



MONITORING OF THE EFFECTIVENESS OF MITIGATION MEASURES IN SLOVENIA

Action D.2: Evaluation (monitoring) of the effectiveness of mitigation measures implemented to prevent traffic related bear mortality

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1 INTRODUCTION

Highways, roads and railways can have negative impacts on bears and many other species of wildlife. Bears killed by motor vehicles and trains are a significant part of the total documented bear mortality in Slovenia (Figure 1). Additionally, bear-vehicle collisions represent an important risk to drivers and passengers. Overall, vehicle-related mortality of bears represents a risk to long term viability of bear population in Slovenia; moreover; highways represents barriers to bear movement and can reduce connectivity of populations(s). Therefore, mitigation measures were implemented along the main road Ljubljana – Kočevje (installation of dynamic signs) and along the railway Postojna – Pivka and Ljubljana – Postojna (installation of acoustic deterrents) to reduce traffic related bear mortality in Slovenia (Al Sayegh Petkovšek et al., 2015).

With the aim to monitor the effectiveness of dynamics signs along the two selected road sections of the main road Ljubljana – Kočevje, the following activities were performed before installation of dynamics signs: (i) monitoring of wildlife (including brown bear) in the very close vicinity of dynamics signs with the use of camera traps; (ii) measuring the speed of vehicles along the road section between Dolenja vas and Gornje Ložine (Jasnica); and (iii) collecting data regarding traffic mortality of brown bear and large game at selected road sections (areas) between Ortnek and Žlebič, and between Zgornje Lozine and Dolenja vas (Jasnica), respectively.

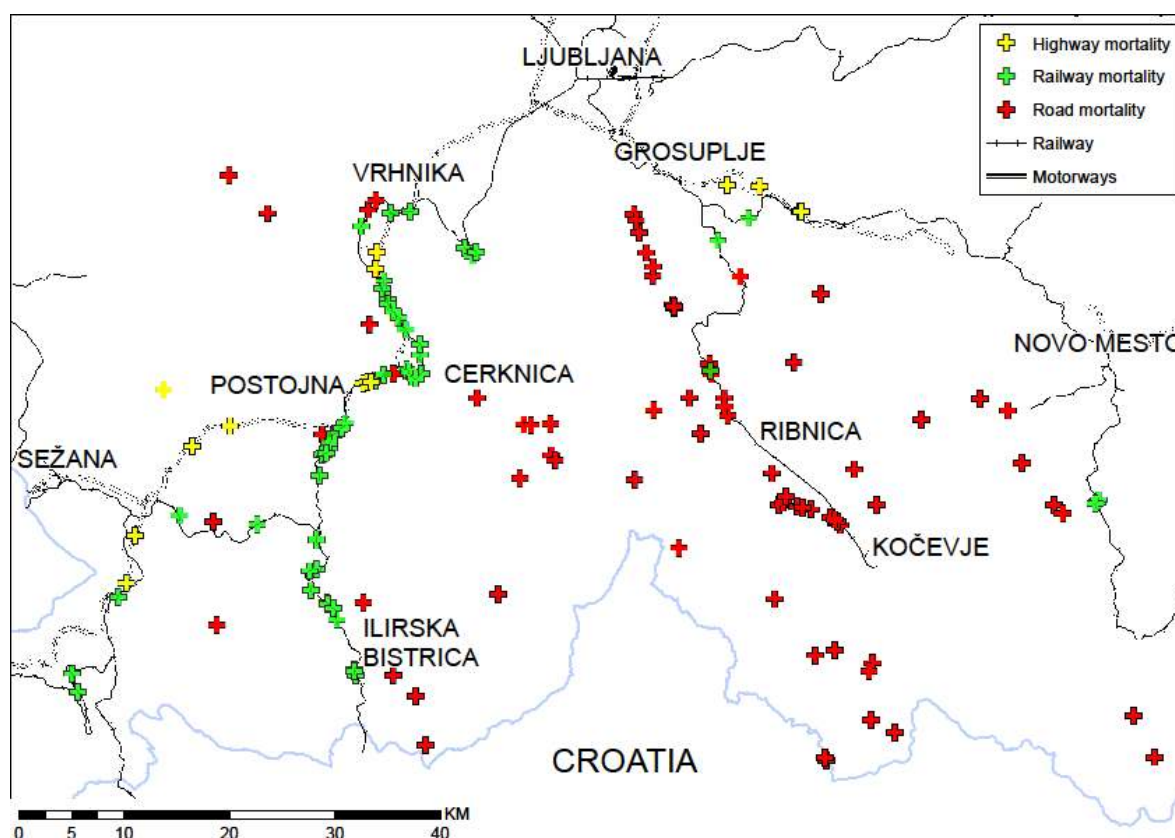


Figure 1: Map of locations of reported brown bear mortality on highways, roads and railways in Slovenia for the period 2004 – 2014.

2 MITIGATION MEASURES IMPLEMENTED TO PREVENT TRAFFIC RELATED BEAR MORTALITY

2.1 DYNAMIC TRAFFIC SIGNS ALONG THE MAIN ROAD LJUBLJANA – KOČEVJE

Dynamic traffic signs were placed along two sections of the main road Ljubljana – Kočevje (between Zgornje Lozine and Dolenja vas (Jasnica) and between Ortnek and Žlebič) to alert and slow down drivers in order to avoid potential collisions with wildlife, including bears. Dynamic signs are coupled to sensors capable to detect large animals approaching to the roadways (see Figure 2). In the case of approaching bear (or ungulates), the signs light on and send the message to the driver that an animal is approaching the road. Since the sensors are not bear-specific, they provide also higher road-safety considering collisions with other large mammals, particularly ungulates.

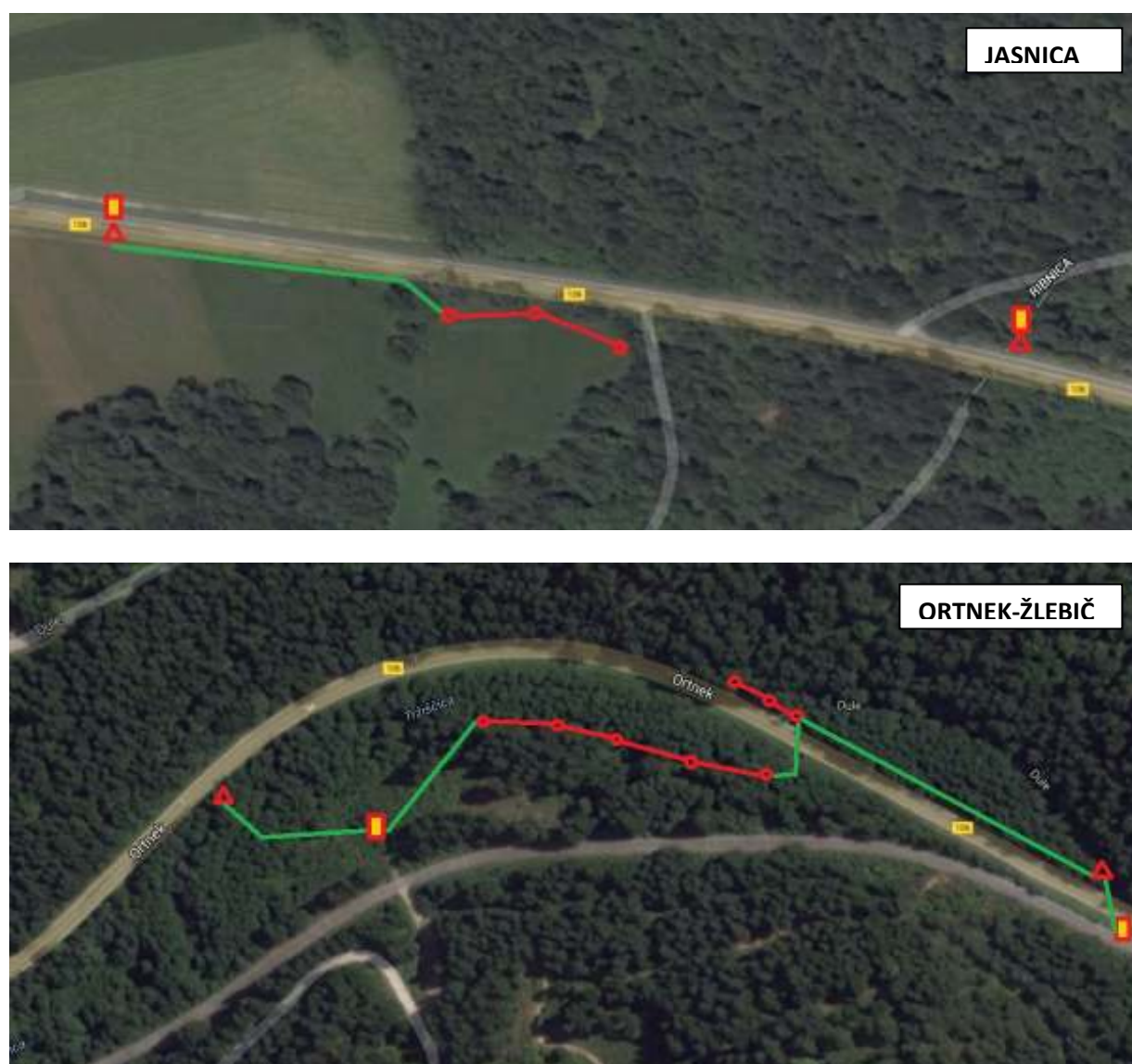


Figure 2: Dynamic traffic signs are coupled to sensors (red line), power lines (green line), solar cells (yellow rectangle) and traffic signs (triangle).

2.2 INSTALATION OF ACUSTIC DETERRENTS ALONG SELECTED RAILWAY SECTIONS

Acoustic deterrents were installed on electric poles along the railway sections Rakek – Postojna and Postojna – Prestranek, where it was stated by field inspection that crossing of wildlife (especially brown bear) is possible (see Figures 5, 6, 7).



Figure 3: Two types of electric poles to which we installed acoustic deterrents (photo: Z. Pavšek, 2015).



Figure 4: Installation of acoustic deterrents on electric poles along railway sections (photo: M. Zaluberšek, 2015).

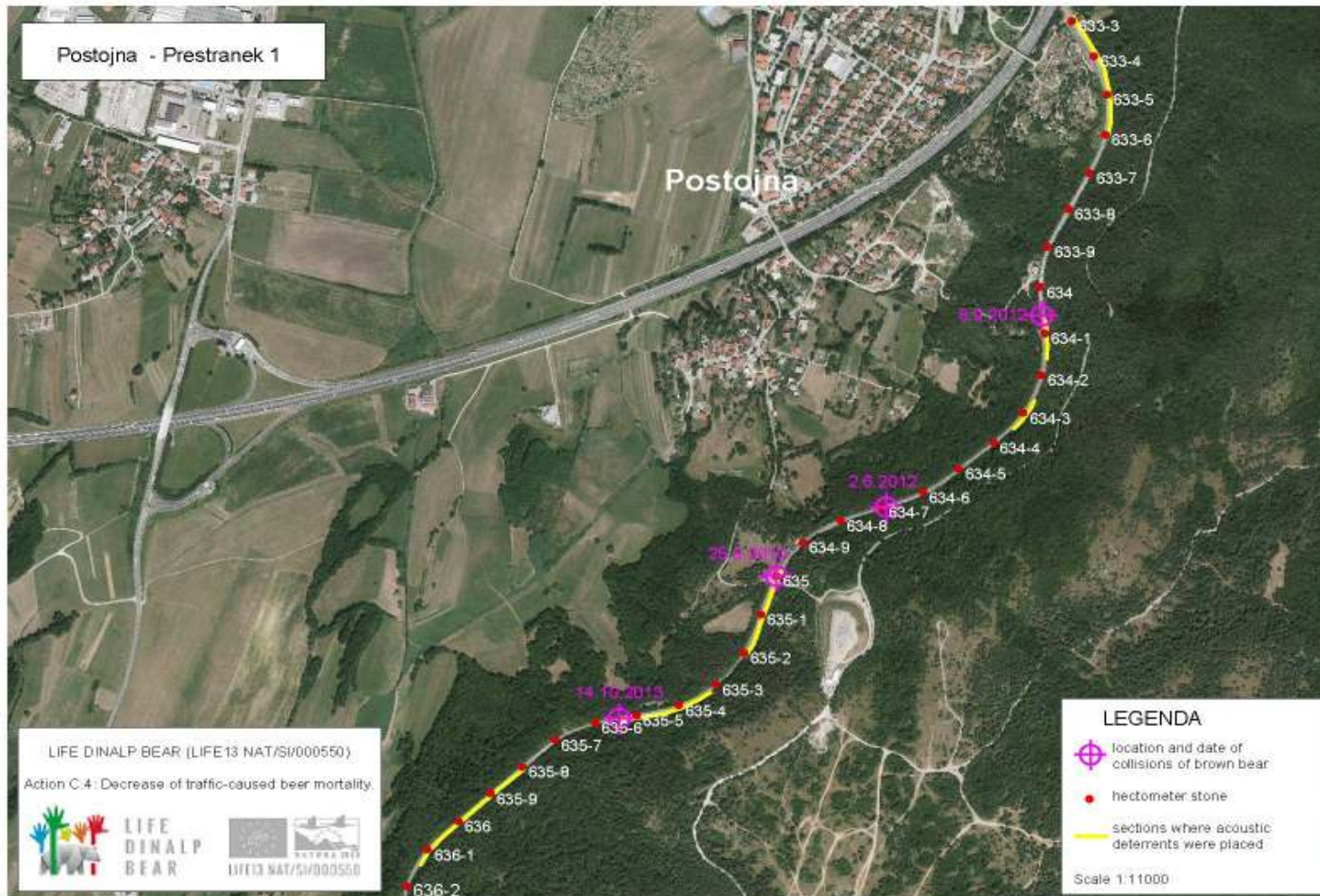


Figure 5: Selected section of the railway Postojna – Prestranek with locations of the traffic related bear mortality, dates of collisions and sections where acoustic deterrents were placed.

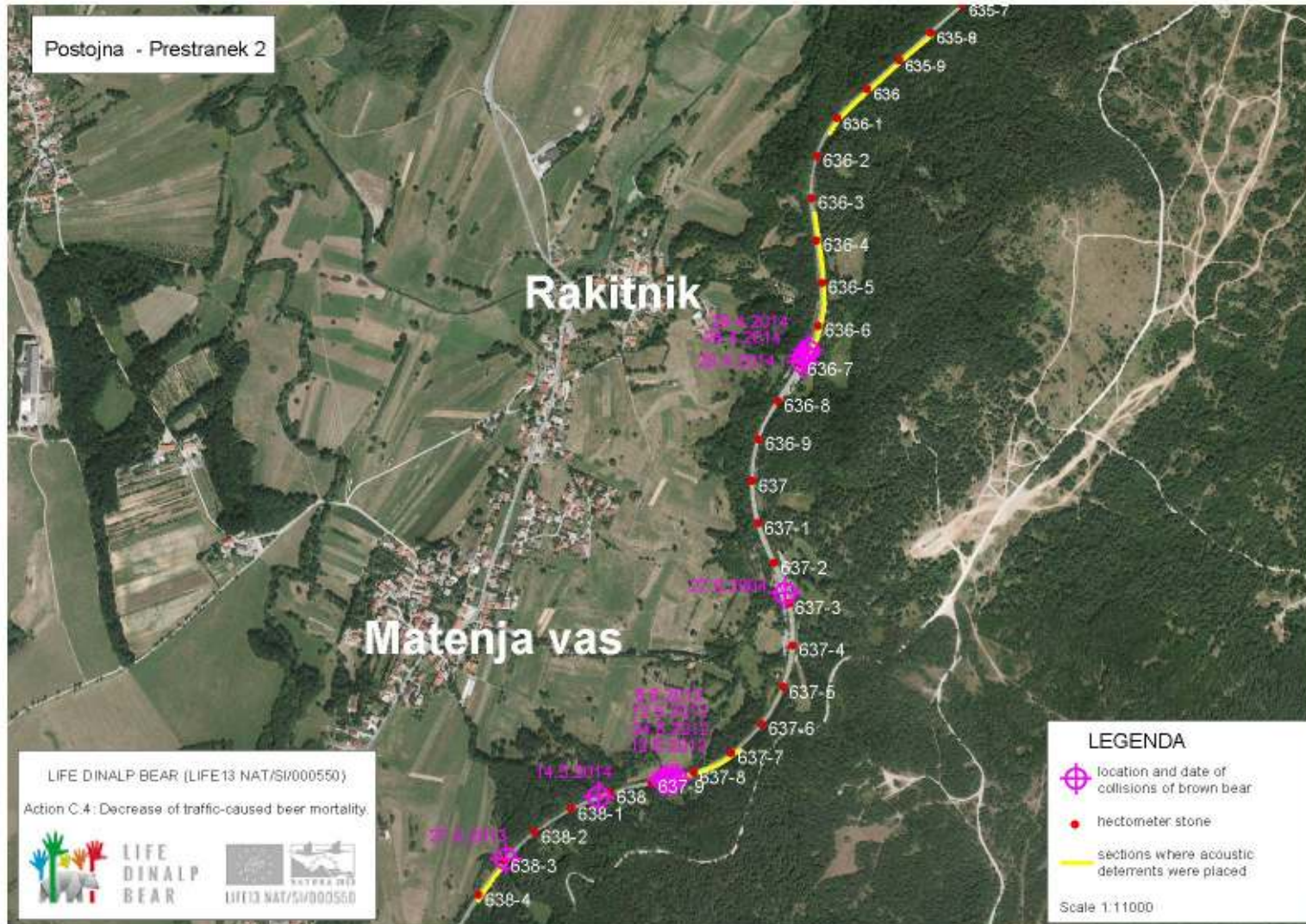


Figure 6: Selected section of the railway Postojna – Prestranek with locations of the traffic related bear mortality, dates of collisions and sections where acoustic deterrents were placed.

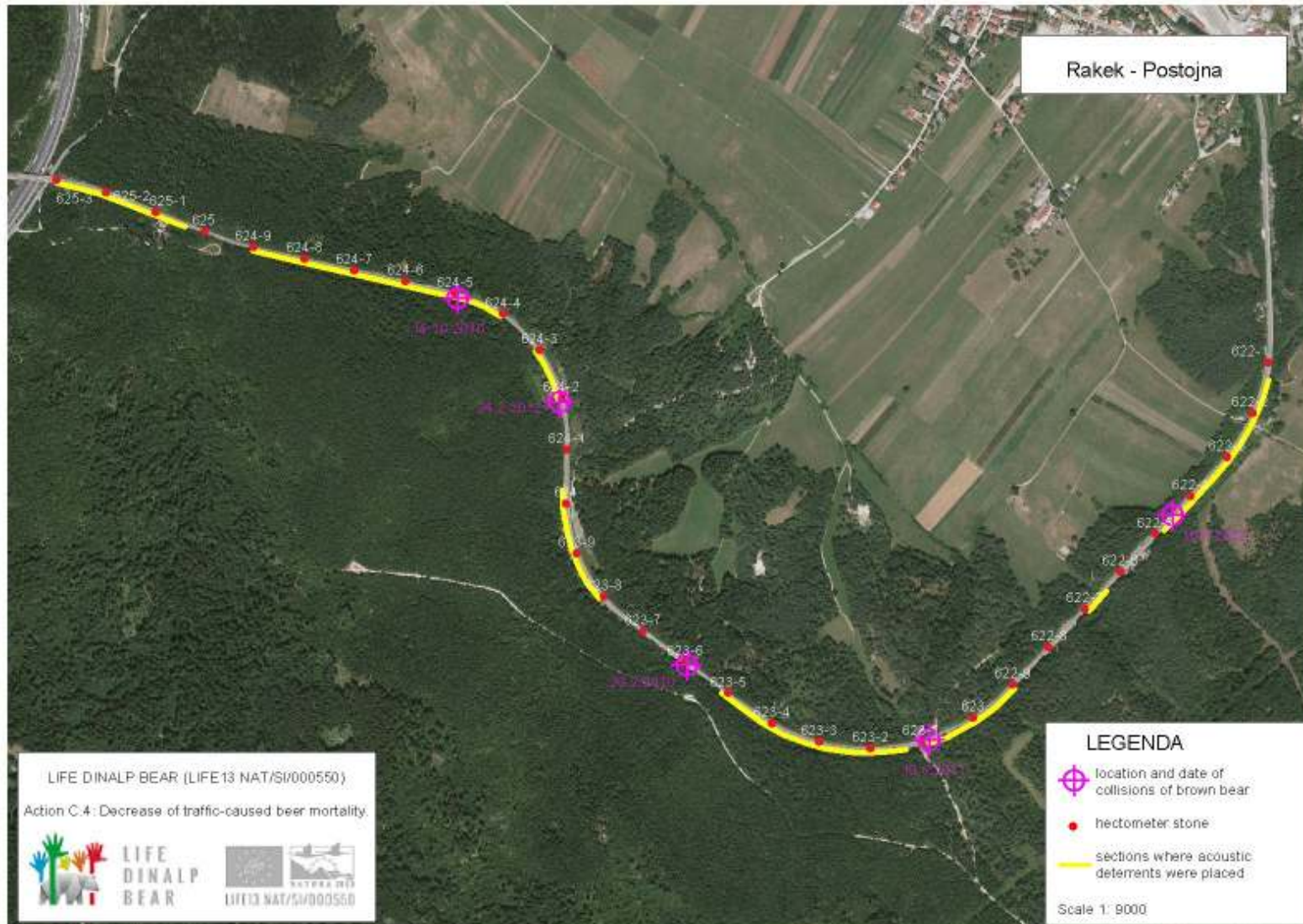


Figure 7: Selected section of the railway Postojna – Prestranek with locations of the traffic related bear mortality, dates of collisions and sections where acoustic deterrents were placed.

3 MONITORING OF THE EFFECTIVENESS OF MITIGATION MEASURES

3.1 MEASURING OF THE SPEED OF VEHICLES

The measuring device Viacount II or traffic counter was placed on the main road Ljubljana - Kočevje between the villages Dolenja vas and Gornje Ložine (Jasnica) in the period between 9.11.2015 (12:00) and 23.11.2015 (12:00) (before installation of dynamic traffic signs) (Grebenc, 2015). The speed of vehicles, which were travelled in both directions, was measured to allow comparison of speed of different type of vehicles before installation of dynamics traffic signs and after installation. Obtained data will enable monitoring of the impact of dynamics signs (more precisely their activation) on the reduction of the speed of vehicles. Driving direction and location of measuring device are shown on the map below (see Figures 8, 9).



Figure 8: Map of location of traffic counter and driving direction along the main road Ljubljana – Kočevje (Jasnica) near Dolenja vas.

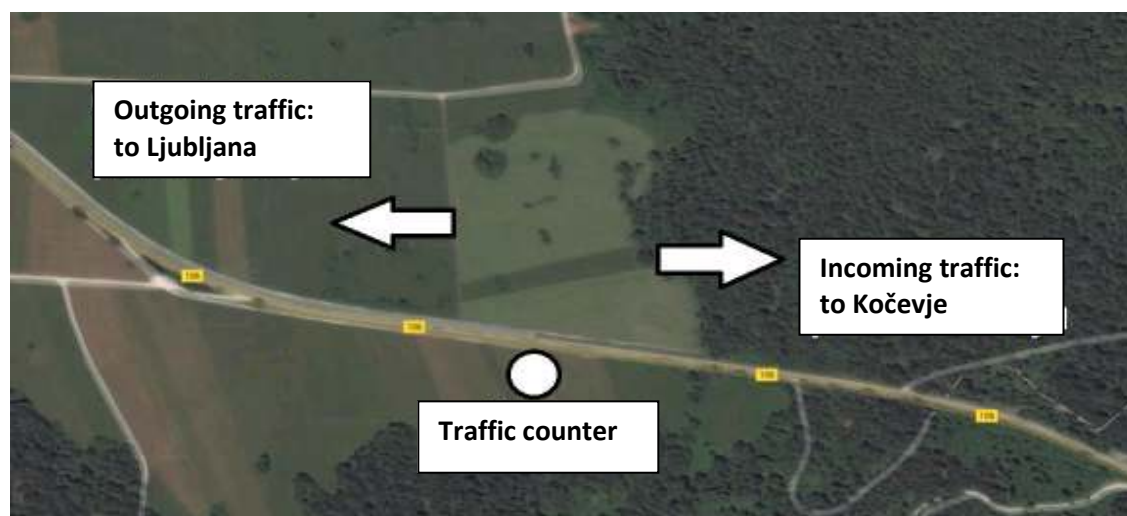


Figure 9: Location of traffic counter and direction of incoming (to Kočevje) and outgoing traffic (to Ljubljana).

Traffic counter Viacount II is radar device for counting and classification of vehicles according to the type of vehicle. Based on the Doppler method of measurement it provides accurate and reliable measurements. The device enables the counting and measurement of the speed of vehicles in both directions, e.g. incoming and outgoing traffic. Traffic counter was placed on the pole of traffic sign at a height of 2.3 m and 1.9 m away from the road (Figure 9). Speed limit in this section of the main road is 90km/h.



Figure 10: Traffic counter placed on the pole of traffic sign near Dolenja vas (Jasnica).

Vehicles are divided into motors, cars, combined vehicles, trucks and semi-trailer. Characteristics of traffic for both directions (incoming and outgoing) are listed in the Table 1.

Table 1: Characteristics of traffic for both directions (incoming and outgoing).

Type	No. of vehicles	Average speed (km/h)	Max. of speed (km/h)	V85 (km/h)*
motors	293	62	141	96
cars	55.387	96	226	111
combined vehicles	15.120	94	186	109
trucks	3.518	84	109	96
semi-trailer	2.285	82	109	92
SUM	76.603	95	226	110

*The 85% percentile speed.

76.603 vehicles drove past the traffic counter within two weeks. The majority of them were cars (72%); the combined vehicles were 20%, while percentages of remaining types of vehicles were significantly lower (Figure 11).

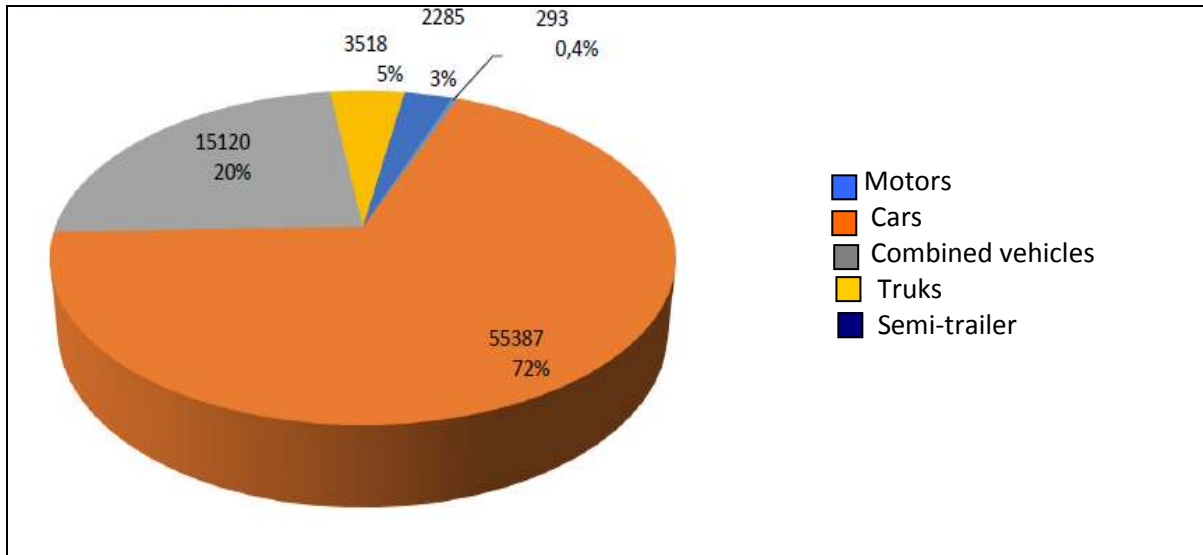


Figure 11: Percentages of different types of vehicles (both direction).

The average speed of all vehicles was 95km/h, and maximum speed was 226km/h. 60% of all vehicles exceeded the speed limit (90 km/h), 31% of all vehicles have speed above 100km/h and 6% above 120km/h (Figure 12).

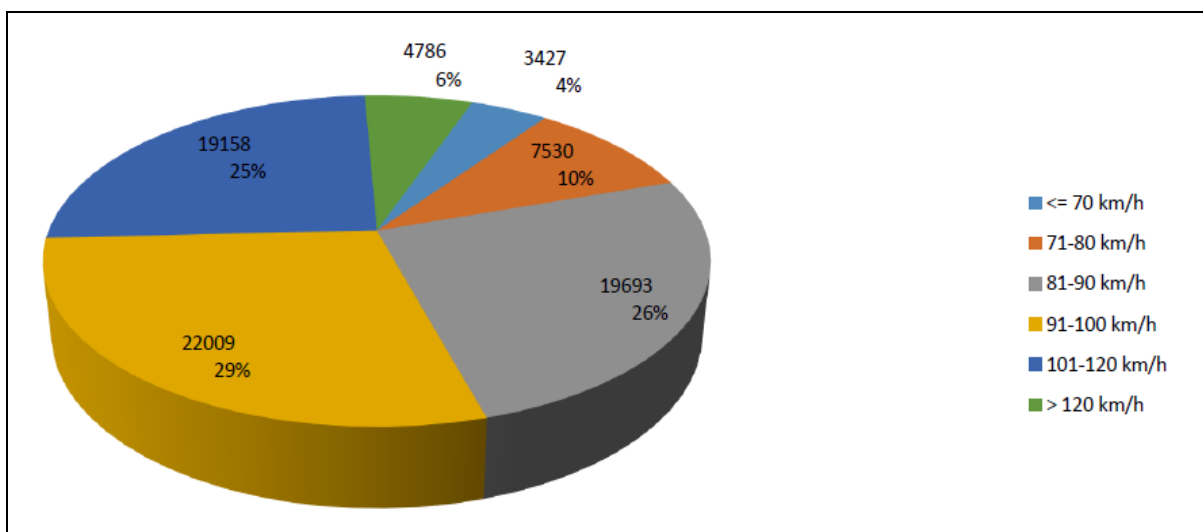


Figure 12: Percentages of vehicles which were classified in different speed classes.

Table 2: Characteristics of incoming traffic.

Type	No. of vehicles	Average speed (km/h)	Max of speed (km/h)	V85 (km/h)*
motors	98	43	115	87
cars	28.151	95	216	108
combined vehicles	7.486	95	186	111
trucks	1.667	87	102	97
semi-trailer	1.151	85	92	92
SUM	38.553	94	216	108

*The 85% percentile speed.

The average speed of vehicles of incoming traffic (to Kočevje, up the hill) was 94km/h, and maximum speed was 216km/h. 56.6% of all vehicles exceeded the speed limit (9 km/h).

Table 3: Characteristics of outgoing traffic.

Type	No. of vehicles	Average speed (km/h)	Max of speed (km/h)	V85 (km/h)*
motors	195	66	141	99
cars	27.236	98	226	114
combined vehicles	7.634	93	184	107
trucks	1.851	82	109	95
semi-trailer	1.134	79	109	91
SUM	38.050	95	226	112

*The 85% percentile speed.

The average speed of vehicles of incoming traffic (to Ljubljana, down the hill) was 95km/h, and maximum speed was 226 km/h. 63.4% of all vehicles exceeded the speed limit (90km/h).

In the future we will monitor the impact of the activation of dynamic signs on the speed of vehicles of incoming traffic at protected sections on the main road Ljubljana - Kočevje between the villages Dolenja vas and Gornje Ložine (Jasnica) and between Ortnek and Žlebič.

3.2 MONITORING OF WILDLIFE USING CAMERA-TRAPS

IR cameras were placed at Ortnek and Jasnica before dynamic signalizations were set up in the period between 2.11.2016 and 15.12.2015.

Table 4: Wildlife filmed during video surveillance at Jasnica between 2.11.2015 and 15.12.2015.

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	/	/	0
<i>Sus scrofa</i>	wild boar	12. 11. 2015	20:03:25	1
<i>Cervus elaphus</i>	red deer	26. 11.2015	03:04:44	1
		1. 12.2015	01:12:25	1
		13. 12.2015	08:14:05	2
<i>Capreolus capreolus</i>	roe deer	8. 11. 2015	18:23:49	2

Table 5: Wildlife filmed during video surveillance at Ortnek between 2.11.2015 and 15.12.2015.

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	17.11.2015	19:48:25	1
<i>Sus scrofa</i>	wild boar	/	/	0
<i>Cervus elaphus</i>	red deer	/	/	0
<i>Capreolus capreolus</i>	roe deer	5.12.2015	16:18:19	1
		9.12.2015	19:55:50	1
		15.12.2015	01:38:00	1
<i>Vulpes vulpes</i>	red fox	8.12.2015	20:51:01	1

Monitoring of wildlife in the period of six weeks had been done with the aim to record the occurrence of brown bear and other wild game species in the area where sensors of dynamics signs were installed at towards. The following wildlife species were observed/recorded: brown bear and roe deer at Ortnek; wild boar, red deer and roe deer at Jasnica, respectively. Brown bear was observed very close to the main road Ortnek – Žlebič. On the basis of this first, relatively short lasting video surveillance, we concluded that the selected sections of the main road had been properly selected. Therefore, the mitigation measures (implementation of dynamics signs) are expected to have positive impact on drives behaviour and will hopefully prevent traffic related mortality of large wildlife, including brown bear.

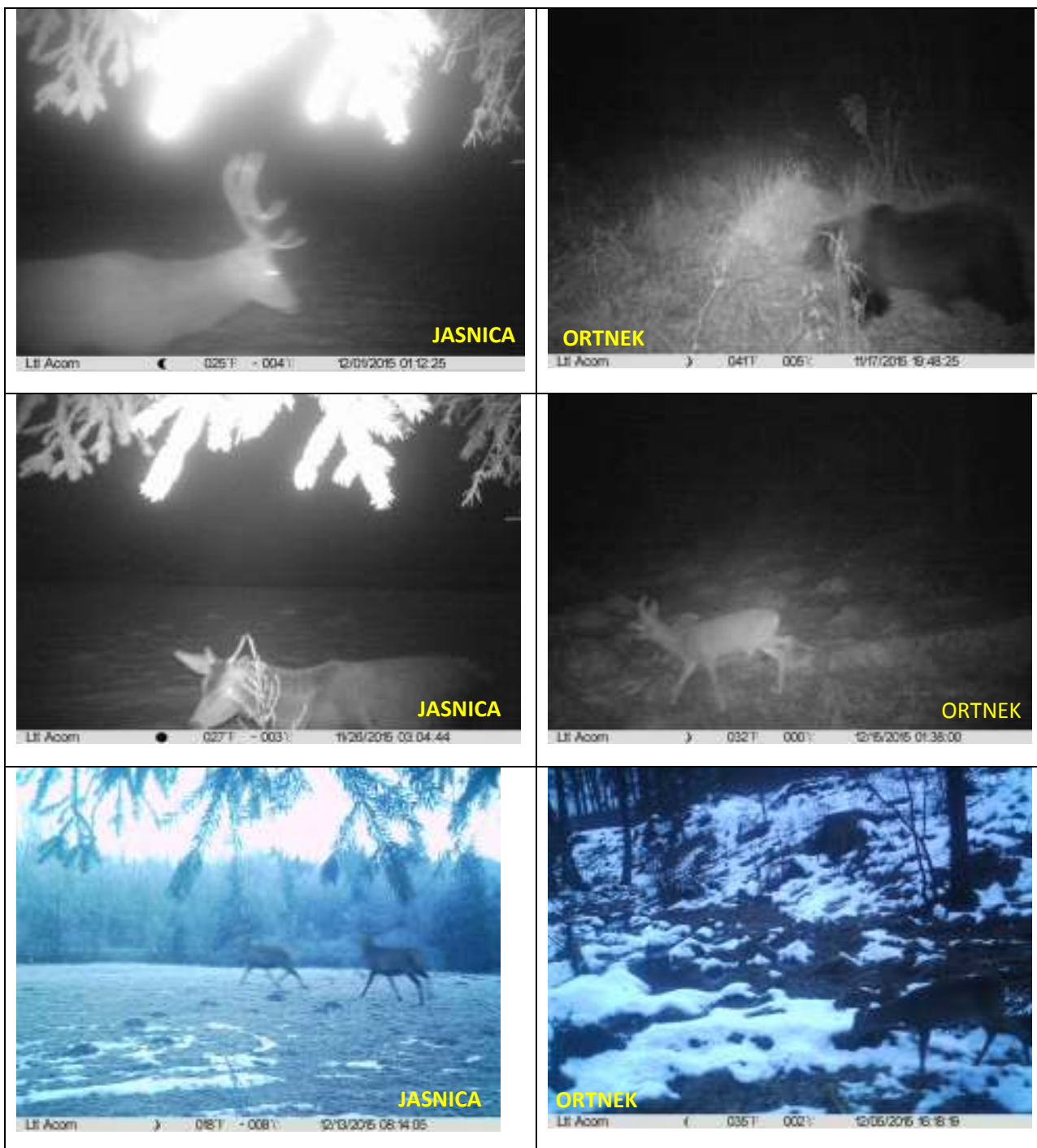


Figure 13: Photos of red deer, brown bear and roe deer, approaching the road sections on which dynamic traffic signs were implemented.

3.3 TRAFFIC RELATED WILDLIFE MORTALITY NEAR SELECTED MAIN ROAD SECTIONS

3.3.1 TRAFFIC WILDLIFE MORTALITY AT JASNICA REPOED FOR THE LAST THREE YEARS

Table 6: Traffic mortality of wildlife reported at selected section of main road between Gornje Lozine and Dolenja vas (Loznica) according to the data from hunting club Dolenja vas (Bojc, 2015).

		2013	2014	2015
<i>Ursus arctos</i>	brown bear	0	0	1
<i>Sus scrofa</i>	wild boar	1	1	0
<i>Cervus elaphus</i>	red deer	0	0	0
<i>Capreolus capreolus</i>	roe deer	2	8	2
<i>Felis silvestris</i>	wildcat	0	0	1
SUM		3	9	4

Table 7: Traffic mortality of wildlife reported in the vicinity of selected road section (the turning to Grčarice) according to the data from hunting club Dolenja vas (Bojc, 2015).

		2014	2015
<i>Ursus arctos</i>	brown bear	1	0
<i>Sus scrofa</i>	wild boar	1	1
<i>Cervus elaphus</i>	red deer	2	1
<i>Capreolus capreolus</i>	roe deer	0	2
Other wild game*		0	0
SUM		4	4

3.3.2 TRAFFIC RELATED GAME MORTALITY AT SELECTED SECTION BETWEEN MAIN ROAD ORTNEK – ŽLEBIČ REPORTED FOR THE LAST THREE YEARS

Table 8: Traffic mortality of wildlife reported at selected section of main road between Ortnek and Žlebič according to the data from hunting club Velike Poljane (Kos, 2015).

		2013	2014	2015
<i>Ursus arctos</i>	brown bear*	0	0	0
<i>Cervus elaphus</i>	red deer	0	1	0
<i>Capreolus capreolus</i>	roe deer	5	4	3
Other wildlife**		0	1	3
SUM		5	6	6

*: The last collision with brown bear was at 18.9.2012.

** : *Meles meles* in 2014; *Vulpes vulpes*, *Meles meles* and *Martes foina* in 2015.

4 CONCLUSIONS

On the basis of monitoring done before installation of dynamics signs, the following findings can be made:

(i) The average speed of all vehicles (all together 76.603) travelled on the main road Ljubljana - Kočevje between the villages Dolenja vas and Gornje Ložine (Jasnica) was 95km/h, and maximum speed was 226km/h. The high speed of vehicles poses a threat to drivers due to possible collisions with wildlife.

(ii) The following species were observed during video surveillance in the close vicinity of protected road sections: brown bear and roe deer at Ortnek, and wild boar, red deer and roe deer at Jasnica, respectively. Brown bear was observed very close to the main road Ortnek – Žlebič.

(iii) During 2013-2015 (till installation of dynamics traffic signs) in total 28 individuals (roe deer: 24, red deer: 1; wild boar: 1, brown bear: 1) of large wildlife species were recorded to be killed in vehicle collisions at selected sections at main road Ortnek – Žlebič and Jasnica, where dynamics signalization were installed.

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