further road casualty deer will in fact have been removed from the roadside either by the TROCs, or indeed by members of public), the true figure was suggested to lie even lower.

#### 3.8.2 Updated broad ranging estimates

Revised estimates based on more recent information on PIAs reported to police and actual proportion of PIAs these are likely to represent (as discussed further in section 3.5.2) suggests that that true totals of all DVCs (including any deer casualties, without or with damage to vehicles) in Scotland still lie somewhere within the wide range of 4,000 to 12,000 per year.
To provide further insights into likely levels of sampling achieved by TROCs, over the three years of the present contract (2013 to 2015), a number of SNH deer officers and other deer managers were encouraged to provide information via an online report form whenever possible giving dates, location and species of any deer road casualties noted by them during car journeys. Total returns received included 112 deer casualties seen on the side of trunk roads in various parts of Scotland. These records were assessed individually by us to check how many of these same deer casualties were later also reported to us in records provided by the relevant TROC. Incidents were marked as plausible or likely duplicates if logged with either the same day or within 24 hours to either side, as well as located on the same road and mapped no more than 4 km from the point reported by the TROC. The number of plausible duplicates identified in this way, were in fact only 17% (19 out of the 112 reports). This suggest that in general an even lower percentage (possibly <20%) of the true number of DVCs than estimated by the earlier carcass search study are likely to be captured by the TROC data in general.

Average numbers of TROC reports since 2012 have amounted to 720 per year for the whole of the trunk network. If we were to accept the above indicator that these may in fact represent less than 20% of all deer casualties and related collisions on trunk roads, the true number on the trunk network alone would be estimated at 3600. Based on the further (rather saver) assumption (as discussed in 5.3.3) that trunk road DVCs are likely to make up no more than 39% of all DVCs countrywide, the full Scotland-wide number of DVCs over recent years would be estimated at 9230 per year.

3.8.3 Proposed alternative independent assessment of national DVC tolls

While the above give a very broad indication of what may be the total number of deer involved in vehicle collisions for Scotland each year, our present sampling regime was never designed to produce such total figures and data available are not well suited for this. The above estimates therefore remain based on a rather weak foundation, using extrapolations from samples for which the true sampling intensity can itself only be estimated.

If it is considered important to obtain firmer figures for true annual Scotland-wide DVC toll, it is likely this would be better achieved through a one-off independent public questionnaire based approach, possibly via one or more national motoring organisations. That is mainly, as even if insurance data on deer related claims were readily available to us, it has previously been shown that minor collisions (i.e. those below insurance claim thresholds and not reported to police) tend to make up the great majority of all DVCs and other wild animal collisions (Hartwig, 1991).

An outline proposal for such a questionnaire based study has previously been we drawn up by us but then not pursued further. In brief we would suggest such an investigation might best be undertaken for the UK as a whole; and in order to obtain unbiased returns, would ask questions of a large national sample (> 1000 to 5000) motorists concerning any animal related vehicle collisions they have been involved in over a set recent period of years, and details of the animal type, as well as approximate month and location. Results from such a fairly simple study, in combination with information from the present and past DVC monitoring work, would provide a much better basis of estimation of the true UK toll (and breakdown by devolved countries and local authorities) than is possible from existing data.
4. DISCUSSION AND CONCLUSIONS

4.1 Progress of data collection and collation

- Data collection during the 2013 to 2015 continuation has progressed largely as planned. The SNH DVC database compiled now includes over 12,500 mapped incident records for the period 2008 to 2015 (of which 10,500 relate to the four core source types that provide the most even sampling across Scotland and throughout that time period). In addition a further 6000 grid reference records for earlier year are contained in the overall database.

- Regular annual input of DVC records is now available not only from the four main Trunk Operating Companies, but also all six of the smaller DBFOs, not all of which had yet provided records in the past; or else in some cases (e.g. Aberdeen Road Ltd for AWPR) were only established very recently. Together the above now provide complete data coverage for all of the Scottish trunk network roads, with broadly comparable records now available for all trunk units throughout the eight years from January 2008 through to end December 2015.

- Data from call-out requests to attend to deer injured in DVCs received by SSPCA and FC rangers have also been obtained annually in comparable manner and these too are available and incorporated in the database for all of these eight years.

- While the two largest data samples (TROCs and SSPCA) rarely provide details on the deer species involved in DVCs, this information is available from most FC records, and over the last three years also from increasing input by SNH deer officers of deer road casualty sightings made by them. The latter are valuable also in other ways, including insights to likely level of sampling achieved via TROCs alone for trunk roads.

- One key gap in relation to data collection for recent years continues to be the paucity of information on DVCs that lead to human injury, as recorded by police if attending such incidents. As records of types of wild animal implicated as hazards or objects on the carriageway do not form part of official ST19 national statistics on road accidents, extraction of this information has needed to be requested via legacy police forces or council road safety teams. To date this has provided coverage of only half of Scotland in most data years, and led on average information on just 30 such injury accidents reports per project year. Following recent discussions with Transports Scotland Road accident statistics section, some further progress has now been made on this; and although it is unlikely complete coverage of all areas will be forthcoming for past years, we are hopeful that improved coverage across all of the Police Scotland area may be possible in future.

4.2 Basic analysis of trends and distribution of DVC occurrence

4.2.1 Trends

- The combined annual volume of records available from all our core data sources combined has risen steadily since 2008 (<1000) to 2012 (>1500), declined slightly in 2013 & 2014, before a further rise (mainly in SSPCA submissions) to over 1600 in 2015 (see Figure 1).

- After many decades of steady growth, traffic volumes across Scotland peaked during 2007 followed by a small downward trend to 2011. Over the last three years traffic has increased again and only since 2013 for the first time exceeded the previous 2007 peak, with gross change still close to 0% averaged over the past five years (Scottish Transport Statistics, 2014; 2015). In the present context this provides confidence that
the persistent increasing trend apparent among total volumes of DVC reports received from 2008 – 2015 reflects a greater rise in the rate of deer casualties on Scotland’s roads that would be expected through changes in traffic volumes alone.

- Figures and tables prepared for the present report generally include, aside from breakdowns of data by source types and mapping to help identify hotspots, comparisons between the first four years and latest four years. It is apparent (e.g. see Figures 3, 5, 6) that the overall distributional patterns are broadly similar for data from these two independent periods. Total numbers of core source records for 2012 to 2015 (5999) have however increased by 35% compared to 2008 – 2011 (4495). The greatest levels of increase appear to have occurred particularly in Aberdeenshire, Fife and The Central Belt, though also e.g. north of Inverness to Helmsdale.

- Overall numbers of DVC reports from TROCs have remained quite stable year to year, but mask rather greater fluctuations with different trunk units. By comparison to the previous 4 years, volume of records for NE, NW and SE Units over the last 4 years have increased by 13 to 26 %, but a reduction by 40% has occurred in the SW. The latter may in part have been affected by changes change in operating company in 2013, and further information on protocols of how and when animal carcasses are logged is being sought for all TROCs.

- Data from SSPCA have increased year on year since 2009, with just one exception (2014) before another large increase in data for 2015. Improved computer storage and extraction may have contributed to some extent, but overall trend is more likely to reflect the overall expansion in population ranges by deer, and especially so in the Scottish lowlands and urban fringes over recent years. However, while it had been thought that SSPCA coverage might possible be rather restricted to more urban areas, it has been particularly encouraging that significant samples of records are obtained from right across all mainland local authorities.

- In the great majority of council areas DVC incidents handled by SSPCA have more than doubled since 2012, compared to the previous four project years. Most notable increases by over 2.5-fold include in North Lanarkshire and South Lanarkshire, as well as only slightly smaller rises in Aberdeenshire and Fife where figures were already among the highest.

4.2.2 Diurnal and seasonal distribution and species involved

- Analysis of diurnal patterns of DVCs for the year as a whole as well as in separate seasons consistently shows early morning peaks in incidents between 06:00 – 09:00 hrs, and an even higher peak from early evening through to midnight (18:00 to 24:00; Figure 9&10). As would be expected as a result of shorter daylight, that evening peak occurs earliest during winter and latest during summer.

- Seasonal patterns of DVC occurrence and how these vary by road types and regions in Scotland were discussed in some detail in an earlier report based on data for 2003 to 2010 (see Langbein 2011, section 5.3). As no significant changes in this are apparent, details of this have not been re-included again here. In summary, a major peak in DVCs occurs during May & June on all road types throughout Scotland. This peak is most pronounced by far for motorways, where over 60% of annual incident occur during May and June, followed by A-class trunk roads (35%). An additional prominent autumn peak and generally wider spread of DVCs across the year is mainly apparent only for NW Scotland and other localised areas where large deer (red, sika, fallow) rather than roe deer predominate.
• Reliable information on the deer species involved is available for only around 10% of our DVC records for the last eight years. A breakdown by council areas of the proportional representation of different species among such species-specific records (Table 9) shows only confirmed roe deer incidents 17 council areas. Red and sika or fallow currently only feature regularly among these records for 7 council areas, and roe predominate in also five of these.

4.2.3 National estimates

• Estimation of the true actual numbers of DVCs that occur nationally across Scotland was neither a specific project objective, nor are the sampling regime and records obtained well suited to such extrapolation. However, as this question is regularly raised, some cautious minimum countrywide estimates are discussed in section 3.8.2., based on, what are themselves at present merely estimates of sampling intensity achieved via differing sub-sets of data.

• On that basis our best current estimate would be that total numbers of deer road casualties and related vehicle collision in Scotland are likely to exceed at least 4000 but may be closer to 9000 per year.

• If wishing to underpin and firm up ability to produce more accurate countrywide and regional estimates based data from the present study, the best way to achieve this may be to obtain some information via a questionnaire based survey of motorists, as discussed further with other recommendations in 4.3 below.

4.3 Recommendations for future monitoring and further analysis

Data on DVCs for the present project have now been gathered in a consistent manner for eight years, providing a database of substantial size and countrywide coverage. The long time span will be continue to be increasingly useful to assess not only distribution and hotspots, but also more comprehensive analysis of changes across years for specific areas or routes. The consistency of sampling across years is one of the main assets of the study, and it is hence important to maintain methods of data collection as comparable as possible also for future monitoring. Nevertheless, there are areas where improvements or additions to data collection, as well as more in depth evaluation and analysis of existing data could help extend the overall worth of the project. In the event that DVC monitoring is to continue, we would make a number of recommendations for such further work.

4.3.1 Improvements of data coverage and consistency

• Total number of trunk ROCs and DBFOs involved in managing the trunk network has increased in recent years, as well as change to which companies manage different units. The approach to animal carcass uplifts and recording employed by each company should be reviewed with them to ensure data are as consistent as possible from all parts of the network.

• Human injury DVC data are a small but important sub-set, that to date have lacked countrywide coverage. Improved coverage and regular extraction should continue to be pursued with TS and Police Scotland for future years.

• Data coverage is at present almost exclusively restricted to mainland council areas. For completeness some efforts to obtain at least some limited regular input from potential sources within the 3 island council areas should be explored.

• Supplementary DVC records provided by especially some SNH deer officers over the past three years have provided useful input not available from most core data including
on deer species, and help to assess likely levels of data capture from core sources. Encouragement would be useful for further deer officers, other SNH ecologists and field staff to use the online form to report any deer casualties seen while travelling or during field studies.

- The OhDeer reporting APP has been discontinued for technical reasons. However, online data gathering by the British Deer Society for their 2016 national deer distribution survey can provide an additional species-specific data source where deer sightings related to road casualties.

4.3.2 Additional evaluation of existing and future data

- Sample data collected annually to date (see 4.2.3 above) is of only limited use for estimation of the true total numbers of DVC that occur for Scotland as a whole or by regions each year. If considered important by SNH to obtain firmer figures of the actual countrywide DVC toll, we would suggest this could be best achieved through a one-off UK-wide public questionnaire based approach (as outlined in 3.8.3) relating to animal-vehicle accidents, possibly via one or more national motoring organisations.

- The grid based approach used in the present contract for mapping and basic analysis provides ready overviews and identification of hotspots, but at present does not consider differences between roads in traffic flows. As such hotspots more so indicate relatively level of risk to deer, rather highlight road sections with highest DVC risk from view of drivers. To make fullest use of existing and future data we would suggest more in depth analysis should be undertaken in future to include:
  - Identification of frequency of DVC reported per km per year for all trunk route ‘sections’ of over 500 meters in lengths to develop relative DVC risk maps, that are also readily broken down by season.
  - Analysis of how these risk maps relate to overall road accident risk based on human injury accidents from other causes.
  - Evaluate past DVC data recorded since 2008 by habitat type and other road characteristics.

- Such assessment of DVC patterns in relation to habitat and other road characteristics based on the A-class trunk roads, should be useful also for predicting relative risk on non-trunk A-roads for which fewer systematic data are available. Development of more comprehensive GIS analysis of DVCs rates should also enable more ready assessments of for example whether DVC rates have shown more notable changes along routes of the road network targeted by the seasonal Transport Scotland VMS (Virtual Message Sign) deer-alert campaigns undertaken over recent years.
5. REFERENCES


ANNEX 1: ADDITIONAL FULL PAGE MAPS

Additional full page maps showing frequency of DVCs recorded for smaller subsections of the trunk road network.

For each pair of figures, the maps show the distribution and frequency per 2 km OS tetrad of DVCs reported from the core sources within different regions of Scotland for two consecutive 4-year periods, to enable comparison between (a) January 2008 to December 2011 and (b) January 2012 to December 2015.

Whilst grid squares are used for ease of presentation, only data from DVC reports logged within no more than 250m to either side of the trunk shape file are included for analysis (see main report text, section 3.3.2).

Figure 11a. DVC frequency map for trunk roads in South West Scotland 2008 to 2011
Figure 11b. DVC frequency map for trunk roads in South West Scotland 2012 to 2015

Figure 12a. DVC frequency map for trunk roads in South East Scotland 2008 to 2011
Figure 12b. DVC frequency map for trunk roads in South East Scotland 2012 to 2015

Figure 13a. DVC frequency map for trunk roads in North West Scotland 2008 to 2011
Figure 13b. DVC frequency map for trunk roads in North West Scotland 2012 to 2015

Figure 14a. DVC frequency map for trunk roads in North East Scotland 2008 to 2011
Figure 14b. DVC frequency map for trunk roads in North East Scotland 2012 to 2015

Figure 15a. DVC frequency map for trunk roads in the Central Belt 2008 to 2011
Figure 15b. DVC frequency map for trunk roads in the Central Belt 2012 to 2015
Figure 11a. DVC frequency map for trunk roads in South West Scotland 2008 to 2011
Figure 11b. DVC frequency map for trunk roads in South West Scotland 2012 to 2015
Figure 12a. DVC frequency map for trunk roads in South East Scotland 2008 to 2011
Figure 12b. DVC frequency map for trunk roads in South East Scotland 2012 to 2015
Figure 13. DVC frequency map for trunk roads in North West Scotland 2008 to 2011
Figure 13b. DVC frequency map for trunk roads in North West Scotland 2012 to 2015
Figure 14. DVC frequency map for trunk roads in North East Scotland 2008 to 2011
Figure 14b. DVC frequency map for trunk roads in North East Scotland 2012 to 2015
Figure 15a. (top) DVC frequency map for trunk roads in the Central Belt 2008 to 2011
Figure 15b. (bottom) DVC frequency map for trunk roads in the Central Belt 2012 to 2015.