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**Animal-train collisions are increasingly serious challenge for modern railways**

**Abstract:** The problem of wildlife collisions with trains appeared with the invention of the railway. This phenomenon increases with the development of new technologies and ongoing modernization of railway lines, leading to an increase in both speed and train traffic volume. Changes in the construction of rail vehicles and the introduction of new, lightweight rolling stock, sensitive to mechanical shocks, increase costs in the case when it comes to a collision. In the article we present sample data on the scale of the phenomenon. One of the major carriers in Poland –Przewozy Regionalne Ltd. (Regional Railways) – in one year registered 268 cases of animal-train collisions. In turn, the PKP Intercity SA in year 2015 as a result of such collisions incurred repair costs amounting to half a million PLN, while Koleje Wielkopolskie Ltd. (Wielkopolska Railways) in the same year incurred costs associated with collisions of nearly 300,000 PLN. The data obtained from the carriers show, therefore, that in Poland there happen at least a few hundred collisions with large animals per year, and the associated repair costs are slightly counting hundreds of thousands of PLN. Through an analysis of places of collisions it is possible to determine the “black spots”, where it is advisable to introduce preventive measures.

**Keywords:** Animal-train collisions; Effects of collisions; Costs of repairs; Railway traffic safety

**Introduction**

The problem of animal-train collisions exist as long as the rail. This phenomenon increases with the development of rail transport, the increase in traffic of trains and the development of technology, both trains and infrastructure, leading, among others, to speed increase. Reduced noise and vibration when passing the train makes it harder to notice when it is coming. At the same time putting into service a new, lightweight rolling stock means that collisions often damage the vehicle, and the repair costs are higher and higher.

Collision problem is multi-faceted, combines environmental issues (killing animals), economical (repair costs) and the safety of trains (the possibility of derailment). This problem is often underestimated by the railwaymen, because collisions among the so-called "non-rail event", i.e. those for which the infrastructure manager has no direct effect. However, this approach is not justified either fully true. Although the number of train collisions with animals

in Poland is several hundred to several thousand a year, this topic has only recently become the subject of detailed analysis.

The article presents an example of data on the quantity and impact of the collision, which we managed to reach.



1. Moose passing through the railway tracks - the view from the camera monitoring the place of high activity of animals around the railway line [Werka i in. 2012]

### **Animal-train collisions and their effects**

The effects of animal-train collisions depend mainly on three factors: the speed of the train, the size of the animal and the vehicle structure. The higher the speed, the heavier the animal, the greater the energy of the collision. At the same time, the lighter and more delicate is the construction of the vehicle, the greater the risk of damage and higher repair costs. Most sensitive to the effects of a collision are modern multiple units and locomotives for operation of trains. Repair of major accidents, in particular for railcars, may be a cost comparable to the cost of a new unit. Besides the cost of repairing severe for the carrier can also be a financial loss resulting from a temporary shutdown of the damaged vehicle out of service. Further costs result from train delays and / or need to involve additional funds (to bring the locomotive replacement). Difficult to estimate are the losses resulting from the loss of confidence in the carrier [Stolarski 2010, Wiśniewska i Pogorzelska-Gos 2010].

### **The data obtained from the carriers in 2013**

The first attempts to obtain information from various railway detailed data on collisions with animals we have taken in 2013. Only one of the twelve freight carriers, who we reached, kept a record of collisions with animals, the others gave indicative information about collisions.

Half of the freight carriers in 2012, did not reported collisions at all, others had several collisions per year. Three carriers had to as a result of collision repair the rolling stock. None of them reported that the train has stopped, but one reported that when the driver see an animal on the track, sometimes stops train.

Out of the six, only four passenger carriers keep records of the collision, and the other gave approximate information. The number of collisions varies from 1-2 per year to several

per week, which is primarily due to the scale of operations of carriers. Three carriers reported detention of rolling stock because of the collision, also three had to repair rolling stock, with a maximum cost of repairs amounted to PLN 50,000. In summary, collisions are more likely to happen passenger carriers rather than carriers of goods, so more often to those whose fleet runs at a higher speed. Passenger carriers rolling stock is also frequently damaged.

### **Data of the Przewozy Regionalne sp. z o.o from 2012**

Przewozy Regionalne sp. z o.o in 2012, recorded 268 cases of collisions with animals [Żyłkowska 2014].

Damages of rolling stock were noted in the middle of the recorded events. In case of occurred damages most often were destroyed air ducts and scrapers. More rarely, there were: burst of the bumper damage to headstock, damage the piping of cooling and heating, engine damage, breakage of the reflector, and in one case there was a damage of the mirrors and side window (damage to the headlight and mirror with glass side occurred as a result of collisions with birds). Species, which fell under the wheels of trains are mainly large forest animals (does, wild boars, deer and elk, which constitute more than 90%). There were also noted several collisions with dogs, single collisions with farm animals and birds [Żyłkowska 2014].

We examined the influence of animal species and number of animals involved in the incident on the likelihood of damage. As expected, the larger animals and larger number animals means a greater risk of damage. In case of large forest animals the most damage followed as a result of collision with deer (77% of collisions ended with failure) and moose (75%), next boar (60%) and roe deer (47%). For each of these types of damage noted in 75% of collision with a pack of large animals, only 47% of collisions with a single large animal [Żyłkowska 2014].

Train delays as a result of collisions occurred in nearly 60% of incidents, including a delay of over an hour accounted for 10% of cases. The maximum recorded delay time was 178 minutes. In 12% of cases were also found secondary delays, i.e. as a result of the collision more than one train was delayed [Żyłkowska 2014].

### **PKP Intercity SA data from 2013 and 2014**

PKP Intercity SA conducts accurate records of collisions with animals, which also contain information about repair costs associated with individual events. A separate register is maintained for EMUs ED250 Pendolino. Excluding the data for Pendolino, in 2013 we recorded 66 cases of collisions with animals, in 2014 - 81 cases. Most cases concerns locomotives Husarz type (39 and 33). Pendolino trains until obtaining the data (from 14.11.2014 to 03.31.2015) underwent collisions 22 times [Kałuża and others 2015].

Damages of rolling stock were observed in 42% of cases in 2013 and in 44% of cases in 2014. Damage to Pendolino followed in 73% of cases. At the same time it should be mentioned that in the case ED250 no damage does not mean no cost. As a result of collision with an animal on the train there will be biological remains, special disinfection is required [Kałuża and others 2015].

Most often damaged parts of locomotives are air systems, power cables, strippers and access steps. In a few cases were also damaged carriages, it was primarily the occurrence of flat places on the wheel sets due to the implementation of emergency braking by the driver after noticing the animal on the tracks [Kałuża and others 2015].

Animals species which have been involved in collisions are mainly large forest animals (roe wild boar, deer and elk, accounting together more than 80%). There were collisions with farm animals, dogs and birds. In case Pendolino all identified animals belonged to three species: wild boar, roe deer, deer [Kałuża and others 2015].

Repair costs of trains in 2013 totaled PLN 345,100, giving an average of 5.229 PLN per collision; including PLN 335,600 which are the cost of repair EU44 - Husarz. The most expensive repair cost 63,000 PLN (it was a train EU44). In 2014, excluding Pendolino costs totaled PLN 496,100 - an average 6.125 PLN per collision, including 468,700 PLN costs of Husarz repairs; the most expensive repair (Husarz) cost 132,900 PLN. For Pendolino trains total cost of repairs and disinfection as a result of 22 collisions in the 14 months was PLN 193,000, the average cost of repairs are PLN 8,773 and the most expensive repair in the time was PLN 28.100 [Kałuża and others 2015].

Excluding data for the Pendolino, the vast majority of costs (about 95%) is associated with repairing locomotives EU44 - Husarz and this despite the fact that the number of Husarz repairs was similar to the number of repairs of other locomotives. Repair costs of Husarz are at least an order of magnitude higher than that to repair similar damage to other (older) type of locomotive. For the received data Husarz repair costs start with the ceiling price at which end the repair costs of other locomotives.

In case ED250 Pendolino each from 22 collisions was associated with the occurrence of the cost of repairs and / or disinfection of composition. The cost of repairs began at around PLN 2,000 and the most expensive repair cost PLN 28.100. The total cost of repairs and disinfection for 14 months of operation amounted to approximately 193,000 PLN [Kałuża and others 2015]. On the photo you can see two sensitive elements ED250 not protected against mechanical shock. Photos 3-5 show the effects of collision trainsets ED250 with animals.



2. The front of Pendolino train with elements sensitive to mechanical shock  
[pic. Marek Stolarski]



3. The biological remains on the aerodynamic cover (the cost of disinfection about 2000 EURO) [Kałuża and others 2015]



4. Cracked aerodynamic cover and scraper [Kałuża and others 2015]



5. Damaged bottom scraper and cover of bow flaps [Kałuża and others 2015]

#### **Data of Koleje Wielkopolskie Sp. z o.o.**

We received from the company Koleje Wielkopolskie a summary of the effects of animals-train collisions in years 2013-2015 [Koleje Wielkopolskie Sp. z o.o., unpublished data]:

- In 2013, on all routes operated by the Koleje Wielkopolskie were registered 108 events. The total delay of trains because of this amounted to 394 minutes (an average of about 3.6 minutes for an event).
- In 2014, 185 events were registered. Train delays totaled 1,629 minutes (average approx. 8.8 minutes per event), while expenses totaled approx. PLN 133,700 (average approx. 720 PLN per event).
- In 2015, 220 events were registered. Train delays totaled 2,569 minutes (average approx. 11.7 minutes per event), while expenses totaled approx. PLN 291,600 (average approx. PLN 1,325 per event).

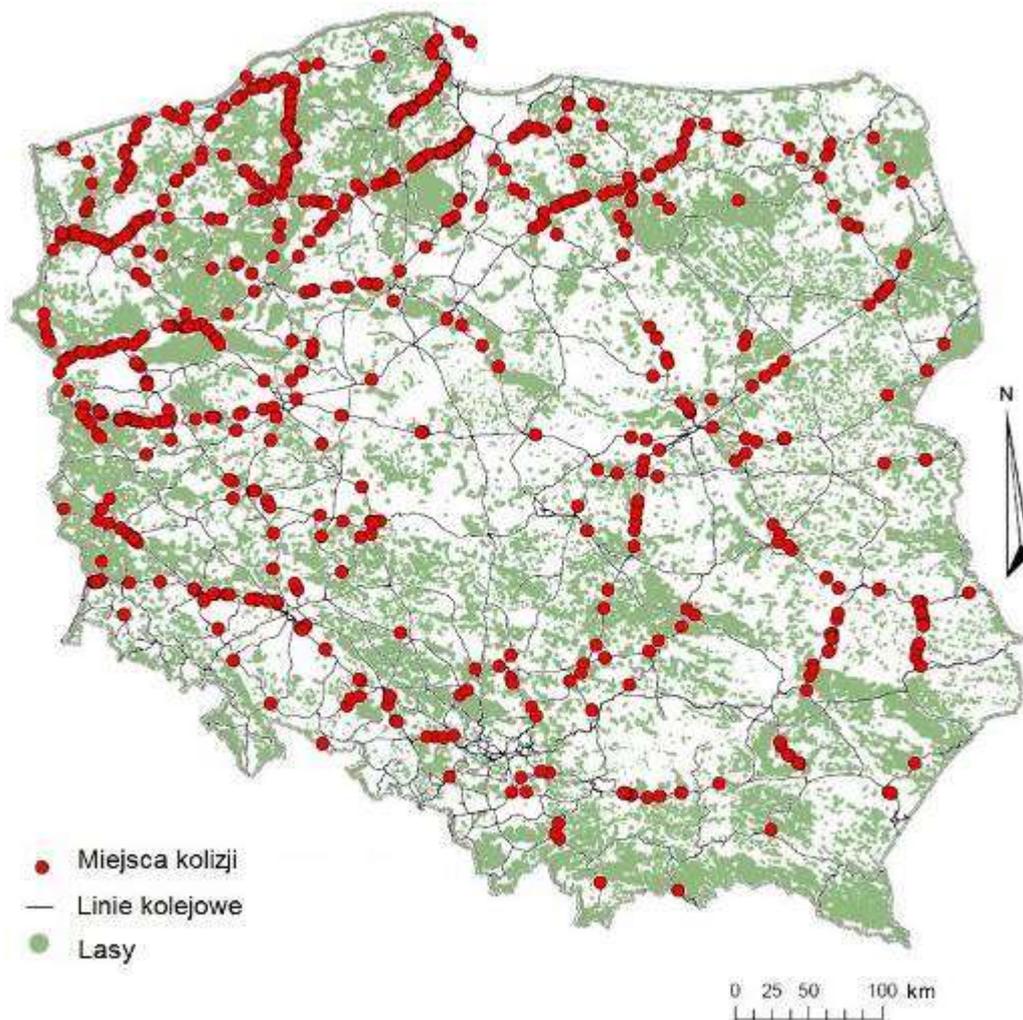
Most events took place on the railway line No. 3 Warszawa Zachodnia - Kunowice, section Kutno - Zbąszynek. On this section in years 2014 and 2015 there was a 22% of the events, which accounted for 40% of the costs associated with accidents involving animals incurred by the carrier.

Obtained data show that the number of events is increasing from year to year, and their consequences measured time delays and costs incurred are becoming more serious, both globally and in terms of a single event. Comparing 2015 from 2014 the number of events has increased by less than 20%, but their costs in 2015 were more than twice higher than in 2014.

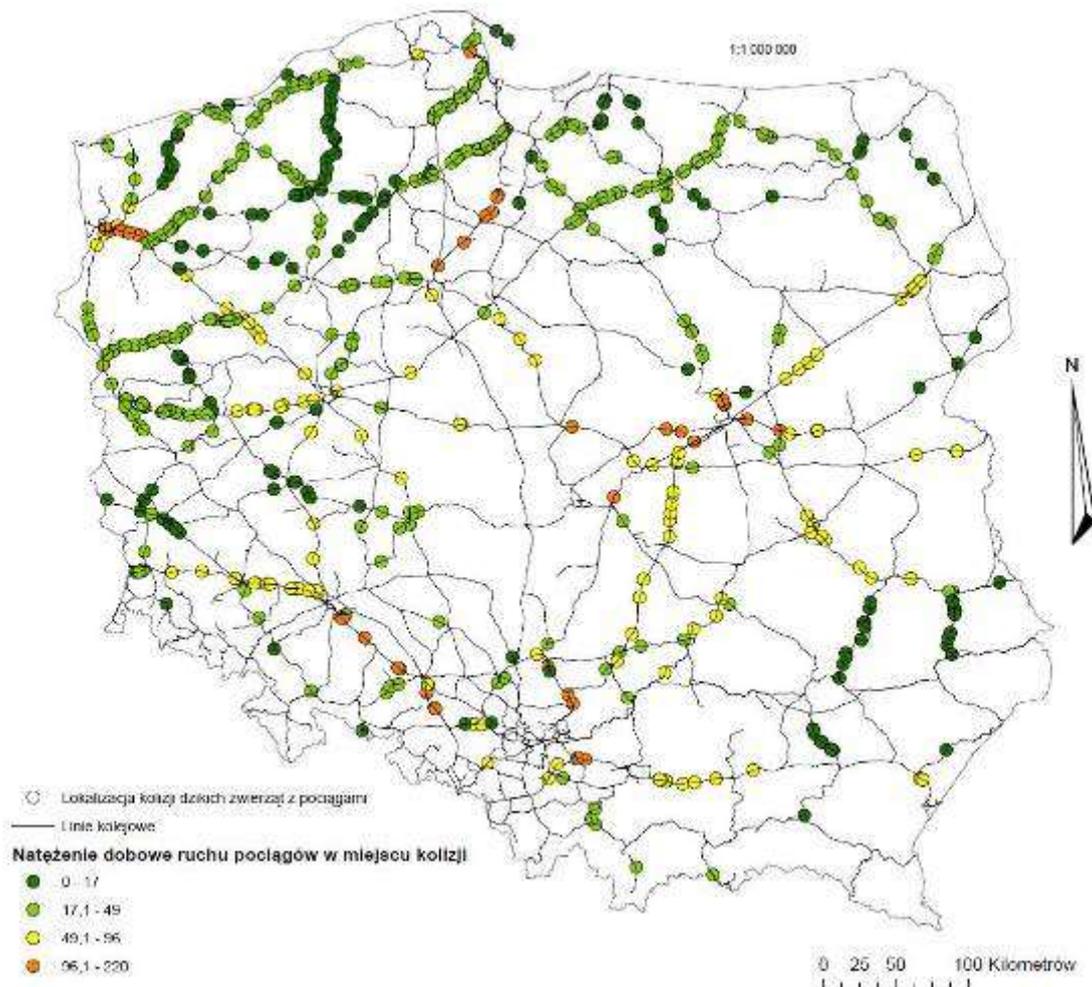
#### **PKP Polskie Linie Kolejowe SA data**

Data concerning collisions with animals in the whole country gathered by the Bureau of Environmental Protection PKP Polish Railway Lines SA. The data come from the SEPE - registration system operational work. On the basis of information given to collisions with wild animals from the years 2007-2012 there was created a map of "black spots" on the railway lines, that is, places where usually there is a collision [Werka and others 2014]. Figure 1

shows a map of the distribution of "black spots". They are visible on the sections with particularly high density of collisions, especially in north-western Poland. The second figure shows the same "black spots" in conjunction from traffic of trains on the given line. The drawings shows that the number of collisions is less dependent on the intensity of the train and the presence of more green areas and, consequently, the occurrence of animals.



1. "Black spots" - locations of numerous train collisions with animals [Werka and others 2014 study based on data PKP PLK SA from years 2007-2012]



2. The occurrence of "black spots", depending on the daily traffic of trains [Werka and others 2014 study based on data PKP PLK SA from years 2007-2012]

### Summary and discussion

The probability of an animal-train collision causing a damage and the size of the damage depends on several factors, all of which are very important: train speed and its design. The faster the vehicle travels, the less reaction time has an animal. At very low speeds, the animals manage to successfully avoid a collision, it is also possible to slowdown the composition after noticing the animal on the tracks. When it comes to the collision, the higher the speed of the train, the greater the impact energy, and thus, the size of damage. For the size of the damage and repair costs it is crucial to the construction of a rail vehicle. New trains, covered by composite elements, are much more susceptible to damage than the older rolling stock.

These two factors make the result that the problem relates to a collision with animals to a much greater degree passenger train than the cargo. In case of passenger trains driver has a very limited opportunity to react, when notices the animals that are on the tracks. Locomotives for freight trains, except that they move at lower speeds, up to now were more massive and resilient construction, so rarely occurred to more serious damage. New construction of locomotives for freight traffic, however, turn out to be just as susceptible to the effects of the collision, and the only thing that can reduce the extent of the damage which are limited to 120 km / h speed of the fastest freight trains. Consequently less frequent there are recorded collisions with animals, because at a lower speed and the lack of any damage

drivers may not report all of collision. Passenger operators often use complex-type units or PCS EMU and rail buses, which, because of low weight and lightweight design are the most susceptible to damage, plus the cost of repairs is not less than the cost of traditional repair of locomotives.

The higher the traffic and higher speed of passenger trains, the more serious is the problem of collisions with animals. Quoted data obtained from the carriers clearly demonstrate the growing scale of the problem - from year to year the number of incidents is growing, so are the associated costs of repair of rolling stock, the costs of delays in train traffic, the cost of losing the trust of the passengers or the costs of reducing the level of security in railway transport.

Collecting detailed data on collisions and their analysis allow the infrastructure manager to determine the so-called "black spots", in which there are especially often collisions. This in turn will allow for use in these locations effective preventive measures, on the one hand reduce the mortality of the animals on the tracks, and on the other increase the safety and reliability of rail transport and will avoid unnecessary costs.

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