# Analysis of the risk from animals on the line – Issue 2


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The report may be downloaded from the RSSB website: www.rssb.co.uk.

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# Report summary

This report provides risk and performance data relating to 'animal on the line' incidents in Great Britain. It was produced following an accident in Germany, in which a passenger was killed when a push-pull train running in 'push mode' derailed after striking a herd of cattle.

It also reassesses how the railway learned from the Polmont accident of 1984 – this being the most recent fatal accident to have occurred in Britain as the result of a collision between a train and an animal.

Polmont highlighted problems with fencing, driving trailer crashworthiness, incident reporting and emergency communication, each of which was addressed by British Rail. Together, subsequent improvements in these areas explain why the risk from post-animal strike derailment is now very low.

### Statistical headlines

- Animal strike incidents account for an estimated 0.06 FWI/year, which represents 0.7% of all train accident risk (7.8 FWI/year). Around 60% of the risk from animal strikes is associated with the risk from derailment.
- The risk is generally low because on-board injuries are rare (although the potential for harm remains when a train derails).
- The average FWI level for the period between 2003 and 2013 is 0.03. Most of the harm from animal strikes takes the form of shock/trauma to the train driver. Drivers can also suffer minor injuries when the impact between train and animal breaks the windscreen.
- There is also the potential for ill health exposure to employees dealing with the clean-up of cattle strikes. The RSSB Workforce Health & Wellbeing project is under way to help members understand and tackle such issues more effectively.
- The total reported number of animal on the line incidents have fallen by 42% since 2003/04. However reported cases of animals being struck by trains have tripled over the same period. (When normalised by train kilometres, the rate has doubled.)

### Animal type

<u>Deer</u>

- The report count for deer on the line is low compared to other animal types. However, the proportion of such cases leading to a strike is high (though the derailment consequences are considered to be lower than with cattle, horses and donkeys).[1]
- Although there has been no clear trend in the number of reported cases of deer on the line, there has been a significant rise in the number of cases of deer being struck by trains since 2003/04.
- There has been a rise in the UK deer population over the last 1000 years. This is due to a number of factors, such as milder winters, the planting of winter crops, increased woodland cover and greater connectivity between green spaces in urban areas.

[1] See Railtrack Great Western's Formal Inquiry into the derailment of 1A91, the 15:30 Penzance–Paddington HST service following an animal strike at 15:52 on 17 August 1999 at Carn Brea (p.15, section 3.6).

Sheep

- Reports of sheep on the line have fallen by 68%. This accounts for most of the overall reduction in 'on the line' incidents seen since 2003/04. However, while a large number of sheep are still reported to have accessed the line, less than 1% are struck by trains.

Cattle and horses

- Reports of cattle, horses or donkeys on the line have fallen by 32% since 2003/04. Of all cattle and horses reported to have accessed the line, 6.9% are struck by trains.

Other[2]

- There has also been a 13% increase in the number of other animals struck by trains since 2003/04. Most are birds, the next highest category being dogs.

**Fencing**

- The recurring causal theme throughout the analysis is damaged fencing. Sometimes vandalism is to blame, sometimes maintenance.
- In at least one case, poor reporting of damage exacerbated the problem; in another, flooding weakened the fence posts. This makes climate change a possible cause in the future.
- The quest for food is the main motivator for cattle using holes in fences. However, two reports in SMIS noted herds that had stampeded the boundary fence after being unnerved by criminal activity.
- Crime was also thought to be behind at least one horse-related incident.
- Deer tend to bound across the railway between areas of natural habitat and grazing.

**Train type**

- Most animal strike incidents involve passenger trains. The increase in incidents is due to a rise in the number of deer incidents since 2006/07.
- The number of freight trains involved in strike incidents is reportedly around one-tenth of the number of passenger trains.

**Route**

- Over the period as a whole, London North Western experienced the greatest number of animal strike incidents, with Scotland taking second place.
- There was a 190% rise in incidents on the Scotland route in 2009/10, compared to 2008/09. Another peak occurred on the same route in 2012/13, which was 79% up on 2011/12.
- Most of the incidents involving deer occur in the Scotland and South East territories, although London North Western has seen an increase since 2007/08. Most trains operating these routes are units (push-pull services now operate primarily on Anglia and London North East).

**Cost**

- On average, 130,000 delay minutes are caused each year by trains striking animals or animals on the line. According to Network Rail, the associated cost of animal on the line

[2] Animals in the 'Other' category include badgers, birds, dogs and foxes.

incidents was around £4.9 million in 2012/13. In addition, the costs of fencing, clean-up and hidden costs such as passenger claims all have to be considered.

- Given that trains striking animals accounts for an estimated 0.06 FWI/year, using the current value of preventing a fatality (VPF) [3] of £1,748,000 (per RSSB, June 2013), it would be justifiable to spend £95,500 per year if the safety risk could be eliminated.
- It might therefore be justifiable to spend around £5m per year to eliminate this risk.

**Closing remarks**

Clearly, many of the risks posed by cattle (and, by implication, other large-boned animals) were addressed after the Polmont accident of 1984. While such animals can still access the line, the chance of a derailment has been minimised by the subsequent upgrade, and later withdrawal, of lighter passenger driving trailers, along with the general improvement in train crashworthiness exemplified by Classes 220, 221 and 390.

Regarding older multiple units in the Class 14x and 15x series, the former's front aprons and the latter's snowplough/obstacle deflectors may have strength, but lack any real energy absorbing capability. Nevertheless, their lower speeds help explain why the derailment risk remains very low. It may get lower still as more of these designs are withdrawn.

As a result of more recent accidents like Letterston Junction, Network Rail has put standards in place to mitigate the different types of fence-related risks evident at different locations. The latest standard for the *Management of fencing and other boundary measures* will use the likelihood of unauthorised access, the consequences of unauthorised access, adjacent land use and the condition of existing boundary measures to determine the initial level of fencing required and the subsequent level of inspection, repair or replacement needed.

Furthermore, animal incursions are a standing item at Network Rail's regular boundary risk management liaison meetings, and will also be covered by an 'objects on the line' deep dive review, which is due to start in July and end in September 2014.

RSSB's analysis shows that the cattle question has largely been replaced by a deer one. At two million, the deer population is reportedly higher now than at any time in the last 1000 years. The reasons for this include milder winters, the planting of winter crops, increased woodland cover and greater connectivity between green spaces in urban areas. Despite the ability of these animals to jump fences of varying heights in order to access woodland habitats and so on, the derailment risk is considered to be less than with a cow or horse.

According to the British Deer Society[4], there are a number of diverse deterrents – ranging from the bizarre and erratic (like the use of creosote and moth balls as barrier repellents) to the bizarre and rather more effective (like spreading a concentrated extract of lion dung along the perimeter).

However, as these solutions are ephemeral, the best way to deter deer remains 'properly erected and maintained deer fences', although the recommended heights do depend on the

[3] Whilst the RSSB figure is considered to be a more up-to-date estimate of the VPF, it is based on provisional estimates of economic performance and is therefore subject to some uncertainty that you should keep in mind when evaluating any options. Guidance on how to incorporate the VPF into industry decision making processes can be found in the Taking Safe Decisions document, which RSSB published on behalf of the industry in 2008. Copies are available on the Taking Safe Decisions webpage.

[4] http://www.bds.org.uk/deer_deterrents.html

specific subspecies involved. A different approach to risk assessment is therefore advisable, as these problems can be distinctly localised. RSSB's work on geo-referenced risk modelling (T972) may make this possible in the future. Based on the Safety Risk Model (SRM), this will use the Wessex route as a pilot to demonstrate how comparisons could be drawn between different locations in order to build up a clearer picture of how risk varies around the system. Obviously, this will help the industry to focus resource where it is most needed. Network Rail is already considering mapping the locations where wild deer access the line. Clearly these two concepts fit together and may – in time – facilitate more targeted, risk-based fencing programmes.

It may also be that electrification – coming soon to the Great Western Main Line (*inter alia*) – may see the erection of larger, eight-foot, fences, much as it did on the West Coast. This may in turn see the risk fall yet further.

In summary, the industry can have a degree of confidence that risk from animal incursion has been reduced by industry improvements in fence management, cab-to-shore communications, the rules for reporting incidents and the robustness of trains to collision. But while Network Rail will continue to monitor the situation, it is noted that the occasional incident can still cause harm, and can impact on the commercial aspect of the railway, in terms of delays, rolling stock cleaning and line clearance.

# 1 Introduction

On 13 January 2012, a Hamburg-bound push-pull service running in 'push mode' struck a herd of cattle and derailed between Stedesand and Langenhorn. One passenger was killed; the driver and one further passenger were injured.

For Deutsche Bahn, the accident raised questions about the fencing of main lines.[5] For GB's cross-industry Operations Focus Group (OFG), the obvious question was 'have we learned from Polmont?' – Polmont being the most recent fatal accident to have occurred in this country as the result of a collision between a train and an animal.

The subsequent investigation centred not only on fencing, but also driving trailer crashworthiness, radio communications and the rules governing the reporting of animal sightings.

The pertinence of these lessons grew on 12 July 2012 when a passenger train struck cattle on the line and derailed at Letterston Junction (see photo).


Photo: Network Rail.

In light of both events, RSSB recommended to OFG that it re-evaluate the potential risk from animal strike incidents. The first edition of this special topic report was the result. It considered all reported incidents of animals on the line, as well as those occasions where the animal was struck by a train. It did *not* consider incidents involving animals accompanied by their owners on level crossings.

The first edition led OFG to form a subgroup to monitor the situation more closely. This report is the result of that monitoring, and includes updated statistical information (to 31 December 2013), along with new information on recorded incidents and recommendations that the industry might care to consider for the future.

## 1.1 Report scope

RIDDOR[6] (Schedule 2, Part IV) classes any case of a train striking cattle or horses as reportable, whether there is damage to the train or not. Cases of trains striking any other animal, where damage *is* caused to the train, are also RIDDOR-reportable.

However, regarding the GB rail industry's Safety Management Information System (SMIS), Railway Group Standard GE/RT 8047 *Reporting of Safety Related Information* contains the following requirements for the mandatory reporting of events:

- **Animals on the line:** Any case of: a) Cattle or a horse or other large animal; b) A group of smaller animals on a running line or in a siding that is Network Rail Managed Infrastructure (NRMI).

[5] The report of the German NIB's investigation into the Langenhorn incident (in German) may be found here: http://erail.era.europa.eu/occurrence/DE-1329-4-1/Trains-collision-with-an-obstacle,-13-01-2012,-Stedesand---Langenhorn-

[6] RIDDOR refers to the *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995*, a set of health and safety regulations that mandates the reporting of, *inter alia*, work-related accidents.

- **Animals struck by trains:** Any case of a train striking: a) Cattle or a horse or other large animal; b) Any other animal where damage is caused to the train necessitating immediate temporary or permanent repair and while the train is on a running line or in a siding that is NRMI.

Events of single animals on the line, where they are not struck by trains but result in damage (unless they are cattle or a horse or a large animal) do not have to be reported via RIDDOR.

Taken together, this report's scope is therefore cattle and horses, deer, sheep and other, smaller mammals.

## 1.2 Data

The data used in the report is taken from SMIS. RSSB bases its safety performance analyses on the latest and most accurate information available at the time of production. We also continually update and revise previous years' data in the light of any new information. The data cut-off date for this report was 31 December 2013 for SMIS data; the analysis period covers the ten fiscal years up to (and including) that date.

All qualitative information is taken from investigation reports supplied to RSSB as mandated by Railway Group Standard GO/RT3119, *Accident and Incident Investigation*. Internet sources have been consulted where appropriate.

It should be noted that all the data herein is subject to both the reporting requirement laid down by RIDDOR and actual reporting practice. Nevertheless, it is hoped that a useful picture of the real situation has been presented.

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### Fatalities and weighted injuries

In assessing the risk and harm arising from events, RSSB and the wider industry use a composite measure – termed fatalities and weighted injuries (FWI) – to assess the overall safety consequences. Non-fatal injuries are weighted in accordance with their relatively less serious outcome. The weightings, which were determined following much research and consultation, are those shown in the following table.

Table 1. Injury degrees and weightings

| Injury degree | Definition | Weighting | Ratio |
|---|---|---|---|
| Fatality | Death occurs within one year of the accident. | 1 | 1 |
| Major injury | Injuries to passengers, staff or members of the public as defined in schedule 1 to RIDDOR 1995. This includes losing consciousness, most fractures, major dislocations, loss of sight (temporary or permanent) and other injuries that resulted in hospital attendance for more than 24 hours. | 0.1 | 10 |
| Class 1 minor injury | Injuries to passengers, staff or members of the public, that are neither fatalities nor major injuries, and are defined as reportable in RIDDOR 1995, amended April 2012, plus: Workforce injuries, where the injured person is incapacitated for their normal duties for more than three consecutive calendar days, not including the day of the injury. | 0.005 | 200 |
| Class 2 minor injury | All other physical injuries. | 0.001 | 1000 |
| Class 1 shock/trauma | Shock or trauma resulting from being involved in, or witnessing, events that have serious potential of a fatal outcome eg train accidents such as collisions and derailments, or a person being struck by train. | 0.005 | 200 |
| Class 2 shock/trauma | Shock or trauma resulting from other causes, such as verbal abuse and near misses, or personal accidents of a typically non-fatal outcome. | 0.001 | 1000 |

# 2 Operational context

## 2.1 Push-pull working

A push-pull train is one which can be driven either from the cab of a locomotive, or from a cab in the rear – non-powered – vehicle. This has the benefit of doing away with the need for a locomotive to run round its carriages at terminal stations, which in turn means that pointwork in dead-end platform roads can be dispensed with.

An East Coast Main Line Mark IV DVT, introduced by BR in 1988 and still in use. (See text). Photo: East Coast.

Many railway companies introduced push-pull working early in the twentieth century to reduce operating costs and bring new services to lightly trafficked routes. Mostly used on branch lines, it was not until the 1960s that technology allowed the industry to consider applying the concept to higher-speed main line services.

The first route to benefit from the concept was the South Western Main Line, which – from June 1967 – used a powered four-car electric multiple unit (EMU) to push up to eight unpowered cars from Waterloo to the limit of electrification at Bournemouth. Here, the EMU was detached and the unpowered rake was hauled to Weymouth by a diesel-electric locomotive.[7] For the return working, the locomotive would push from Weymouth back to Bournemouth, where it would detach, and the train would be hauled back to Waterloo by an EMU.[8]

The next development in push-pull operation was seen in Scotland, when the use of two locomotives working 'top and tail' between Edinburgh and Glasgow was replaced by a more powerful Class 47 fitted with two-wire time division multiplex technology (TDM). This allowed a converted locomotive to be controlled from its own cab or a driving trailer at the rear of the train.

These 'Driving Brake Second Open' (DBSO) vehicles had been converted from air-conditioned Mark II stock. Twelve locomotives were fitted with TDM equipment and long-range fuel tanks. The new motive power was also capable of 100 mph. Services were introduced in 1979 and were extended to Aberdeen in 1983.

With their use of (then) new Mark III coaches, the trains offered a step-change in quality that quickly became popular with passengers.

Yet the DBSOs had a design flaw that Polmont would make all-too-apparent.

[7] Push-pull operation was also used on other Southern Region services, such as Waterloo–Salisbury and Clapham Junction–Kensington Olympia.
[8] This system worked efficiently and ceased only when the third rail reached Weymouth in 1988.

## 2.2 Polmont, 1984

### 2.2.1 The accident

The most recent fatal animal strike incident in Britain occurred at Polmont in Scotland on 30 July 1984. Thirteen people were killed and 14 suffered major injuries, including the driver.

The accident occurred just after 17:55 when an Edinburgh–Glasgow service – running at 85 mph in 'push mode' – struck a cow. Its carcass was dragged along before the DBSO's leading left-hand wheel flange lifted and rode the top of the rail. When the right-hand wheel lost purchase, the coach clattered along the sleepers before striking the cess rail, turning on its side and veering up the bank.

Forward momentum caused the DBSO to twist and collide with the side of the third coach. The second coach was pushed up the opposite cutting wall, its tail having been struck, causing it to divide from the train and turn end-for-end.

### 2.2.2 The causes

The mechanics of the accident were highly unusual, in that a specific part of the cow had to have been struck at a specific moment, on a specific trajectory, to lift the wheel with the right amount of force to derail the train.

However, there were other elements which made Polmont a classic example of an accident where multiple defences are breached.[9] The subsequent investigation highlighted the following:

- **Fencing:** the cow had accessed the line through a vandalised fence at an abandoned level crossing.
- **Rules:** the driver of an earlier train had seen the cow on the bank inside the boundary fence. The rules in force at the time only required the reporting of groups of animals, or those actually *on the line*.
- **Communication:** at the time, there was no way of contacting the driver to stop a train other than via the signalling systems.
- **DBSO:** the vehicles had a light axle weight of 8.4 tonnes and were not fitted with obstacle deflectors.

### 2.2.3 The lessons learnt

Her Majesty's Railway Inspectorate (HMRI) investigated the accident, its report being published on 7 February 1985.[10] The following section sets out the main lessons learnt.

[9] Prof James Reason said that a company's or industry's defence mechanisms against failure are a series of barriers, which he represented by slices of Swiss cheese. The holes in the slices signify weaknesses in parts of the system. When all of the holes in each of the slices align, it creates a 'trajectory of opportunity', so that a hazard can pass through all the holes in all the defences, leading to a failure – or accident. See (for example) James Reason, *Managing the Risks of Organizational Accidents* (Ashgate Publishing Ltd, 2002).

[10] http://www.railwaysarchive.co.uk/documents/DoT_Polmont1984.pdf

### Fencing

As the cow had accessed the line through a vandalised fence, the investigation recommended a review of the way fences were inspected, and the way damage was reported, adding that 'where push-pull operation is to be introduced, improvements to fencing must be considered as part of the route development'.

This prompted the then General Manager of BR's Scottish Region – Chris Green – to use surplus funds from the other BR Regions[11] to erect new fencing along many routes.

> In Britain, boundary fences are the responsibility of the railway, under obligations imposed by the Railways Clauses Consolidation Act 1845.
>
> This is ***not*** the case in mainland Europe, where fencing is the responsibility of the landowner. (See section 4.3.)

### Rules

A Rule Book change was also recommended, to make sure large animals within the boundary fence were treated 'as an immediate danger to trains':

*20.1 Dangerous obstructions*[12]

*This instruction applies if you see:*

- *an obstruction on the line which could cause danger to other trains*
- *a cow, bull or other large animal within the boundary fence, even if it is not an immediate danger to trains*
- *any other animal on or near the line which might be a danger to trains.*

*You must:*

- *warn the driver of any approaching train by carrying out the instructions in section 20.3 of this module.*
- *place a track-circuit operating clip and three detonators 20 metres (approximately 20 yards) apart on each affected line, at least 2 km (1 miles) from the obstruction*
- *tell the signaller immediately by using:*
  - *the cab radio emergency call procedure*
  - *any available telephone*
  - *any radio system.*

### Communication

The recommendation that driver-to-shore communication be fitted to the cabs of all trains travelling at 100 mph and over was acted on quickly, BR investing some £3 million in the National Radio Network (NRN), which was introduced from 1986, and which is now being replaced by the Global System for Mobile Communications–Railway (GSM-R), whose implementation is due for completion in 2014.

[11] At this point, BR was divided into five Regions: the Eastern, London Midland, Scottish, Southern and Western.

[12] Rule Book Module TW1, *Preparation and movement of trains – General*, Section 20 ('When trains could be put in danger'), p.77.

**DBSO**

The investigation noted that the axleload of a DBSO was just 8.4 tonnes, but added that BR had not seen a need to increase it, as it was similar both to its own multiple unit fleet and to push-pull trailers used in Europe.

The feasibility of increasing the DBSO axleload was considered, but the investigator found that 'the most that [could] be achieved without building a completely new vehicle [was] an increase to 12 tonnes, which in any case [would] take time and involve considerable modification and expense'. However, he concluded that the fitting of an obstacle deflector would 'provide protection commensurate with the maximum speeds involved'. The recommendation to fit such a device to the DBSO fleet was actioned by BR.

The Polmont investigation recognised that, for speeds in excess of 100 mph (as intended for Anglo-Scottish services) the consequences of a collision became progressively greater, but acknowledged that a separate study into the subject was already under way.

The push-pull 'Gatwick Express' service was introduced in May 1984 –just before Polmont – and used a 90-mph Class 73 electro-diesel at one end and a powered (thus heavier) non-passenger carrying driving coach at the other.

These 'Gatwick Luggage Vans' were converted Mark I Class 414 vehicles.

BR took the HST power car as its benchmark, no animal strike having led to an HST derailment since its launch in 1976.[13] The project team concluded that, in order to achieve performance comparable with the HST, body-mounted obstacle deflectors would need to be fitted to leading vehicles whose operational speed was 90 mph and above (unless their axleload was 17 tonnes or more). This criterion – together with the geometrical and load characteristics of the deflectors – was applied to all vehicles built after 1985, including the Mark III and IV driving van trailers (DVTs).[14] These vehicles also feature obstacle deflectors, and a cab constructed from substantial steel beams and pillars, whose strong frame is welded to the main structural members at floor and roof level. They are also heavier and ballasted at the leading pivot, making them behave more like a locomotive when in collision with a large-boned animal.

Furthermore, the Health & Safety Executive (HSE) also banned the carriage of passengers in driving trailers at speeds above 100 mph – hence the DVTs' status as luggage vehicles. This was challenged by later designs like the Voyagers and Pendolinos, which both include passenger accommodation in the leading/trailing vehicles. However, these trains have ballasted leading ends, stronger bodyshells, rigid couplers and improved bogie retention capability, meaning that protection and collision energy is distributed along their full length.

Indeed, the superior crashworthiness of the Pendolino was confirmed by the high-speed derailment at Grayrigg in February 2007. As the picture overleaf shows, the train did not disintegrate and its carriages remained generally intact. One passenger died and 26

[13] The first HST derailment as a result of an animal strike is thought to be the incident at Carn Brea on 17 August 1999. Given that there were no passenger or staff injuries, and that the incident was unusual (both bullocks being side-by-side within the four-foot), the investigation recognised that the risk remained low.

[14] In 1993, the requirements were embodied in Railway Group Standard GM/RT2100, *Structural requirements for railway vehicles*. See www.rgsonline.co.uk for details. Note that, for rolling stock confined to third rail areas, obstacle deflectors were only required for maximum operating speeds of 100 mph and over.

passengers, the driver and another crew member were seriously injured, but these figures would probably have been much higher had an older train been involved.

DBSOs continued in service in Scotland until displaced by new diesel multiple units (DMUs) in the late 1980s. They were cascaded to the Great Eastern Main Line, where they worked until withdrawal in 2006, having been displaced by Mark III DVTs.[15] Mark III DVTs also remain in use on selected services from London Marylebone, while their Mark IV counterparts continue to be rostered on Anglo-Scottish services out of King's Cross. Since the late 1980s, however, the move has been away from loco-hauled/propelled services towards unit train operation.

The situation is a little different with secondary services that utilise slower multiple units. In the late 1980s and early 90s, BR fitted its Sprinter classes (150, 155, 156 etc.) with snowploughs which also had the capability of deflecting minor obstacles on the track. Though unable to cope with the stiffer requirement for full-strength obstacle deflectors specified in Railway Group Standards, the one on the '150' involved in the Letterston collision of July 2012 was only slightly distorted by the impact. This indicates a high level of strength in the coupler and headstock areas, but scant energy absorbing capability. Neither do the front aprons on the Class 14x and 159 series have any significant structural properties.

**RED 39** included a segment on Polmont and animals on the line

RED 39

See Opsweb for details.

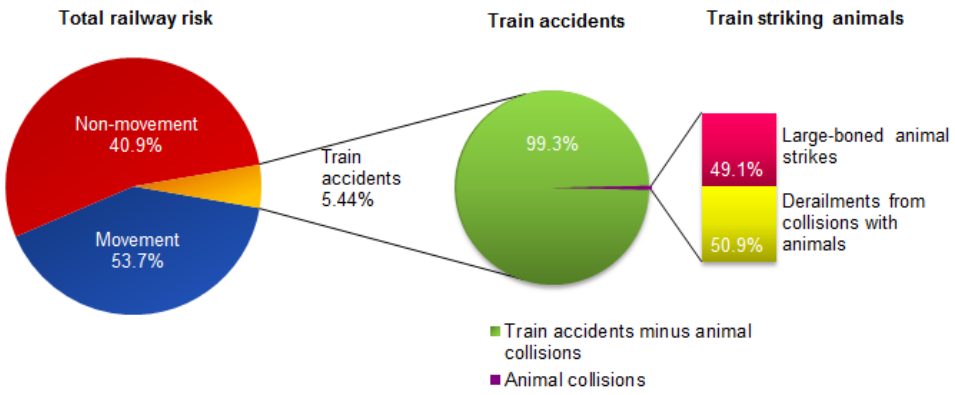
Nevertheless, the developments in express train crashworthiness, coupled with the lower speeds associated with incidents involving the Sprinter and Pacer classes, explain why the risk figures presented in section 4.1 are so low.

[15] Five DBSOs were purchased by Network Rail for use with its measurement trains.

# 3 Risk and safety performance

## 3.1 Risk

Chart 1. Risk profile as a subset of total rail risk (SRMv8)




Animal strike incidents account for an estimated 0.06 FWI/year, which represents 0.7% of all train accident risk (7.8 FWI/year). Around 60% of the risk from animal strikes is associated with the risk from derailment.

The risk is generally low because developments in express train crashworthiness, coupled with the lower speeds associated with the Sprinter and Pacer classes, have meant that on-board injuries are rare (although the potential for harm remains when a derailment occurs).

Despite this, the safety performance figures suggest a rise in animal strike incidents over the last ten years. This will be explored in the next section.

## 3.2 Safety performance

### 3.2.1 Fatalities and weighted injuries

Chart 2. Animal strike incidents: fatalities and weighted injuries, 2003/04–2012/13

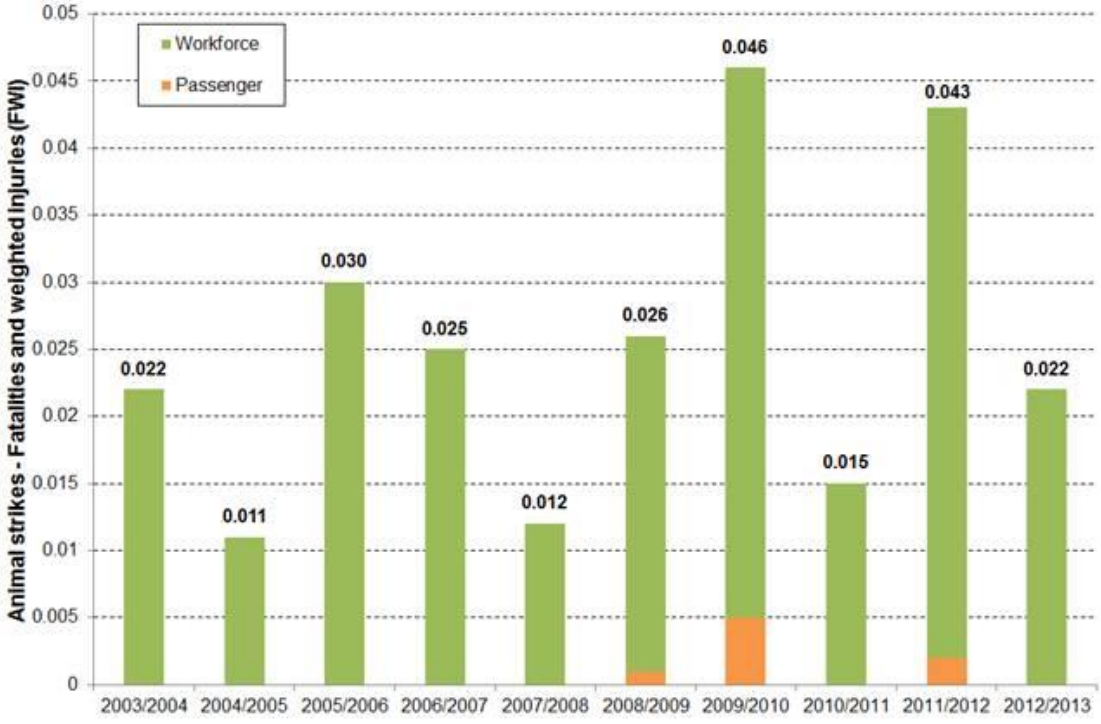



Chart 2 shows the number of fatalities and weighted injuries associated with trains striking animals. The average FWI level for the reporting period (2003/04-2012/13) is 0.03.

Most of the harm from animal strikes takes the form of shock/trauma to the train driver, who may have thought they had struck a person, as opposed to an animal. Indeed, in some cases, they may be unable to continue with their shift. Drivers can also suffer minor injuries when the impact between train and animal breaks the windscreen.

Fortunately, there are very few minor injuries to train guards and passengers; most involve persons being thrown against the saloon interior during a collision.

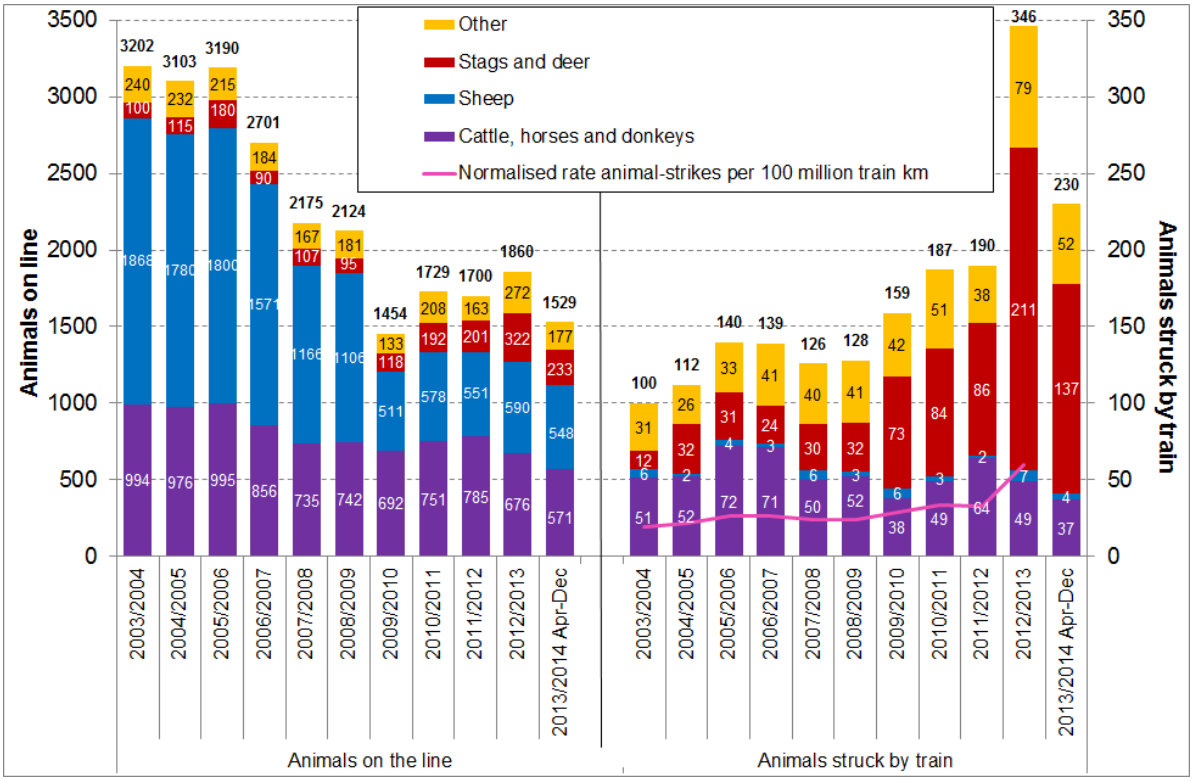
RSSB acknowledges that there is also the potential for ill health exposure to employees from dealing with the clean-up of cattle strikes. Research project T385, *Managing the health risks from dealing with human or livestock body parts*, which was supported by the Railway Industry Advisory Committee's Occupational Health Working Group, developed rail-specific guidance to ensure that rail industry personnel are adequately protected from the limited risk of disease or infection when dealing with human and livestock remains.

The RSSB Workforce Health & Wellbeing project has developed a roadmap that will drive a number of tasks and projects to help members understand and tackle such health issues more effectively. The roadmap is now available on the RSSB website.

### 3.2.2 Overall trend: access and strikes

Chart 3 shows the reported number of animal on the line incidents (left), along with the number subsequently struck by trains (right).

Chart 3. Animals on the line: overall trend, 2003/04–2012/13 (inc Apr-Dec 2013/14)




- The total reported number of animal on the line incidents has fallen by 42% since 2003/04.
- However, reported cases of animals being struck by trains have tripled since 2003/04. (Note that, when normalised by train kilometres, the rate has doubled.)

The right-hand bars also show a generally increasing trend (300%) in the number of animals other than cattle, horses and donkeys being struck by trains. Comparing these bars with Chart 4, suggests that we might justly name this rise the 'deer peak'.

Deer (and stags)[16]

- Although there has been no clear trend in the number of reported cases of deer on the line, there has been a significant rise in the number of cases of deer being struck by trains since 2003/04.
- The number of reports of deer on the line is relatively low compared to other animal types. However, the proportion of cases where deer on the line are struck by trains is

[16] Note that some SMIS inputters use 'stag' and 'deer' to mean the same thing, regardless of any question of animal gender etc.

high compared with other categories, although the derailment consequences are considered to be lower than with cattle, horses and donkeys.[17]

Sheep

- Reports of sheep on the line have fallen by 68%. This accounts for most of the overall reduction in 'on the line' incidents seen since 2003/04. However, while a large number of sheep are still reported to have accessed the line, less than 1% are struck by trains.

Cattle, horses and donkeys

- Reports of cattle, horses or donkeys on the line have fallen by 32% since 2003/04.

Other[18]

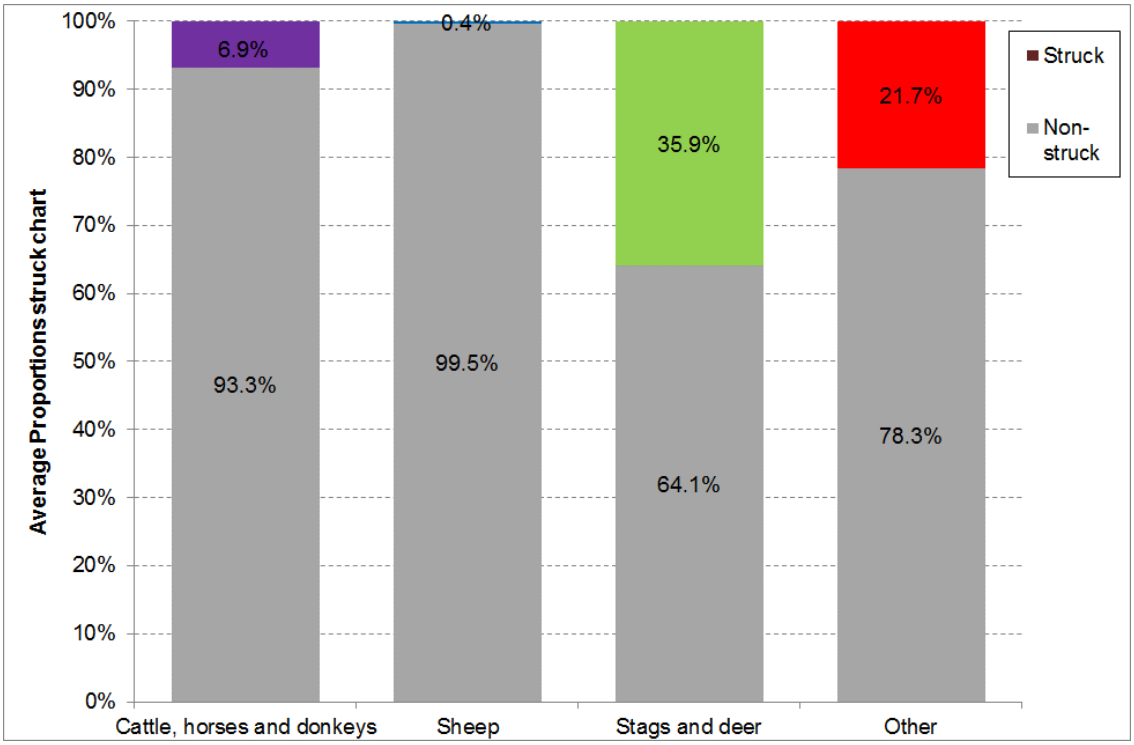
- There has also been a 13% increase in the number of other animals struck by trains since 2003/04, in contrast to a generally decreasing number of cases of other animals on the line. Most of these other animals are birds, the next highest category being dogs.

[17] See Railtrack Great Western's Formal Inquiry into the derailment of 1A91, the 15:30 Penzance–Paddington HST service following an animal strike at 15:52 on 17 August 1999 at Carn Brea (p.15, section 3.6).
[18] Animals in the 'Other' category include badgers, birds, cats, dogs, foxes and pigs.

### 3.2.3 Animal strikes

Chart 4 shows average proportion of animals struck by trains, based on Chart 3.

Chart 4. Average proportion of strike to non-strike incidents, 2003/04–2012/13




- Of all cattle, horses and donkeys reported to have accessed the line, 6.9% are struck by trains.
- Of all sheep reported to have accessed the line, less than 1% are struck by trains.
- Although few deer have been recorded as accessing the line, most that do are struck by trains.

The above raises some interesting points about animal behaviour and incident situation.

**Sheep**

According to the University of Tennessee, sheep have good peripheral vision, being able to see in all directions when grazing. While tending to flock, they also tend to run when a train approaches.[19]

Although comparatively rare, collisions with sheep do occur. A notable event happened in Germany on 28 April 2008, when an express passenger train struck a flock of 20-30 sheep at 120 mph and derailed. Twenty-two passengers were injured. The difference here was that the sheep had gathered in Landrücken Tunnel and had nowhere to go when the train bore down on them. The (northbound) service immediately before the (southbound) incident train struck one sheep and resumed its journey after just three minutes having suffered the loss of an aerial. In similar fashion to the 'pre-Polmont' situation in Britain, the driver of the 'northbound' did not consider that the situation represented a danger to other trains and did

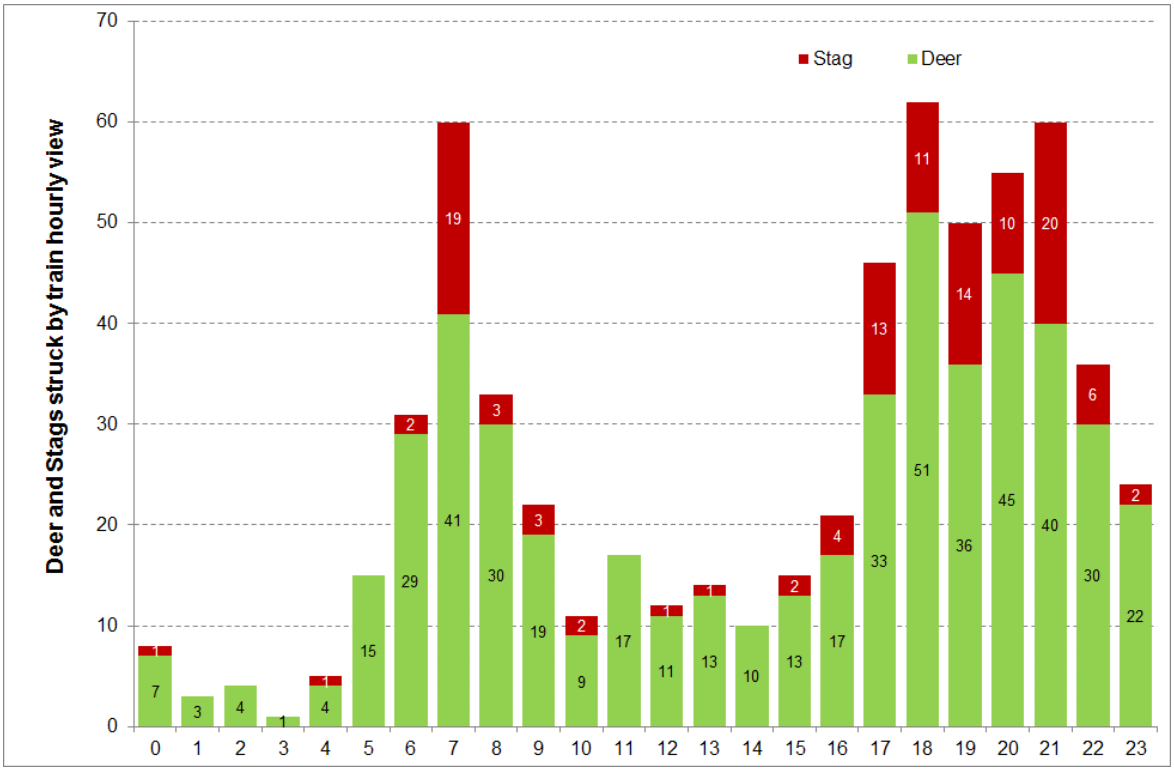
[19] http://animalscience.ag.utk.edu/sheep/pdf/appliedsheepbehavior-wwg-2-04.pdf

not therefore request that traffic be stopped. The subsequent investigation concluded that this was the correct action to take and that the rules were fit for purpose.

As Chart 6 shows, sheep account (on average) for less than 3% of all GB animal strike incidents.

**Deer**

Chart 5. Deer (and stags) struck, by hour




Like sheep, deer have excellent peripheral vision, but most deer incidents take place while the beasts are traversing the railway as part of their natural movement pattern between habitats at dawn/dusk – a time when more trains are running as part of the morning and evening peaks (see Chart 5, above).[20]

One might suggest that a dark-coloured fast-moving animal which has leapt the boundary fence is less likely to be seen by train drivers than a cow or sheep grazing in the four-foot. However, deer also tend to 'freeze' in headlights like rabbits[21], while anecdotal evidence suggests a tendency for them to run away, down the track, when confronted by a train.[22]

Furthermore, deer have a problem recognising movement of an object travelling directly towards them unless they can see moving legs. It may be, therefore, that during dusk and at night when a train's headlight prevents the actual train from being seen, it is not perceived as a threat to them until it is very close.

[20] http://wildlifecontrol.info/pubs/Documents/Deer/Deer-Vehicle_factsheet1.pdf
[21] http://wiki.answers.com/Q/Why_do_deer_stop_when_they_see_headlights
[22] http://answers.yahoo.com/question/index?qid=20100208195453AAhgsH0

According to Defra, deer can be found in the wild, where they are not owned, but are managed on the land on which they roam. Deer are kept for ornamental purposes and for venison production in deer parks. Park deer populations have to be controlled. Red Deer (and occasionally Fallow) are also farmed following conventional agricultural practices.[23]

The deer population has grown to around 2 million, and is reportedly higher now than at any time in the last 1000 years. The reasons for this include milder winters, the planting of winter crops, increased woodland cover and greater connectivity between green spaces in urban areas.[24] Deer also have the ability to jump fences with a dexterity cattle cannot match. Yet, while the derailment risk is minimal, there is a business risk, as the incident at Gatwick on 24 November 2013 demonstrated:

- At 06:53, the driver of a Brighton–Bedford service (319459) reported from Platform 4, Gatwick Airport, that the train was being evacuated due to a small fire having occurred underneath the front coach, after the train had struck a deer near Balcombe Tunnel. The fire was entirely below the sole-bar and there were no passenger issues. The fire was extinguished by the Fire Brigade based at Gatwick Airport.

On the surface, this sounds fairly innocuous. However, Network Rail reported 3040 delay minutes for this incident, caused by all the requisite line blockages for line checks, repairs to the unit's shoegear and so on. Delays were also compounded by the blocking of the Up and Down Slow lines for planned engineering works between Redhill and Three Bridges. Attempts to clear the possession were explored, but an unstaffed tamper prevented this from being achieved. The latter was an unforeseen problem laid over an unforeseen problem (although the Gatwick/Balcombe Tunnel area is a known 'hotspot' for deer incursions). Yet an unforeseen *consequence* was all the compensation payments to passengers who missed their flights, thanks to the time it took to clear the area and re-open the lines. These could have been saved had the deer not got on to the line in the first place. There would also have been a reputational cost, which is perforce hard to quantify, but could have affected more than merely the operator concerned.

Deer can also pose a danger to motorists, as an incident between Ware and Puckeridge on 15 October 2013 demonstrated. At 07:45, a deer struck a car, causing it to go out of control before striking another car and bursting into flames. Both occupants were killed; the driver of the second car required hospital treatment for leg injuries. But while it's worth remembering that deer cause more injury to road users than passengers and rail staff, it should also be remembered that Network Rail owns and operates some 7,000 cars, vans and support vehicles.

**Cattle**

Defra records that there were 77,774 recorded cattle-holding premises in Great Britain on 1 June 2008, on which 8,868,469 cattle were recorded as present. Between 1 June 2003 and 1 June 2008, there was a 6% fall in the cattle population.[25] However, the right-hand side of Chart 3 suggest there to be no clear trend in the numbers of cattle or horses being struck by trains.

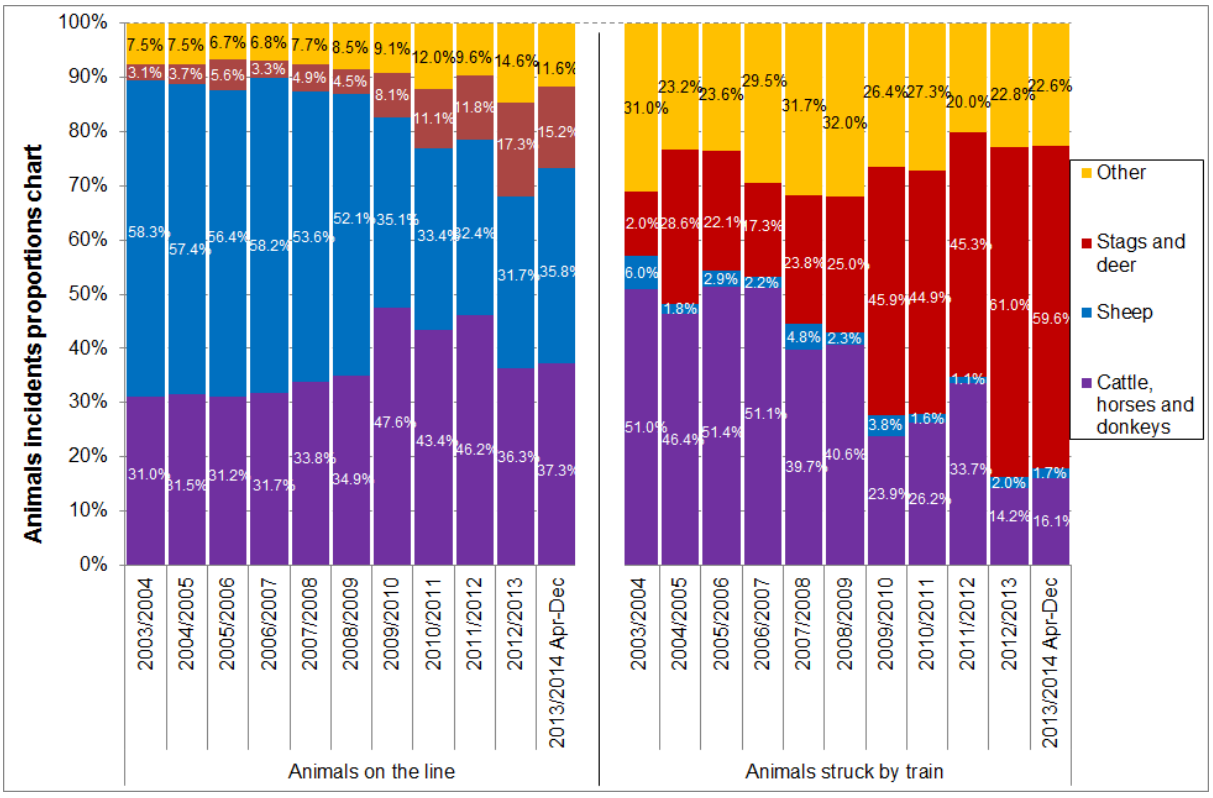
[23] http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/species/deer.htm (and ibid)
[24] See http://www.thedeerinitiative.co.uk/about_wild_deer/
[25] http://archive.defra.gov.uk/foodfarm/farmanimal/diseases/vetsurveillance/documents/cattlebook-2008.pdf

The Langenhorn incident demonstrated an interesting cattle character trait, in that the animals involved absconded from a farm which was not their home base. Their incursion came about after they accessed the line from a level crossing in an attempt to reach that home base once more. Dairy cattle tend to do this as they become attuned to the regularity of their daily routine – and their daily route to and from the milking parlour (and so on).[26]

The quest for food is also an important factor: RAIB's consideration of the Letterston Junction derailment highlighted that 'the herd of cows that gained access to the track had been temporarily placed in the field which had previously been heavily grazed, without provision of alternative feed. It is likely that they pushed against the gate post while attempting to reach grass within the railway boundary'.

Chart 6 shows the proportion of various types of animals on the line and the subsets of those hit by trains.

Chart 6. Proportions of animals on the line and those struck by trains 2003/04–2012/13




- The left-hand bars show that cattle, horses or donkeys incidents now constitute the largest proportion of all 'animal on the line' incidents. This change occurred in 2007/08, when the number of sheep incidents began to drop.
- The right-hand bars show that deer made up the largest component of all animal strikes in 2002/03. Although the actual number of cattle, horses and donkeys struck by train incidents remained fairly level, the proportion fell over the ten years up to 2011/12, as the numbers of incidents involving other animals (like deer) increased over the same period.

[26] http://erail.era.europa.eu/occurrence/DE-1329-4-1/Trains-collision-with-an-obstacle,-13-01-2012,-Stedesand---Langenhorn-

- Though the proportion of sheep to all animals on the line is high, sheep actually account for less than 3% of all reported animal strike incidents.

### 3.2.4 Letterston Junction

The most recent animal incident to lead to an investigation occurred at Letterston Junction on 12 July 2012.

**The incident**

At around 18:40, 150217, forming a Gloucester–Fishguard Harbour service, struck several cows at 52 mph on the single line near Clarbeston Road and derailed. There were no reported injuries to the 28 passengers, but the driver and guard suffered shock/trauma, the former losing three working days, the latter five.

The emergency services were called immediately, but because the location was remote, it took them 39 minutes to reach the train; it was 20:11 before the passengers were evacuated to a bus to complete their journeys.

Seven cows and a calf were killed either in the accident or as a result of having to be destroyed afterwards. There was substantial damage to 60 metres of track, and minor damage to the train.

**RAIB's bulletin and its lessons**

RAIB decided not to conduct a full investigation because it did not believe this would identify any significant new safety lessons for the industry. However, its bulletin did reiterate that the accident demonstrates the importance of preventing livestock from getting onto the railway.

Furthermore, 'Railway infrastructure managers should ensure that they have adequate arrangements in place to inspect, repair and renew lineside fences and gates, and that their fences and gates are built and installed to a standard which is appropriate for the location and is, where necessary, stock proof.'

The question of Class 150 crashworthiness was discussed in section 2.2.3, but to reiterate the unit's snowplough/obstacle deflector was only slightly distorted by the impact, suggesting a high level of strength in the coupler and headstock areas, but scant energy absorbing capability – hence the derailment.

Undoubtedly, this does raise questions about the crashworthiness of Classes 14x and 15x, although the overall derailment risk remains very low, and is likely to get lower as more of these older designs are withdrawn.

## 3.3 Fencing – the recurrent theme

### 3.3.1 Background

The relationship between railways, landowners and farmers was established in our industry's earliest days. Landowning interests were extremely powerful in Victorian Britain and the arrival of a new line was not always welcome.

Each line was subject to a separate Act of Parliament. In order for them to be successful, arrangements had to make to made to maintain farmers' access to their land, by means of bridges or crossings. It therefore became the railways' responsibility to ensure that livestock

could not stray onto the track. These requirements were embodied in the Railway Clauses Consolidation Act 1845[27] which is still in force today.

Section 68 of the Act states:[28]

*The (railway) company shall make and at all times thereafter maintain… sufficient posts, rails, hedges, ditches, mounds, or other fences, for separating the land taken for the use of the railway from the adjoining lands not taken, and protecting such lands from trespass, or the cattle of the owners or occupiers thereof from straying thereout, by reason of the railway, together with all necessary gates, made to open towards such adjoining lands, and not towards the railway, and all necessary stiles; and such posts, rails, and other fences shall be made forthwith after the taking of any such lands, if the owners thereof shall so require.*

This effectively made the GB rail industry responsible for erecting and maintaining fences along the entire length of the network, both to prevent trespass and straying animals; today the onus falls on Network Rail as the direct successor of the original railway companies. This arrangement is unusual internationally and railways are not routinely fenced in continental Europe or North America, except on high-speed lines. Indeed, the line involved in the Langenhorn incident had been fenced by the farmer, not the railway (although in this case the cattle had accessed the line via a level crossing).

### 3.3.2 How and why

The following sections look at how and why animals transgress boundary fencing.

**Vandalism, maintenance and reporting issues**

Deer tend to jump fences as they bound across the railway between areas of natural habitat. Cows, however, are more likely to gain access to the line via vandalised or poorly maintained fencing. The former was the case at Polmont, the latter at Letterston Junction. As RAIB's bulletin noted, the cows in this case had accessed the line via gates at Midland Farm footpath crossing.

Sometimes the issue is exacerbated by reporting problems, as occurred in January 2011, when an HST struck a cow at Bourton, near Swindon. The investigation found that the close working relationship between the Permanent Way team and the Off Track team led the patrolman to report a broken fence direct to the Off Track team, as he thought this would speed the organisation of an inspection and prove more productive when planning team members' work. However, it also meant that no immediate risk assessment was undertaken by Route Control.

The collision and derailment at Carn Brea on 17 August 1999 – the first to involve an HST – shows that it is not only the railway boundary fence that can cause problems. In this incident, four bullocks escaped from a field whose fence was broken. Two then managed to get themselves into a contractors' yard, where they plunged into a thicket, through a (non-existent) boundary fence and onto the line.

More recently (09/05/12), ten cows trampled the fence at Tackley and were struck by an express, damaging the unit's front coupler, but not causing injury to passengers or staff

[27] http://www.legislation.gov.uk/ukpga/Vict/8-9/20/contents
[28] There was a separate Act that applied to Scotland, the *Railways Clauses Consolidation (Scotland) Act 1845*, in which the equivalent section is number 60.

(although a member of the clean-up team became temporarily unwell due to the smell of the carcasses).

The investigation found that the field from which the cattle originated had been flooded by heavy rain and it is believed that the cattle were looking to escape. The timber fence line attached to a concrete end restraint seemed to have been weakened by the wet ground. The fence may not have been constructed in accordance with Network Rail standard NR/L2/TRK/5100. It had been erected by persons unknown, but previous inspections had not identified that it was non-compliant.[29]

Nevertheless, the flooding element makes climate change a possible cause in the future.

**Food, fear and crime**

In its report on Letterston Junction, RAIB noted that witness evidence suggested that 'the herd of cows [involved in the accident] had been temporarily placed in the field which had previously been heavily grazed, without provision of alternative feed. It is likely that they pushed against the gate post while attempting to reach grass within the railway boundary, and that the post broke off at or just below ground level.'

Two reports in SMIS also noted herds of cattle that had stampeded the boundary fence after being unnerved by motor car races run in their field by members of travelling communities. Another described how joyriders had frightened cattle by setting fire to a stolen car which then exploded, again causing them to stampede. In cases like this, even a good fence may not maintain its integrity.

### 3.3.3 Fencing management

Network Rail carries out routine inspections at varying intervals and takes into account condition of fencing the number of instances of trespass or vandalism or livestock incursions through the fence by large or small boned animals.

All the company's Delivery Units have a plan for carrying out fencing inspections. Records are kept and faults are reported through control. If the nature of the fault is severe enough, the inspector will stay at the fence until the repair team arrives. Network Rail is also informed at local level if adjacent land use changes (from, say, arable to animal).

As a result of accidents like Letterston Junction, and other near miss events, however, Network Rail has put standards in place to mitigate the different types of risks posed at different locations. The current standard for the *Management of fencing and other boundary measures* (NR/L2/TRK/5100, Version 2) was updated and re-issued in 2008.

The standard uses the likelihood of unauthorised access, the consequences of unauthorised access, adjacent land use and the condition of existing boundary measures to determine the initial level of fencing required and the subsequent level of inspection, repair or replacement needed.[30]

[29] See Network Rail's Local Investigation into the collision between 1M58, the 14:45 Bournemouth–Manchester Piccadilly and cattle at Tackley on 9 May 2012.
[30] The process was originally devised to prevent trespass on the railway by people; later versions have addressed livestock incursions and principles of evaluating risk.

Furthermore, the company has considered three separate papers on animal incursions since April 2010; as a result, NR/L2/TRK/5100 Version 3 has been drafted for publication.

Version 3 will require the fence inspector to verify the condition of the fencing physically, rather than just visually, and sign to confirm that they have done so. Network Rail envisages that this physical verification of fence condition will reduce the number of incursions caused by fencing being in a poor condition.

In addition, animal incursions are a standing item at the company's regular boundary risk management liaison meetings, and will also be covered by an 'objects on the line' deep dive review, which will start in July and end in September 2014.

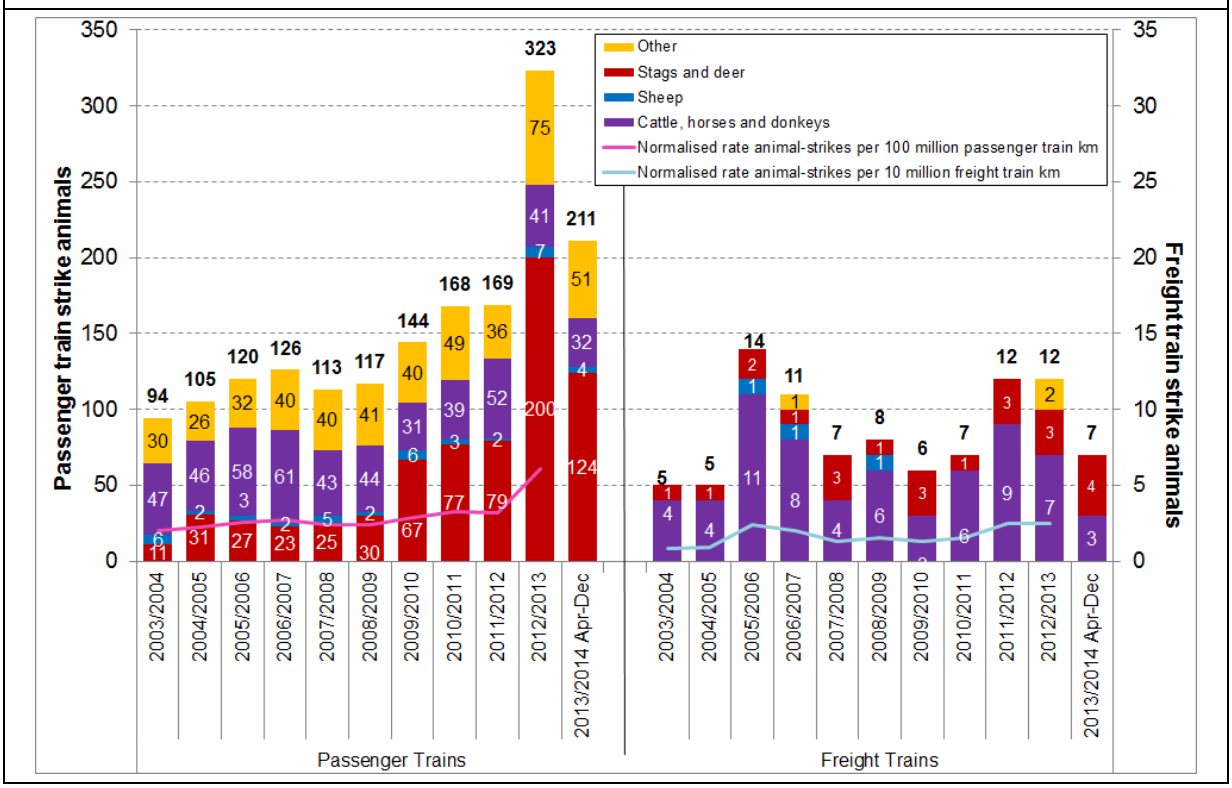
The challenge comes with wild animals like deer, as these not only sit outside all legislative requirements, they also have a great capacity for jumping fences of any height. Furthermore, as many are wild, the railway cannot always control their movement in conjunction with the relevant land owner.

## 3.4 Further analysis of animals struck by trains

### 3.4.1 Types of train involved in animal strike incidents

Chart 7 shows a comparison between the number of animal strike incidents involving passenger and freight trains during the analysis period.

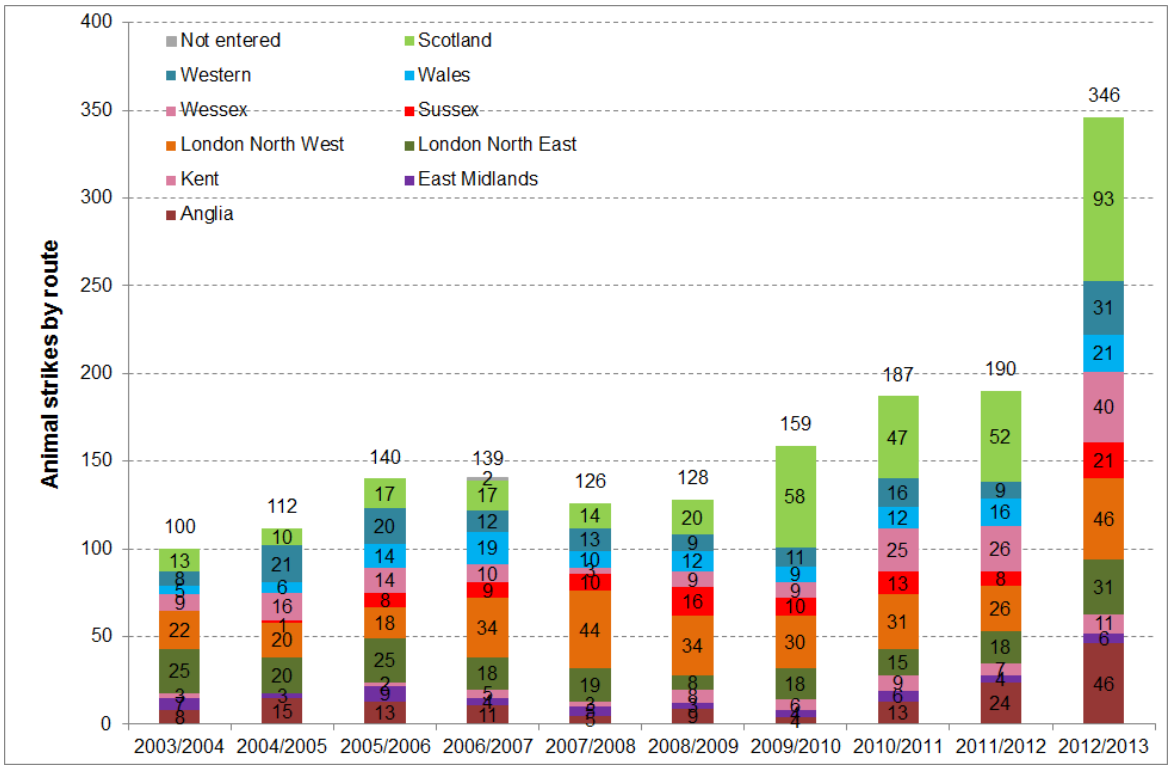
Chart 7. Types of train service involved in strike incidents, 2003/04–2012/13




- Most animal strike incidents involve passenger trains. The increase is due to a rise in the number of deer incidents since 2006/07.
- The number of freight trains involved in strike incidents is reportedly around one-tenth of number of passenger train strikes. Reported freight train strikes have also doubled since 2003/04, but the actual recorded number of incidents are low (12 events in 2012/13).
- Passenger train kilometres have increased by 14% over the last ten years. When taking this change into account by normalising the data, the rate of animals struck by passenger trains may be seen to have risen by 200%. This may reflect the higher running speeds of passenger trains (ranging from 90mph to 125mph), which minimises the 'escape time' for any animals that have accessed the line; it may also reflect the fact that freight trains tend to be hauled by 130-tonne locomotives, which makes them harder to damage and therefore may make any strike incident less reportable (see section 1.1).
- Freight train kilometres have fallen by 19% over the period, whilst the normalised rate is more variable, showing an increase of 195%. Looking at the average normalised rate per 100 million train kilometres travelled, incidents of passenger trains striking animals are around just under 50% higher than incidents involving freight trains.

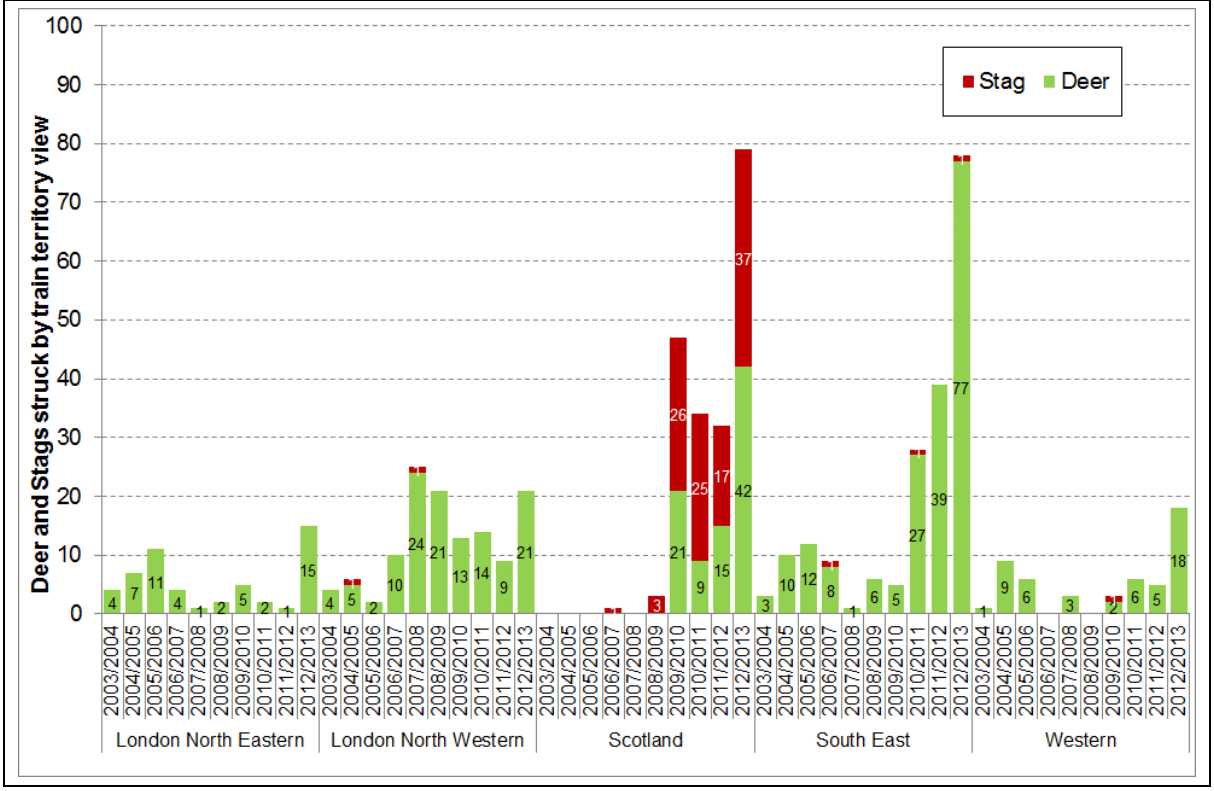
### 3.4.2 Animals strike incidents by route

Chart 8. Strike incidents by route, 2003/04–2012/13




- Over the period as a whole, the most common route for animal strike incidents is London North West, with Scotland taking second place.
- There was a 190% rise in incidents on the Scotland route in 2009/10, compared to 2008/09. Another peak occurred on the same route in 2012/13, which was 79% up on 2011/12.

Chart 9. Stag or deer strike incidents by territories , 2003/04–2012/13



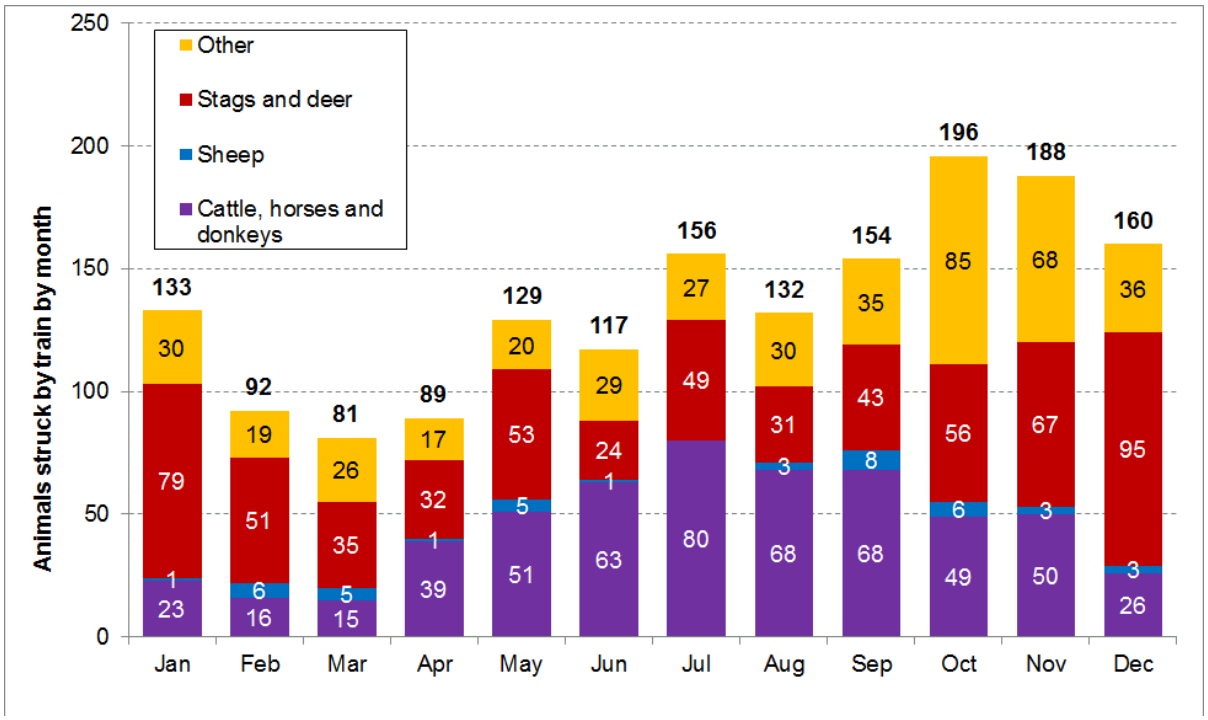

Note that most of the incidents involving deer occur in the Scotland and South East territories, although London North Western has seen an increase since 2007/08. This again suggests the presence of a 'deer peak'.

According to Network Rail, the worst deer incursion 'blackspot' on South East is Balcombe Tunnel Junction, where 41 incidents have been recorded in the last three years. The steep cutting sides at this location allow the deer to jump while running at an angle which usually guarantees success in terms of clearing the boundary. It is also right on the local deers' route between their habitat and grazing area. The company has considered erecting higher fences here, but the local topography – which determines they type of fencing that can be used whatever the location – would preclude Red Zone working in the area. It may be that the only solution for Balcombe is therefore an engineering one – a specific 'deer bridge', for example, the case for which is bolstered by the low levels of human trespass in the area.

Either way, Network Rail's analysis has been shared with each of its routes for them to consider as part of the National Safety Improvement Plan.

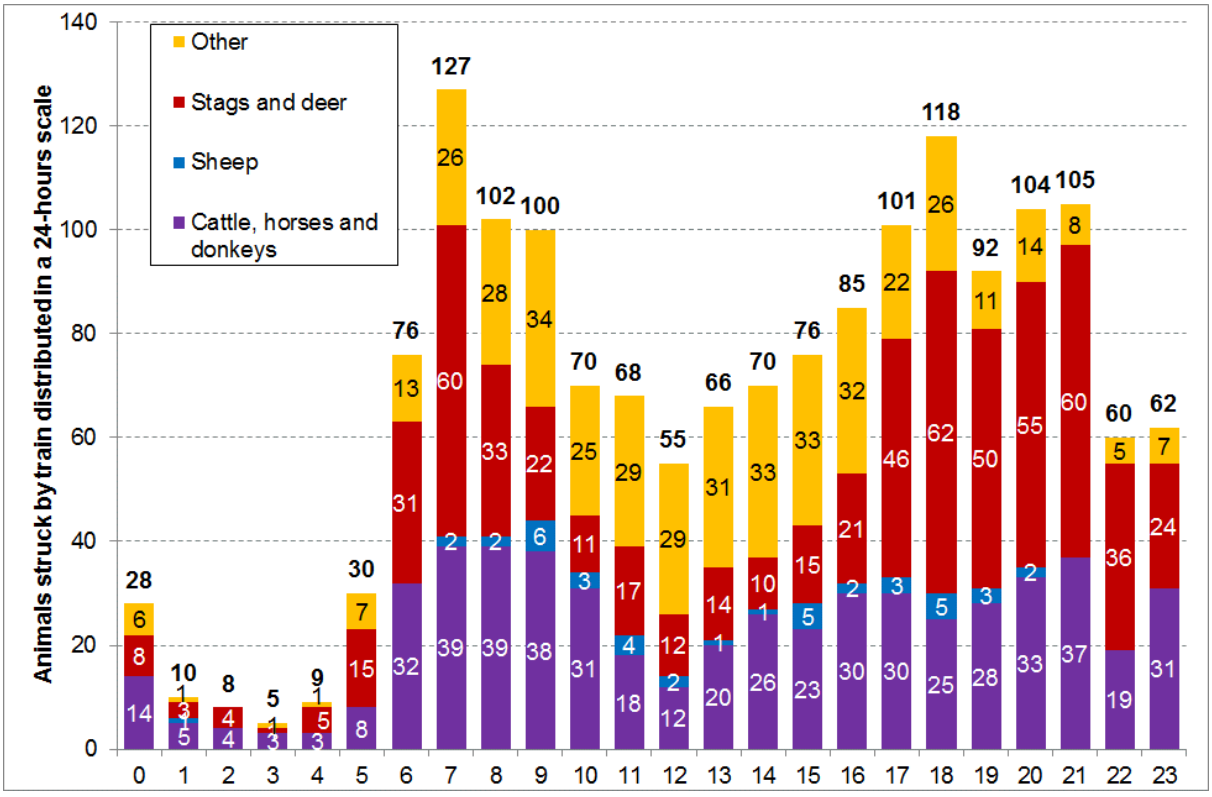
### 3.4.3 Strike incidents analyses by month

Chart 10. Strike incidents by month, 2003/04–2012/13




- The number of cattle, horses or donkeys incidents struck by trains reaches a peak in July before falling as autumn turns to winter.
- The peak month for animal strikes is October, which includes many in the 'Other' category.
- 50% of all deer incidents occur between October and January.
- The fewest number of animal strike incidents occur between February and April.

Chart 11. Strike incidents by hour, 2003/04–2012/13

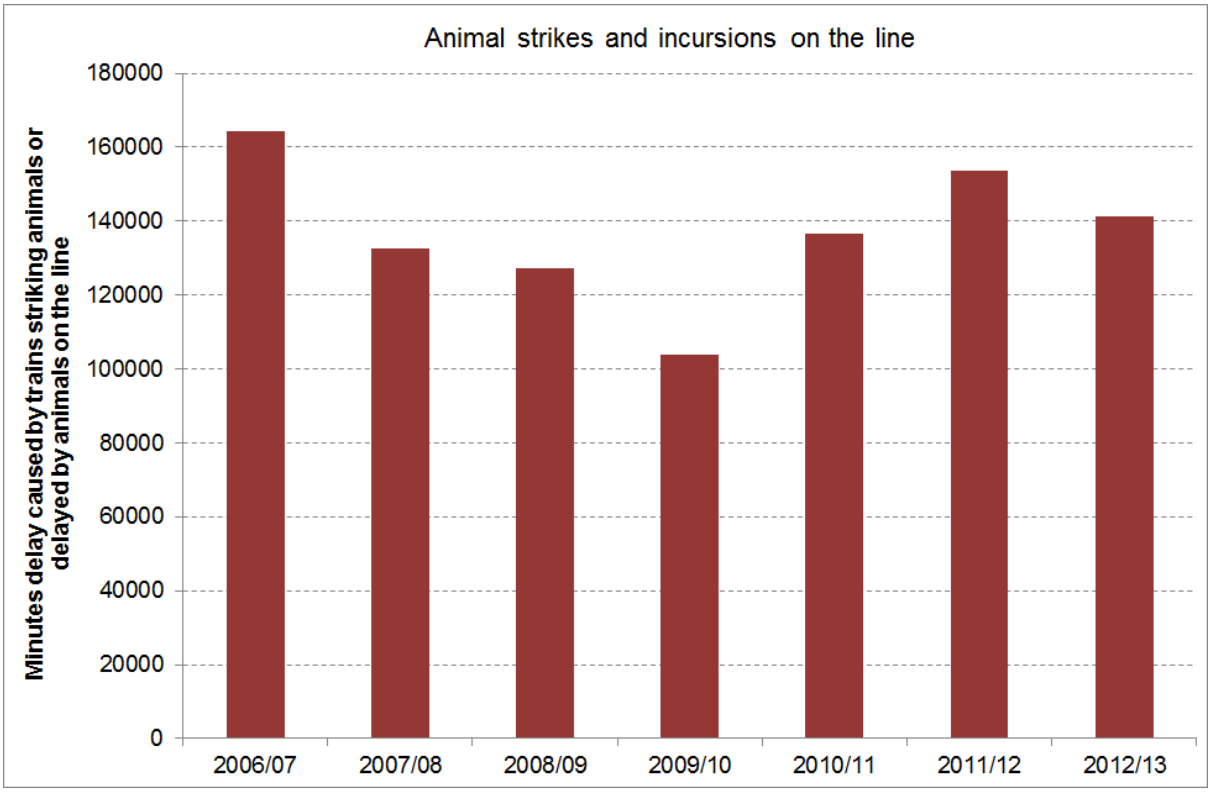



- Only 6% of all striking events occur before 06:00. This clearly reflects the timetable pattern of the mainline railway.
- Unsurprisingly, most incidents occur during the morning and evening peaks. All animal types follow this trend.

### 3.4.4 Delay minutes

The data for Chart 12 is from Network Rail's TRUST DA system.[31]

Chart 12. Delay (excl. cancellations) accrued due to animals strikes 2006/07–2012/13




- On average, around 137,000 delay minutes are caused each year by trains striking animals or animals on the line (mainly the former).
- The chart shows that there was a continuous fall in delay minutes between 2006/07 and 2009/10. Though the rate began to rise again in 2010/11 and 2011/12 to over 150,000 minutes, the delay minutes in 2012/13 decreased again to around 140,000, which is 3% higher than the average delay minutes.
- According to Network Rail, the associated cost of animal on the line incidents was around £4.9 million in 2012/13.

The following example shows how an incident with low damage consequences can still carry a performance impact.

On 21 June 2012, a Cleethorpes–Manchester Airport service struck one of a herd of 12 Shetland ponies which were on the line near Thorne South. The train did not sustain significant damage and the driver was fit to continue to Doncaster, where he was relieved of duty. However, another train had to examine the line, after which an RSPCA vet attended and despatched the severely injured animals, whose carcasses were removed to the nearest access point to await collection. After the Down line was reopened at caution and a third

[31] The following TRUST fields were selected: I8 (Animal Strike/Incursion within the control of Network Rail), V8 (Train striking other birds) and X8 (Animal Strike/incursion not within the control of Network Rail).

horse was attended to and walked to the access point, the Up line also reopened. This created 1,651 delay minutes.

Incidents involving smaller animals may not cause so much actual harm as those involving larger animals, but they can still cost money by damaging trains. They can also traumatise drivers, who may be unaware what sort of animal has been hit and who may therefore believe their train to have struck a person in the first instance.

In addition, they can be just as costly as those involving larger animals. On 7 January 2013, for example, the driver of a Stratford–Bishops Stortford service (317506) reported that the train had struck a swan on leaving Northumberland Park. The train had a loss of air due to a compressor fault on the unit. The driver declared the unit a complete failure and assistance was arranged. At 08:23, the driver discovered that the loss of air was due to a detached main reservoir pipe between two coaches which was reattached allowing the air to build. The assisting unit was still attached and the combined trains were on the move at 08:45. In all, the incident caused 788 delay minutes.

# 4 Closing remarks

Clearly, many of the risks posed by cattle (and, by implication, other large-boned animals) were addressed after the Polmont accident of 1984. While, such animals can still access the line, the chance of a derailment has been minimised by the subsequent upgrade, and later withdrawal, of lighter passenger driving trailers, along with the general improvement in train crashworthiness exemplified by Classes 220, 221 and 390.

Regarding older multiple units in the Class 14x and 15x series, the former's front aprons and the latter's snowplough/obstacle deflectors may have strength, but lack any real energy absorbing capability. Nevertheless, their lower speeds help explain why the derailment risk remains very low. It may get lower still as more of these designs are withdrawn.

As a result of more recent accidents like Letterston Junction, Network Rail has put standards in place to mitigate the different types of fence-related risks evident at different locations. The latest standard for the *Management of fencing and other boundary measures* will use the likelihood of unauthorised access, the consequences of unauthorised access, adjacent land use and the condition of existing boundary measures to determine the initial level of fencing required and the subsequent level of inspection, repair or replacement needed.

Furthermore, animal incursions are a standing item at Network Rail's regular boundary risk management liaison meetings, and will also be covered by an 'objects on the line' deep dive review, which is due to start in July and end in September 2014.

RSSB's analysis shows that the cattle question has largely been replaced by a deer one. At two million, the deer population is reportedly higher now than at any time in the last 1000 years. The reasons for this include milder winters, the planting of winter crops, increased woodland cover and greater connectivity between green spaces in urban areas. Despite the ability of these animals to jump fences of varying heights in order to access woodland habitats and so on, the derailment risk is considered to be less than with a cow or horse.

According to the British Deer Society[32], there are a number of diverse deterrents – ranging from the bizarre and erratic (like the use of creosote and moth balls as barrier repellents) to the bizarre and rather more effective (like spreading a concentrated extract of lion dung along the perimeter).

However, as these solutions are ephemeral, the best way to deter deer remains 'properly erected and maintained deer fences', although the recommended heights do depend on the specific subspecies involved, as the table demonstrates.

[32] http://www.bds.org.uk/deer_deterrents.html

| Species | Mesh size (mm) | Fence height (m) |
|---|---|---|
| Muntiac/CWD | 75 x 75 | 1.5 |
| Roe | 200 x 150 | 1.2 |
| Fallow | 220 x 200 | 1.5 |
| Red/Sika | 220 x 300 | 1.8 |

This means that a different approach to risk assessment may be advisable. RSSB's work on geo-referenced risk modelling (T972) may make this possible in the future. Based on the Safety Risk Model (SRM), this will use the Wessex route as a pilot to demonstrate how comparisons could be drawn between different locations in order to build up a clearer picture of how risk varies around the system. Obviously, this will help the industry to focus resource where it is most needed. Network Rail is already considering mapping the locations where wild deer access the line. Clearly these two concepts fit together and may – in time – facilitate more targeted, risk-based fencing programmes.

It may also be that electrification – coming soon to the Great Western Main Line (*inter alia*) – may see the erection of larger, eight-foot, fences, much as it did on the West Coast. This may in turn see the risk fall yet further.

In summary, the industry can have a degree of confidence that risk from animal incursion has been reduced by industry improvements in fence management, cab-to-shore communications, the rules for reporting incidents and the robustness of trains to collision. But while Network Rail will continue to monitor the situation, it is noted that the occasional incident can still cause harm, and can impact on the commercial aspect of the railway, in terms of delays, rolling stock cleaning and line clearance.

# Appendix 1. Glossary

For a full list of definitions, see RSSB's *Annual Safety Performance Report*.

| Acronym | Expansion |
|---|---|
| ALARP | as low as reasonably practicable |
| AOCL | automatic open crossing, locally monitored |
| ASPR | Annual Safety Performance Report |
| BR | British Rail |
| CSR | Cab Secure Radio |
| DBSO | driving brake second open |
| DMU | diesel multiple unit |
| DVT | driving van trailer |
| ECS | empty coaching stock |
| ERA | European Railway Agency |
| EMU | electric multiple unit |
| ERTMS | European Rail Traffic Management System |
| FOC | freight operating company |
| FWI | fatalities and weighted injuries |
| GB | Great Britain |
| GSM-R | Global System for Mobile communications – Railway |
| HMRI | Her Majesty's Railway Inspectorate |
| HSE | Health & Safety Executive |
| HST | high speed train |
| LOE | Learning from operational experience |
| MOM | mobile operations manager |
| NRMI | Network Rail managed infrastructure |
| NRN | National Radio Network |
| OFG | Operations Focus Group |
| ORR | Office of Rail Regulation |
| PIM | Precursor Indicator Model |
| RAIB | Rail Accident Investigation Branch |
| RGS | Railway Group Standard |
| RIDDOR | Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 |
| ROGS | Railway and Other Guided Transport Systems (Safety) Regulations 2006 |
| RSPCA | Royal Society for the Prevention of Cruelty to Animals |
| RSSB | Rail Safety and Standards Board |
| SMIS | Safety Management Information System |
| SRM | Safety Risk Model |
| TOC | train operating company |
| TDM | time division multiplex |
| TPWS | train protection and warning system |
| TRUST | TRain RUnning SysTem TOPS |
| UWC | user-worked crossing |