



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

July 2018



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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 (Al Sayegh Petkovšek *et al.*, 2015a; 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 population(s). Therefore, mitigation measures were implemented along the main road Ljubljana – Kočevje (installation of dynamic signs and acoustic deterrents) and along the railway Ljubljana – Postojna (Rakek) and Postojna - Prestranek (installation of acoustic deterrents) to reduce traffic related bear mortality in Slovenia.

With the aim to monitor the effectiveness of mitigation measures along the selected road sections of the main road Ljubljana – Kočevje and the selected railway sections between Ljubljana – Postojna (Rakek) and Postojna - Prestranek, the following activities were performed in years from 2015 to 2018: (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 between Ortnek and Žlebič; and (iii) collecting data regarding traffic mortality of brown bear at selected road and railway sections, respectively.

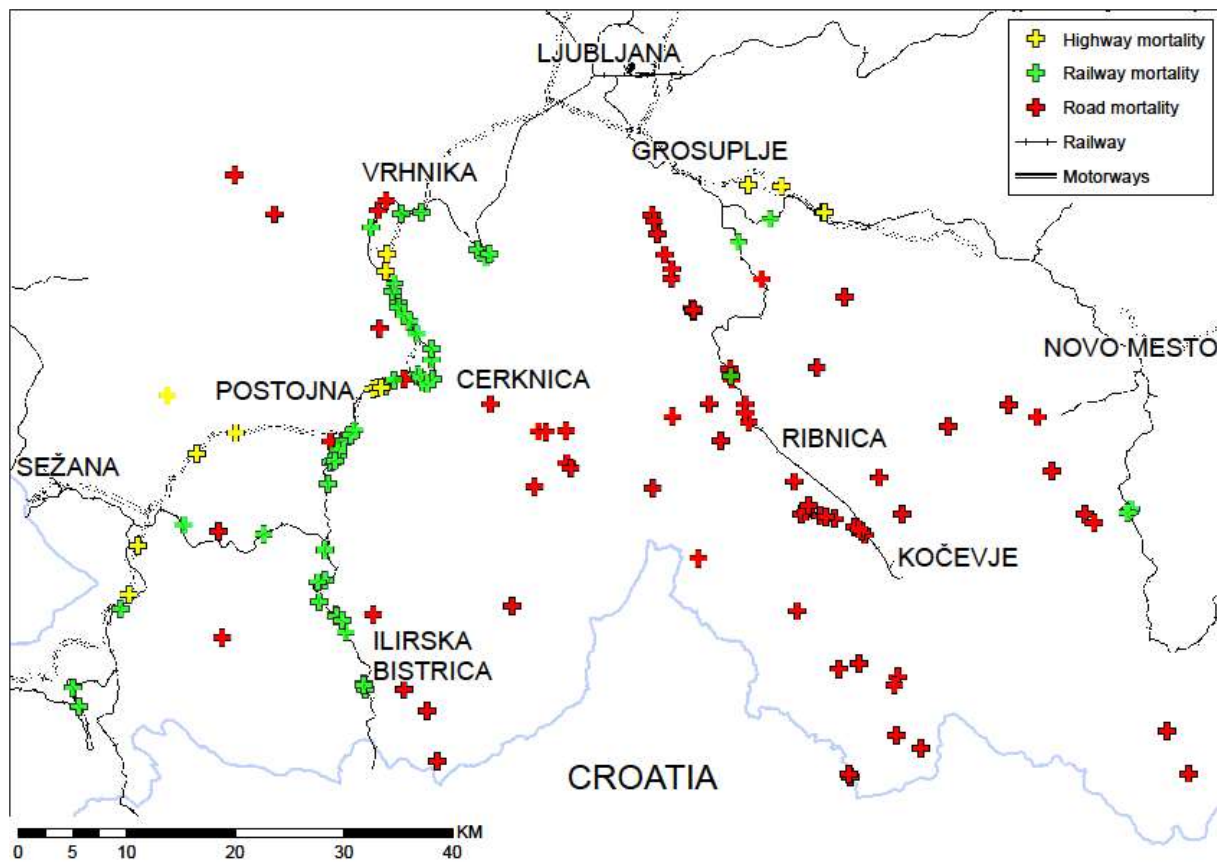


Figure 1: Map of locations of reported brown bear mortality on highways, roads and railways in Slovenia for the period 2004 – 2014 (Al Sayegh Petkovšek *et al.*, 2015a).

2 MITIGATION MEASURES IMPLEMENTED TO PREVENT TRAFFIC RELATED BEAR MORTALITY

2.1 DYNAMIC TRAFFIC SIGNS ALONG THE MAIN ROAD LJUBLJANA – KOČEVJE

At the end of the year 2015, two systems of 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 were 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.

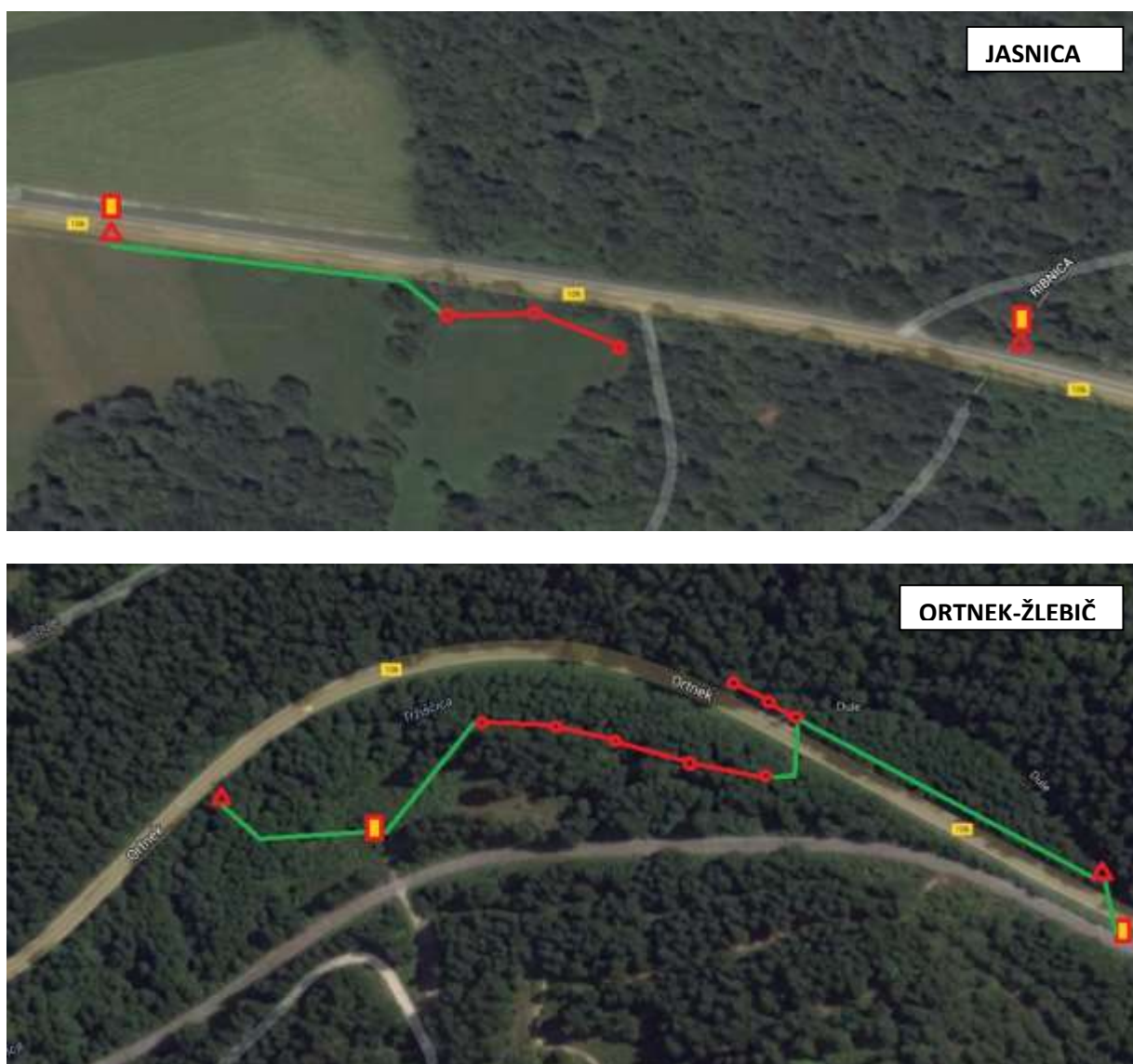


Figure 2: Dynamic traffic signs; sensors (red line), power lines (green line), solar cells (yellow rectangle) and traffic signs (triangle). Above: Jasnica; below: Ortnek.



Figure 3: Dynamic traffic signs placed along two sections of the main road Ljubljana – Kočevje (above: Ortnek; below: Jasnica) (photo: Z. Pavšek, 2016).

At the end of the year 2017, the third dynamic traffic sign was installed along another highly problematic section of the state road Ljubljana – Kočevje (south from Turjak), which was approved by the EU Commission additionally (Figure 4, 5). It also helps to reduce vehicle collisions with brown bear and other wildlife by warning the drivers about approaching animal and therefore helps to reduce traffic caused bear mortality on another hot spot.



Figure 4: Dynamic traffic sign at Turjak - sensors (red line) and traffic signs (triangle).



Figure 5: Dynamic traffic sign placed along the main road Ljubljana – Kočevje near Turjak (photo: I. Jelenko Turinek, 2018).



Figure 6 : Location of three dynamic signs systems along the main road Ljubljana – Kočevje.

2.2 INSTALATION OF ACUSTIC DETERRENTS ALONG SELECTED RAILWAY SECTIONS

At the end of 2015, 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 9, 10, 11).



Figure 7: Two types of electric poles to which we installed acoustic deterrents (photo: Z. Pavšek, 2015).



Figure 8: Installation of acoustic deterrents on electric poles along railway sections (photo: M. Zaluberšek, 2015).

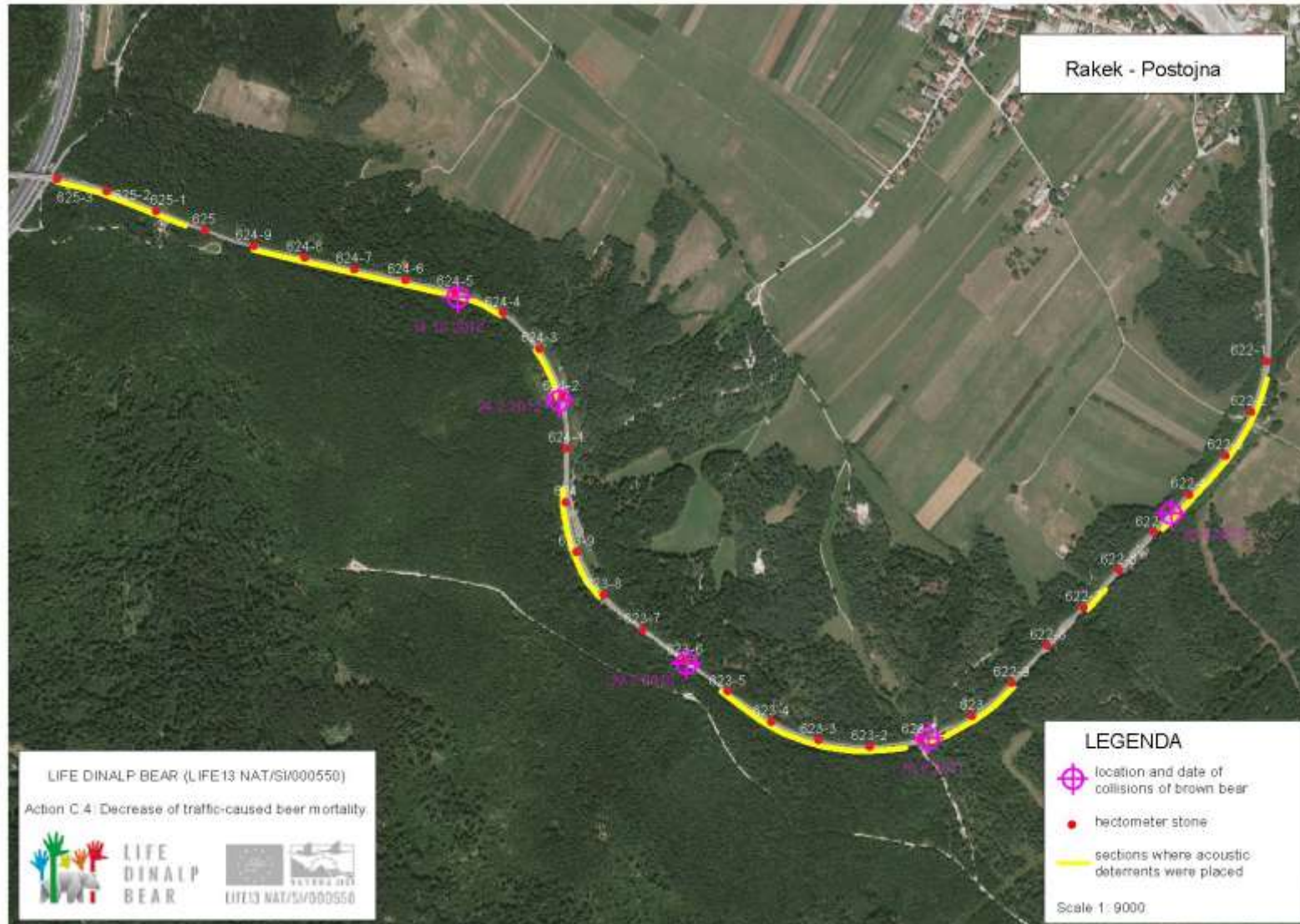


Figure 9: Selected section of the railway Rakek – Postojna with locations of the traffic related bear mortality, dates of collisions and sections equipped with acoustic deterrents.

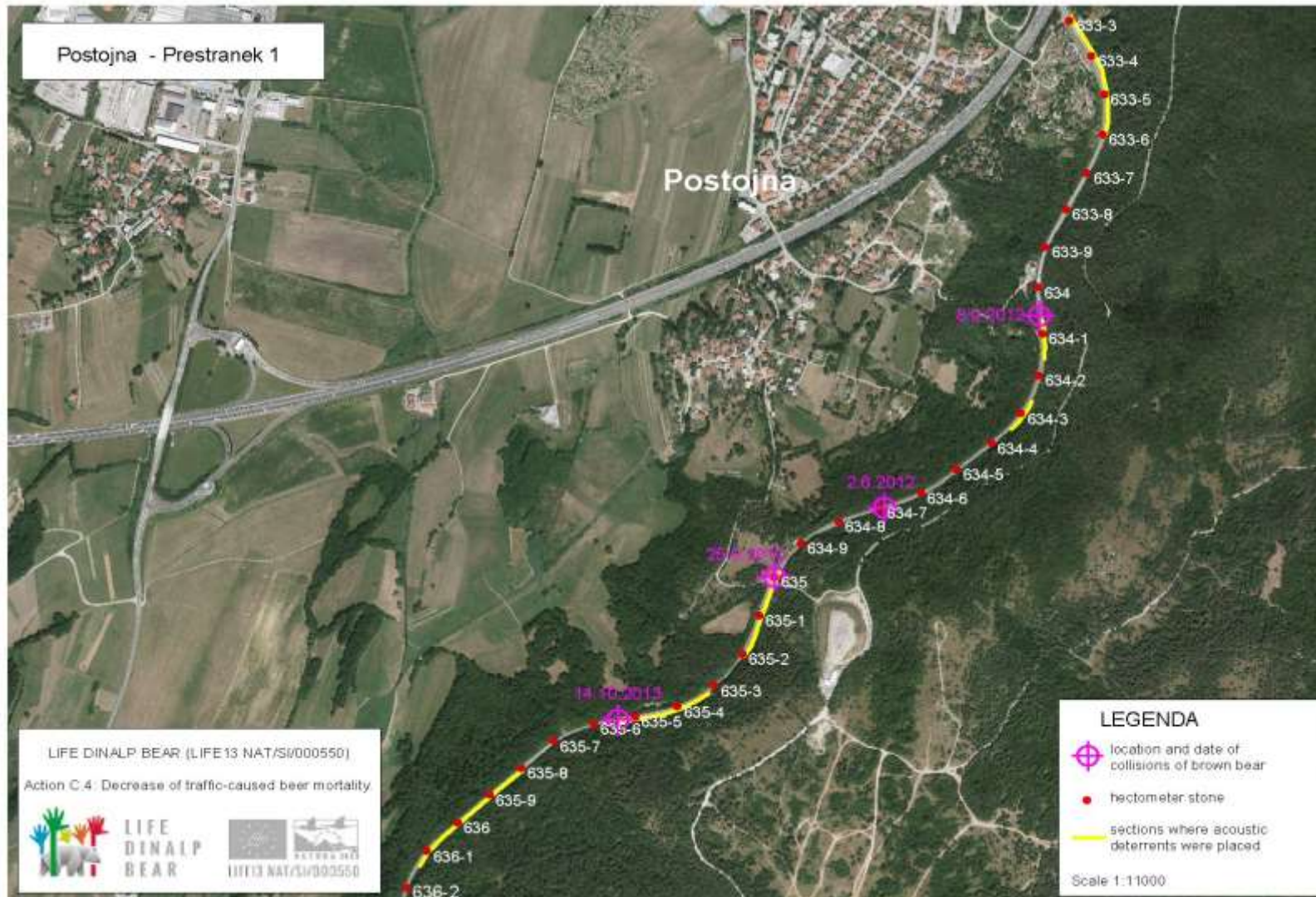


Figure 10: Selected section of the railway Postojna - Prestranek with locations of the traffic related bear mortality, dates of collisions and sections equipped with acoustic deterrents.

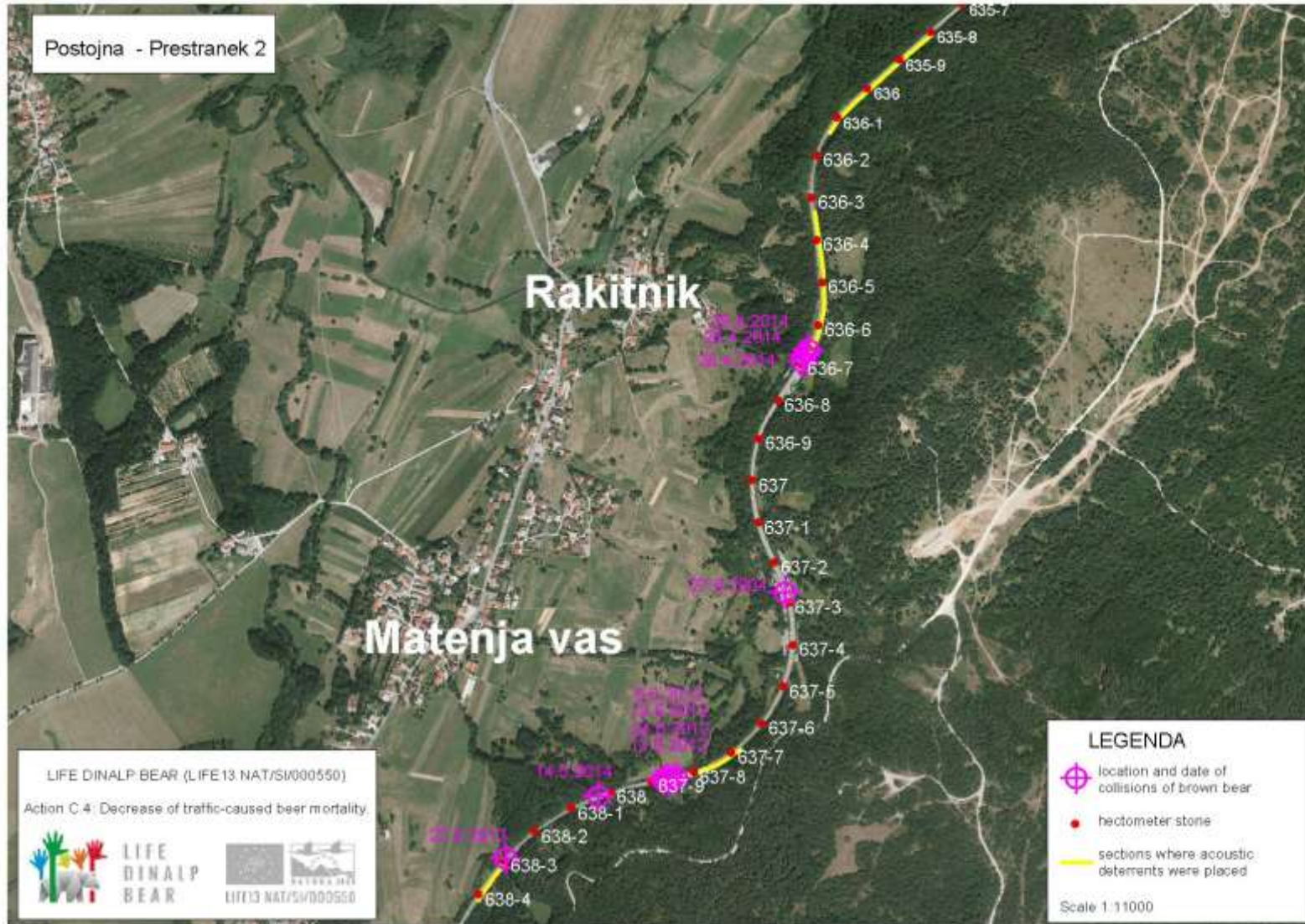


Figure 11: Selected section of the railway Postojna – Prestranek with locations of the traffic related bear mortality, dates of collisions and sections equipped with acoustic deterrents.

2.3 INSTALATION OF ACUSTIC DETERRENENTS ALONG SELECTED MAIN ROAD SECTIONS

Acoustic deterrents (ultra- and infrasound emitting electronic devices coupled with sensors activating the sound by the approaching vehicle) were installed directly into the roadside trafficators/pillars along the 'black-spots' considering bear-vehicle collisions along the main road Ljubljana – Kočevje (Figures 13-16). In total, app. 7.5 km of roads are protected by 240 acoustic deterrents (Table 1).

Table 1: Road sections where acoustic deterrents were implemented (main road Ljubljana – Kočevje)

Number	Road	Section 1	Section 2	Length	No. of deterrents
1 Nove Ložine	106/0263	13.6	15.5	1.9 km	63
2 Gornje Ložine	106/0263	10.5	12.3	1.8 km	55
3 Ortnek	106/0262	9.1	11.5	2.4 km	73
4 Turjak	106/0261	14.2	15.6	1.3 km	49



Figure 12: Acoustic deterrents installed along the main road Ljubljana – Kočevje (photo: M. Zaluberšek, 2016).



Figure 13: Selected road section along main road Ljubljana – Kočevje (between Ortnek and Žlebič), where acoustic deterrents are installed. Blue triangles represent dynamic traffic signs.

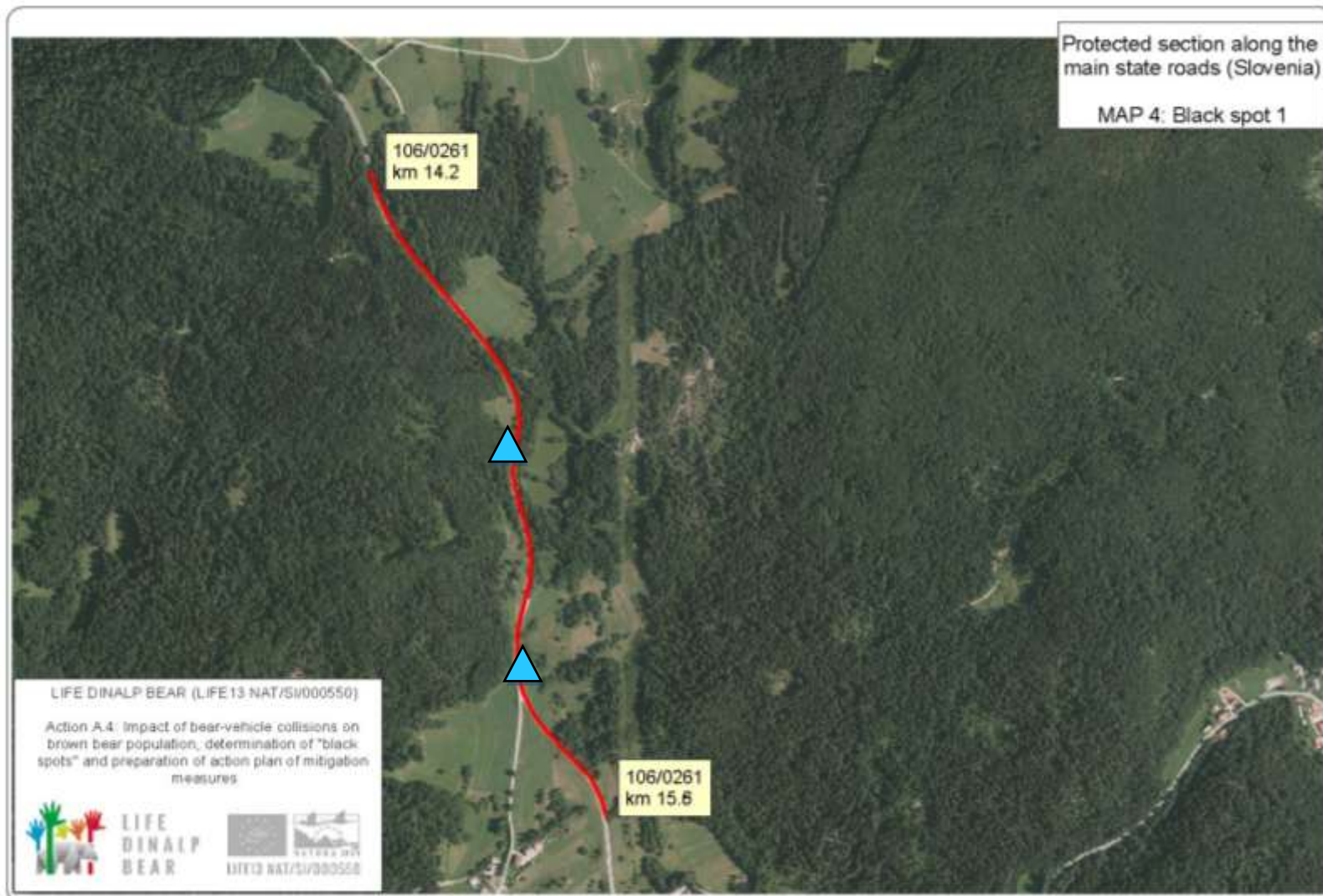


Figure 14: Selected road section along main road Ljubljana – Kočevje (near Rašica and Turjak), where acoustic deterrents are installed. Blue triangles represent dynamic traffic signs.

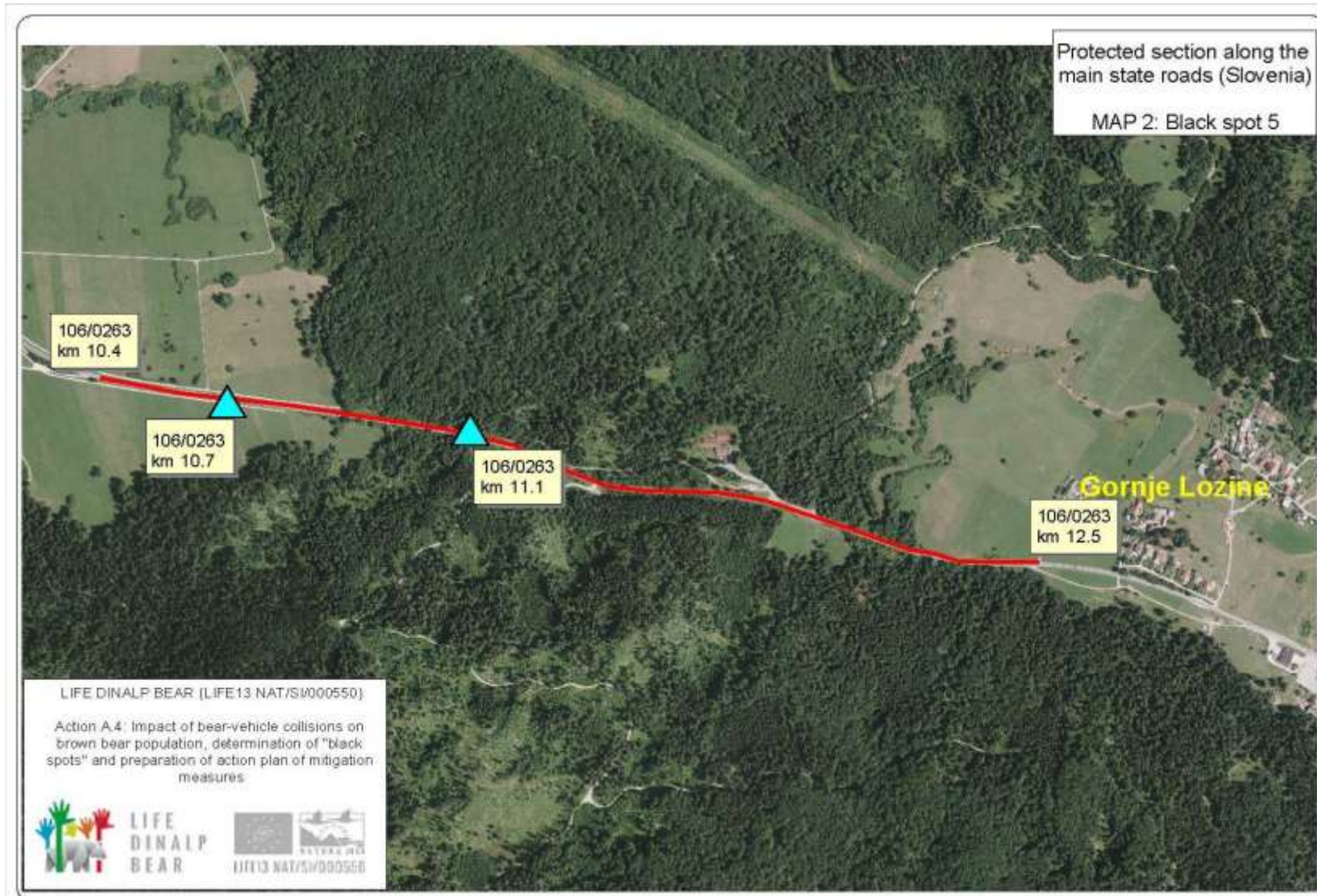


Figure 15: Selected road section along main road Ljubljana – Kočevje (Jasnica), where acoustic deterrents are installed. Blue triangles represent dynamic traffic signs.

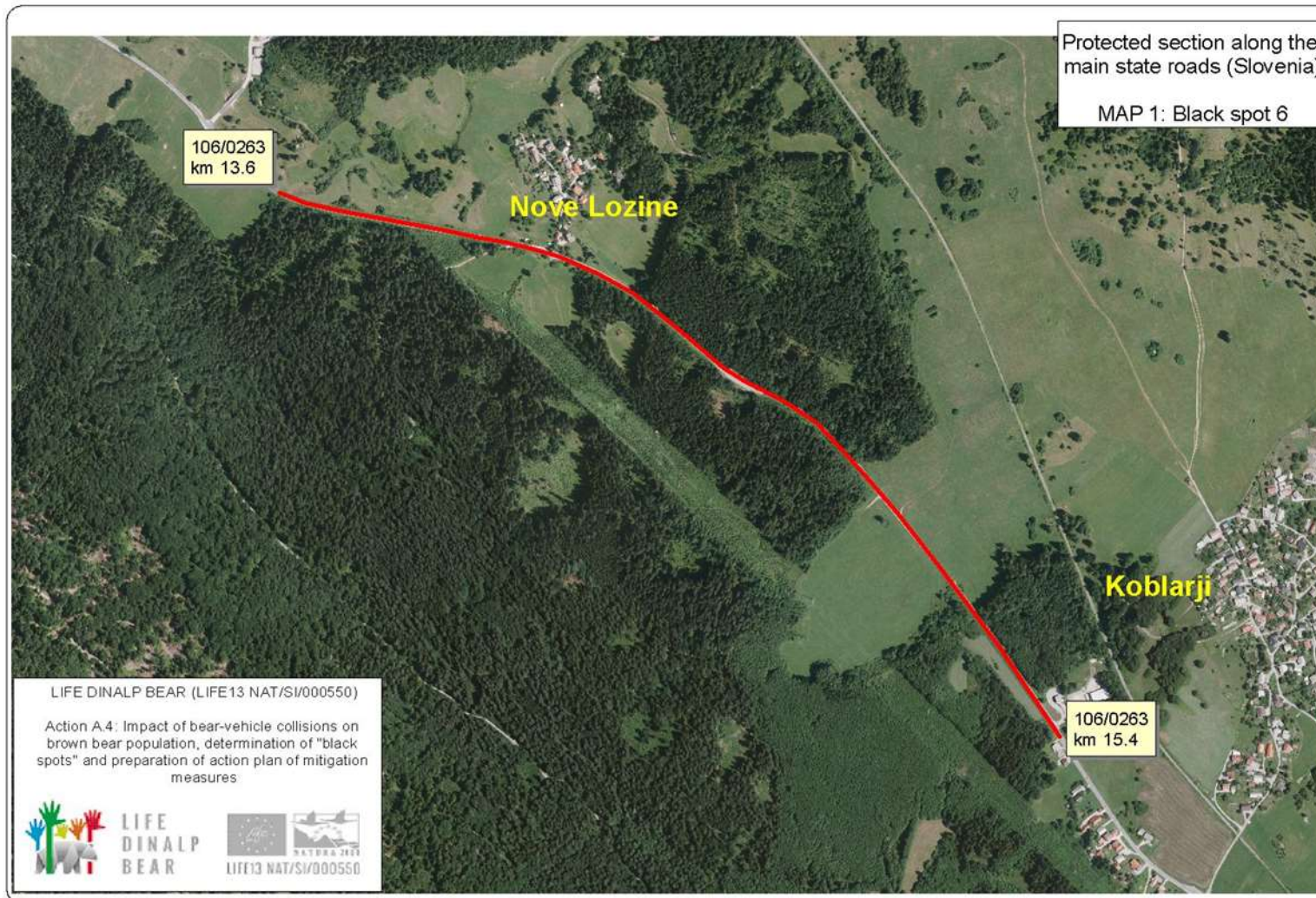


Figure 16: Selected road section along main road Ljubljana – Kočevje (near Nove Lozine), where acoustic deterrents are installed.

3 MONITORING OF THE EFFECTIVENESS OF MITIGATION MEASURES

3.1 MEASURING THE SPEED OF VEHICLES IN 2015

We have measured the speed of vehicles to allow comparison of speed of different type of vehicles before installation of dynamic traffic signs and after installation. 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 November 2015 (12:00) and 23 November 2015 (12:00) (before installation of dynamic traffic signs on this road section) (Grebenc, 2015). Driving direction and location of measuring device are shown on the map below (see Figures 17, 18).



Figure 17: Map of location of traffic counter and driving direction along the main road Ljubljana – Kočevje (Jasnica) near Dolenja vas.

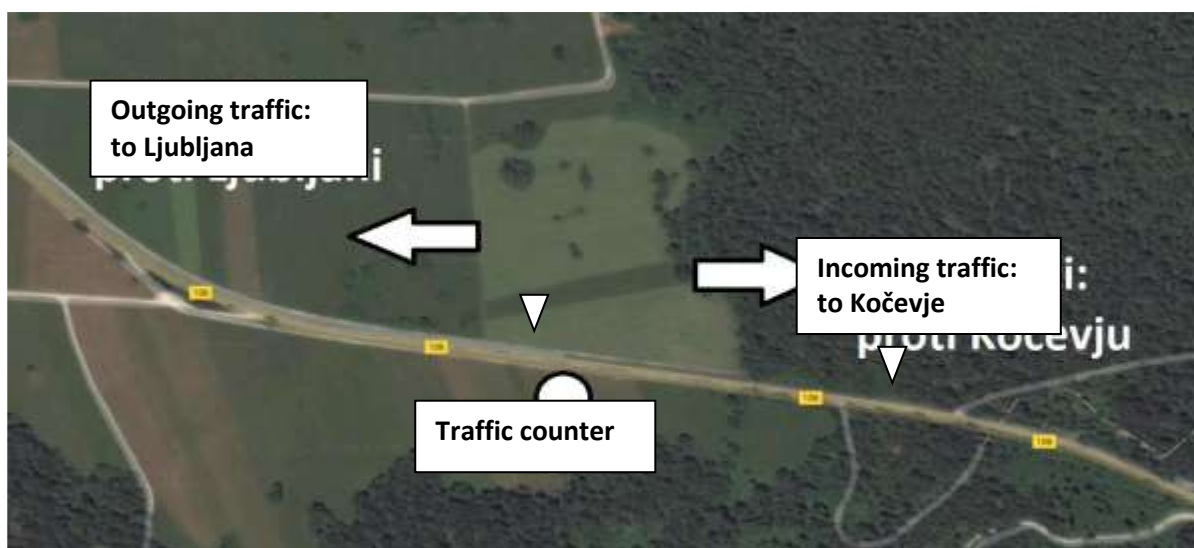


Figure 18: Location of traffic counter and direction of incoming (to Kočevje) and outgoing traffic (to Ljubljana) and location of dynamic signs (triangle), which were installed afterwards.

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 19). Speed limit in this section of the main road is 90 km/h.



Figure 19: Traffic counter placed on the pole of traffic sign near Dolenja vas (Jasnica).

Vehicles were divided into motors, cars, combined vehicles, trucks and semi-trailer. Characteristics of traffic for both directions (incoming and outgoing) are listed in the Table 2.

Table 2: 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%); then combined vehicles were 20%, while percentages of remaining types of vehicles were significantly lower.

The average speed of all vehicles was 95 km/h, and maximum speed was 226 km/h. 60% of all vehicles exceeded the speed limit (90 km/h), 31% of all vehicles have speed above 100 km/h and 6% above 120 km/h (Figure 20).

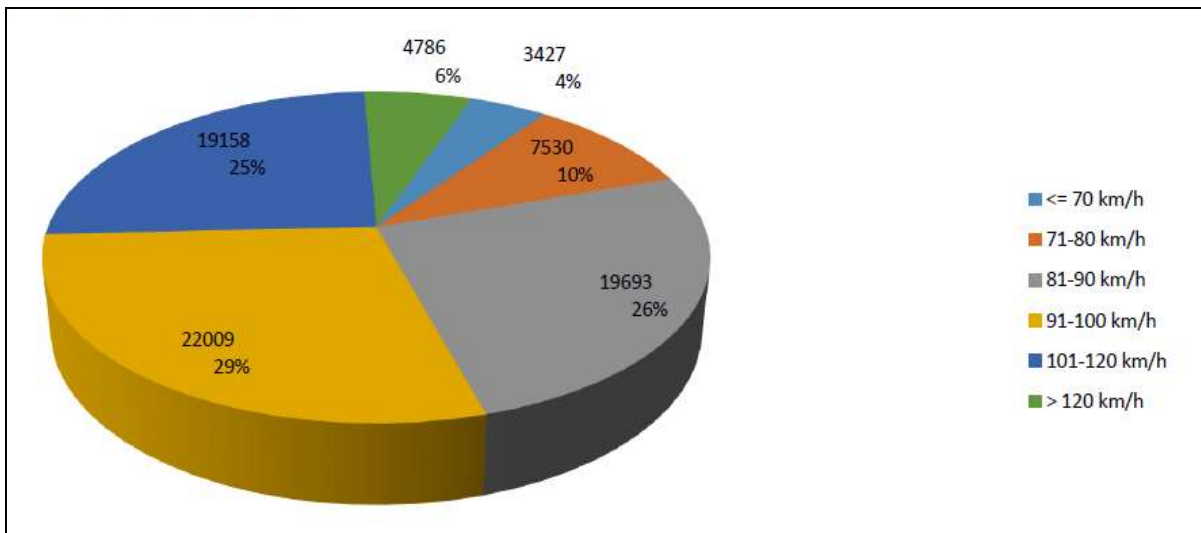


Figure 20: Percentages of vehicles, which were classified in different speed classes.

Table 3: 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 94 km/h, and maximum speed was 216 km/h. 56.6% of all vehicles exceeded the speed limit (90 km/h).

Table 4: 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 95 km/h, and maximum speed was 226 km/h. 63.4% of all vehicles exceeded the speed limit (90 km/h).

3.2 MEASURING THE SPEED OF VEHICLES IN 2016

In the year 2016, we monitored 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. Traffic counter was placed on the pole with a dynamics sign. The comparison between average speed during activation and inactivation of dynamic signs was done (Table 5, 6). We determined that at both locations (Jasnica and Ortnek) speed of vehicles, passing the active dynamic signs, was significantly lower in comparison with average speed of vehicles, passing the inactive dynamic signs. This finding was confirmed in all periods of measuring speed during inactive and active dynamics signs (Table 5 and Table 6). The reduction of speed was for app. 8 km/h (Ortnek: 77.1 km/h vs. 69.4 km/h and Jasnica: 87.6 km/h vs. 79.4 km). The reduction of speed of vehicle in year 2016 confirm the positive impact of activation of dynamic signs on driver's behaviour.

Table 5: Average speed of traffic at Ortnek when dynamic signs were active vs. inactive in 2016.

Period	Average speed (km/h)	Average speed during inactive dynamic signs (km/h)	Average speed during active dynamic signs (km/h)
27.5. - 3.6.2016	69.8	78.1	69.6
3.6. - 10.6.2016	74.9	81.2	68.8
17.6. -24.6. 016	70.4	77.8	69.6
24.6. - 1.7.2016	73.1	76.6	71.7
16.7. - 24.7.2016	71.6	77.3	70.6
24.7. - 31.7.2016	70.9	76.7	70.4
31.7. - 5. 8.2016	70.4	76.6	69.8
5.8. - 14.8.2016	71.3	77.0	70.9
26.8. - 2.9.2016	71.4	77.3	70.5
2.9 - 9. 9.2016	74.7	76.2	65.6
9.9. - 16.9.2016	73.9	76.9	71.3
16.9. - 26.9.2016	72.6	77.0	68.7
30.9. - 21.10.2016	72.2	75.9	65.0
21.10. - 16.11.2016	72.7	75.6	70.5
23.11. - 25.11.2016	74.6	76.6	69.1
2.12.-12.12. 2016	72.6	76.4	69.0
SUM	72.3	77.1	69.4

Table 6: Average speed of traffic at Jasnica when dynamic signs were active vs. inactive in 2016.

Period	Average speed (km/h)	Average speed during inactive dynamic signs (km/h)	Average speed during active dynamic signs (km/h)
30.5. - 3.6.2016	83.3	92.8	83.2
4.6. - 10.6.2016	81.5	85.4	81.4
18.6. - 24.6.2016	83.3	89.2	82.6
24.6. - 1.7.2016	83.0	86.7	81.3
1.7. - 8.7.2016	82.5	83.8	81.9
8.7. - 15.7.2016	80.5	86.6	79.6
16.7. - 24.7.2016	81.1	87.3	79.3
24.7. - 31.7.2016	85.5	85.7	74.4
31.7. - 5.8.2016	86.3	86.9	85.0
5.8. - 16.8. 2016	80.2	87.6	78.5
26.8. - 2.9.2016	76.8	85.7	75.3
2.9. - 9.9.2016	79.9	87.7	77.7
9.9. - 16.9.2016	79.6	85.7	76.1
16.9. - 26.9.2016	86.6	88.9	76.0
30.9. - 21.10.2016	89.6	91.6	79.3
21.10. - 4.11.2016	85.9	90.0	78.1
SUM	82.9	87.6	79.4

3.3 MEASURING THE SPEED OF VEHICLES IN 2017

In the year 2017, we continued with monitoring of 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. Traffic counter was placed on the pole with a dynamics sign. The comparison between average speed during activation and inactivation of dynamic signs was done. We again determined that at both locations (Jasnica and Ortnek) speed of vehicles, passing the active dynamic signs was significantly lower in comparison with average speed of vehicles, passing the inactive dynamic signs. The reduction of the speed was 7 km/h at Ortnek and 18 (!) km/h at Jasnica, respectively (Ortnek: 75.9 km/h vs. 69.0 km/h and Jasnica: 87.2 km/h vs. 69.1 km/h). The reduction of speed of vehicle in the year 2017 confirms the positive impact of activation of dynamic signs on driver's behaviour.

Table 7: Average speed of traffic at Ortnek and Jasnica when dynamic signs were active vs. inactive in year 2017.

Location / Period	Average speed (km/h)	Average speed during inactive dynamic signs (km/h)	Average speed during active dynamic signs (km/h)
Ortnek: 7.2. – 12.12.2017	71.5	75.9	69.0
Jasnica: 8.3. – 20.12.2017	81.1	87.2	69.1



Figure 21: Active dynamic sign at Jasnica (photo: Z. Pavšek, 2016).

3.4 MEASURING THE SPEED OF VEHICLES IN 2018

In the year 2018, we again continued to 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. This time the monitoring was conducted between the villages Dolenja vas and Gornje Ložine (Jasnica) and between Turjak and Rašica (Turjak). At Turjak, we monitor the effectiveness of the new, third dynamic traffic sign system. Again, we concluded that the speed of vehicles, passing the active dynamic signs was significantly lower in comparison with average speed of vehicles, passing the inactive dynamic signs. The reduction of the speed was at the first half of the year 2018 6 km/h at Jasnica and 5.5 km/h at Turjak, respectively (Jasnica: 84.9 km/h vs. 79.3 km/h and Turjak: 72.2 km/h vs. 66.6 km/h). The same as previous, the reduction of speed of vehicle in the year 2018 confirms the positive impact of activation of dynamic signs on driver’s behaviour, who became more alert to the activity on the road.

Table 8: Average speed of traffic at Jasnica and Turjak when dynamic signs were active vs. inactive in year 2018.

Location / Period	Average speed (km/h)	Average speed during inactive dynamic signs (km/h)	Average speed during active dynamic signs (km/h)
Jasnica: 15.2. – 20.7.2018	84.6	84.9	79.3
Turjak: 7.2. – 20.7.2018	69.9	72.2	66.6



Figure 22: Active dynamic sign at Turjak (photo: I. Jelenko Turinek, 2018).

3.5 MONITORING OF WILDLIFE USING CAMERA-TRAPS

3.5.1 VIDEO SURVEILLANCE IN THE YEAR 2015

Camera traps were placed at Ortnek and Jasnica before dynamic signalizations was set up in the period between 2nd November 2015 and 15th December 2015.

Table 9: Wildlife filmed during video surveillance at Jasnica between 2nd November 2015 and 15th December 2015.

Latin name	Name	Date	Time recorded	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 10: Wildlife filmed during video surveillance at Ortnek between 2nd November 2015 and 15th December 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 was done with the aim to record the occurrence of brown bear and other wildlife species in the area where sensors of dynamics signs were installed afterwards. 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. Based on this first, relatively short-lasting video surveillance in the year 2015, we concluded that the selected sections of the main road was properly selected. Therefore, the mitigation measures (implementation of dynamics signs) was expected to have positive impact on drives behaviour and will hopefully prevent traffic related mortality of large wildlife, including brown bear.



Figure 23: Photos of red deer, brown bear and roe deer, approaching the road sections on which dynamic traffic signs were implemented afterwards (left: Jasnica; right: Ortnek).

3.5.2 VIDEO SURVEILLANCE IN THE YEAR 2016

IR camera traps were placed at Ortnek and Jasnica in the direct vicinity of sensors of dynamic traffic signs in the period of five months, from March to October 2016. The following wildlife species were observed/recorded: roe deer and red fox at Ortnek; brown bear, wild boar, red deer, roe deer, red fox, European badger and European hare at Jasnica, respectively (Table 11 and 12; Figures 25, 27-34). Brown bear was observed twice very close to the main road at Jasnica (Table 11; Figure 27). Video surveillance in the year 2016 additionally confirmed that the selected sections of the main road and locations, where dynamics signs were placed, had been properly selected. Especially at Jasnica we filmed several individuals of different wildlife species in the vicinity of road; therefore, there is significant possibility for their crossing the road and for causing vehicle collisions.



Figure 24: Meadow near main road at Jasnica, where camera was placed and wildlife was frequently detected (arrows indicate sensors in wooden stumps capable to detect large animals approaching the roadways) (photo: S. Al Sayegh Petkovšek, 2016).



Figure 25: Images captured by the camera at Jasnica (left) and Ortnek (right) (arrows indicate sensors).

Table 11: Wildlife filmed during video surveillance at Jasnica in 2016 (17th March 2016 to 16th June 2016; 13th July 2016 to 12th September 2016).

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	15.8.2016	21:54:42 - 22:19:08	1
		4.9.2016	21:25:49	1
<i>Sus scrofa</i>	wild boar	19.8.2016	22: 28:17	1
<i>Cervus elaphus</i>	red deer	21.3.2016	21:50:48	1 hind
		22.3.2016	02:54:05 - 12''	1 stag
		22.3.2016	04:12:43	1 stag
		28.3.2016	00:16:51 - 55''	1
		29.3.2016	03:23:17 - 03:26:28	1 stag
		30.3.2016	00:49:00	1 stag
		14.7.2016	03:51:52 - 56''	1 stag
		16.7.2016	02:47:24 - 02:48:32	1 stag
		16.7.2016	04:25:56 - 04:27:05	1 stag
		19.7.2016	23:05:41 - 23:09:37	1 stag
		23.7.2016	22:28:53 - 22:29:57	1 stag
		26.7.2016	02:15:49 - 01:30:21	3 (1 hind + 2 calf)
		28.7.2016	21:24:45	2 hind + calf
		3.8.2016	00:53:04 - 02:11:17	2 hind
		3.8.2016	23:27:03 - 10''	2 hind
		4.8.2016	00:08:06 - 00:09:18	1 hind
		4.8.2016	00:11:10 - 01:41:12	2 hind + calf
		4.8.2016	02:36:46	2 hind
		9.8.2016	00:18:00 - 03''	1 hind
		10.8.2016	21:39:46 - 21:40:53	1 hind
		13.8.2016	00:43:39 - 42''	1 hind
		18.8.2016	01:13:00 - 01:15:23	1 hind
		20.8.2016	22:40:21 - 22:41:40	1 stag
		22.8.2016	23:32:37 - 23:42:23	3 (hind, stag, calf)
23.8.2016	23:37:10 - 23:39:3	2 hind		
24.8.2016	01:02:01 - 08''	2 hind		
<i>Capreolus capreolus</i>	roe deer	19.3.2016	05:47:33 - 36''	1 doe
		27.3.2016	05:39:17	1 buck
		30.3.2016	22:33:10 - 22:40:32	1 doe
		5.4.2016	19:17:06 - 33''	1 buck
		10.4.2016	21:07:48 - 21:08:07	1 buck
		17.4.2016	04:47:27	1 buck
		17.4.2016	20:11:01	1 buck
		18.4.2016	19:21:19	1
		20.4.2016	06:14:11 - 13''	1 doe
		26.4.2016	23:42:14	1
		28.4.2016	01:20:43 - 47''	1 buck
		28.4.2016	do 02:53:48	1 buck
		19.6.2016	22:00:17	1 doe
		29.6.2016	21:45:56	1 doe
		9.7.2016	21:46:00	1
		15.7.2016	20:51:22 - 20:54:30	1 doe

Table 11: continuation

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Capreolus capreolus</i>	roe deer	15.7.2016	22:08:27 - 31''	1 buck
		18.7.2016	06:05:26 - 28''	1 doe
		24.7.2016	06:04:01 - 03''	2 doe
		29.7.2016	05:49:22	1 buck
		30.7.2016	20:16:19	1 buck
		31.7.2016	05:38:20	1 doe
		31.7.2016	07:31:00	1 doe
		1.8.2016	05:33:24	2 (buck +)
		2.8.2016	20:23:49	1 doe
		2.8.2016	20:34:39 - 45''	2 doe + buck
		5.8.2016	06:39:33 - 06:49:12	1 doe
		7.8.2016	06:16:19 - 22''	1 doe
		7.8.2016	07:54:40 - 45''	1 buck
		9.8.2016	06:17:39	1 buck
		12.8.2016	05:48:02 - 05''	1 doe
		12.8.2016	06:10:23	1 doe
13.8.2016	04:51:54 - 04:52:01	1 buck		
10.9.2016	06:26:54	1 buck		
<i>Vulpes vulpes</i>	red fox	20.3.2016	00:04:17 - 00:27:19	1
		23.3.2016	21:46:41	1
		26.3.2016	22:40:41 - 22:44:47	1
		28.3.2016	19:12:41	1
		1.4.2016	03:25:19 - 54''	1
		7.4.2016	01:05:43	1
		15.8.2016	04:27:55	1
		16.8.2016	21:00:21	1
		17.8.2016	04:56:41	1
		10.9.2016	05:58:35	1
<i>Meles meles</i>	European badger	19.3.2016	04:26:02	1
		22.3.2016	19:22:04	1
		24.3.2016	23:15:23 - 26''	1
		2.4.2016	22:24:47 - 54''	1
		10.4.2016	20:58:05	1
		16.4.2016	19:12:06	1
		21.4.2016?	04:13:17	1
		22.4.2016	03:53:04	1
		22.4.2016	22:18:31	1
26.4.2016	22:23:11	1		
<i>Martes sp.</i>	marten	8.4.2016	03:09:17 - 20''	1
<i>Lepus europeus</i>	European hare	21.7.2016	00:59:14	1



Figure 26: Data collection from cameras at Ortnek (photo: S. Al Sayegh Petkovšek, 2016).

Table 12: Wildlife filmed during video surveillance at Ortnek in 2016 (17th March 2016 to 16th June 2016; 13th July 2016 to 12th September 2016).

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	/	/	/
<i>Sus scrofa</i>	wild boar	/	/	/
<i>Cervus elaphus</i>	red deer	/	/	/
<i>Capreolus capreolus</i>	roe deer	21.4-14.6.2016*	no data available	3 (doe with fawns)
		21.4-14.6.2016*	no data available	2 (doe with fawn)
		24.3.2016	21:21:33	1 buck
		18.8.2016	21:38:28	1 buck
		19.8.2016	23:26:00 - 07''	1 buck
		20.8.2016	06:13:05	1 buck
		20.8.2016	22:24:32	1 buck
		21.8.2016	02:49:32	1 buck
		23.8.2016	06:05:52	1 buck
		23.8.2016	00:12:59	1 buck
24.8.2016	03:42:30	1 buck		
<i>Vulpes vulpes</i>	red fox	2.4.2016	20:05:34	1
		4.4.2016	19:59:59	1
		6.4.2016	20:22:03	1

Note: *: no data.



Figure 27: Brown bear filmed at Jasnica on 15th August 2016 and on 4th September 2016.



Figure 28: Wild boar filmed on 19th August 2016 (above) and European badger (below) filmed on 19th March 2016 at Jasnica.



Figure 29: Red deer stags filmed on 16th July 2016 and 20th August 2016 at Jasnica.



Figure 30: Red deer hinds filmed on 3rd August 2016 and 4th August 2016 at Jasnica.



Figure 31: Red deer hind with calves filmed on 4th August 2016 at Jasnica.



Figure 32: Roe deer filmed on 7th August 2016 and on 18th July 2016 at Jasnica.



Figure 33: Red fox and marten filmed on 15th August 2018 and 8th April 2016 at Jasnica.



Figure 34: Roe deer doe with fawn filmed at Ortnek (dates on photos are not correct).

3.5.3 VIDEO SURVEILLANCE IN THE YEAR 2017

IR camera traps were placed at Ortnek and Jasnica near sensors in the period of eight months from April to November 2017. In year 2016, we filmed large number of individuals of different wildlife species in the vicinity of the road at Jasnica; therefore, we selected another location in 2017 in very close vicinity of first IR camera (Jasnica II: forest). The following wildlife species were observed/recorded at Jasnica I and Jasnica II in 2017: wild boar, red deer, roe deer, red fox, European badger, European hare and squirrel (Table 13 and 14; Figures 36-48). On the other hand, in this year we did not record any wildlife during the video surveillance at Ortnek due to technical problems with IR camera.

Table 13: Wildlife filmed during video surveillance at Jasnica II (forest) in 2017 (4th April 2017 to 8th August 2017).

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	/	/	/
<i>Sus scrofa</i>	wild boar	12.5.2017	03:14:03	1
		19.5.2017	23:26:40 – 47''	1
<i>Cervus elaphus</i>	red deer	18.4.2017	21:56:31-39''	1 stag
		19.4.2017	17:23:18 – 21''	1 stag
		19.4.2017	19:14:08 – 11''	1 stag
		22.4.2017	02:27:02 – 06''	1 stag
		22.4.2017	02:34:21 – 27''	1 hind
		22.4.2017	02:38: 57 till 02:39:91	1 stag
		24.4.2017	00:04:30 – 38''	1 hind
		24.4.2017	21:12:10 – 13''	1 hind
		10.5.2017	23:45:11 – 15''	1 hind
		11.5.2017	21:41:20 – 27''	1 hind
		19.5.2017	01:16:57	1 hind
		21.5.2017	01:37:31 – 38''	1 stag
		23.5.2017	21:26:43 – 47''	1 stag
		24.5.2017	20:43:50; 20:44:29 – 36''	1 stag
		1.6.2017	21:27:50 – 57''	1 stag
		1.6.2017	21:28:10 – 58''	1 stag
		7.7.2017	23:36:36	1 stag
		9.7.2017	02:42:05 – 12''	1 hind
		14.7.2017	02:24:09 –18''	1 stag
24.7.2017	04:13:15 – 22''	1 stag		
31.7.2017	02:00:29 – 36''	1 stag		
1.8.2017	01:00:52 – 59''	1 stag		
2.8.2017	02:00:43 – 51''	1 stag		
4.8.2017	03:32:02 – 09''	1 stag		
5.8.2017	01.25.12 – 16''	1 stag		
<i>Capreolus capreolus</i>	roe deer	9.4.2017	20:53:41 – 45''	1 buck
		10.4.2017	23:02:16 – 20''	1 buck
		15.4.2017	19:36:42 – 46''	1 doe
		23.4.2017	20:28:13 – 16''	1 buck
		26.4.2017	06:18:00 – 04''	1 buck
		26.4.2017	23:15:35 – 38''	1 buck
		28.4.2017	19:43:20 – 26''	1 doe
		28.4.2017	19:45:10 – 43''	1 doe

Table 13: continuation

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Capreolus capreolus</i>	roe deer	29.4.2017	05:28:59	1 doe
		30.4.2017	02:14:32	1 doe
		11.5.2017	01:20:55 – 15''	1 doe
		11.5.2017	06:24:26	1 doe
		15.5.2017	16:48:58	1 doe
		17.5.2017	21:37:17 – 24''	1 doe
		18.5.2017	21:03:09	1 doe
		26.5.2017	05:18:39	1 doe
		26.5.2017	09:07:51 – 54''	1 doe
		27.5.2017	07:32:04	1 doe + 1 buck
		1.6.2017	20:43:33 – 36''	1
		6.6.2017	06:28:47 – 52''	1 doe
		6.7.2017	00:44:56 do 00:45:00	1 doe
		21.7.2017	06:57:44 – 46''	1 buck
		28.7.2017	05:25: 20	1 doe
		31.7.2017	21:26:09 – 12''	1 buck
		4.8.2017	18:38:48 – 50''	1 doe
		6.8.2017	09:53.52 – 54''	1 buck
		6.8.2017	19:57:51	1 doe



Figure 35: Installation of IR cameras at Ortnek and sensors in wooden stumps capable to detect large animals approaching the roadway (photo: Z. Pavšek, 2017).

Table 14: Wildlife filmed during video surveillance at Jasnica I (meadow) in 2017 (7th April 2017 to 23rd November 2017).

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	17.10.2017	23:29:11 – 7'	1
<i>Sus scrofa</i>	wild boar	19.5.2017	22:57:04 – 08''	1
		11.10.2017	01:49:26 – 7'	3
<i>Cervus elaphus</i>	red deer	24.4.2017	03:25:13 – 21''	1 stag + 1
		25.4.2017	00:51:21 – 24''	1 stag
		11.5.2017	21:50:32	1 stag
		12.5.2017	02:06:19 – 23''	1 hind
		17.5.2017	22:25:01	1 hind
		3.6.2017	02:15:38	1 stag
		15.8.2017	01:58:30	1 stag
		16.8.2017	03:57:48 – 171'	1 stag
		18.8.2017	23:37:57 – 140'	1 stag
		27.8.2017	02:28:15 – 7'	1 hind
		27.8.2017	03:24:58 till 03:39:47	1 hind
		26.9.2017	22:56:41 – 30'	2 (stag and hind)
		27.9.2017	22:18:45 – 8'	1 stag
		2.10.2017	20:03:03 – 8'	1 hind
3.10.2017	19:27:07 – 71'	1 hind		
3.10.2017	23:10:08 – 7'	1 stag		
<i>Capreolus capreolus</i>	roe deer	7.4.2017	23:11:16 – 19''	1 doe
		13.4.2017	20:32:28 – 32''	1 doe
		14.4.2017	03:57:06 – 10''	1 doe
		23.4.2017	21:29:39 – 42''	1 doe
		25.4.2017	21:19:10	1 buck
		1.5.2017	02:18:48	1 doe
		5.5.2017	05:39:57 till 05:40:04	1 doe
		5.5.2017	20:07:44 – 50''	1 doe
		6.5.2017	04:50:37	1 doe
		11.5.2017	06:34:30 – 35''	1 doe
		11.5.2017	20:34:39 – 45''	1 doe
		12.5.2017	01:27:34 – 37''	1 doe
		18.5.2017	04:53:18 – 26''	1
		18.5.2017	05:03:28 – 32''	1 doe
		20.5.2017	05:37:38 – 44''	1 doe
		30.5.2017	12:07:02 – 05''	1 buck
		10.8.2017	02:19:53 – 08'	1 buck
		11.8.2017	22:12:25 – 138'	1 buck
		16.8.2017	21:05:28 – 7'	2 (doe with fawn)
		19.8.2017	21:54:04 – 8'	1 buck
		21.8.2017	06:00:49 – 7'	2 (doe and buck)
		22.8.2017	02:15:40 – 3'	1 buck
		23.8.2017	09:22:37 – 4'	1 fawn
23.8.2017	19:27:23 – 108'	2 (doe with fawn)		
24.8.2017	08:40:22	1 doe		
24.8.2017	10:38:25 – 5'	1 fawn		
24.8.2017	10:40:57 – 65'	1 doe		

Table 14: continuation

<i>Capreolus capreolus</i>	roe deer	3.9.2017	02:10:19	1 buck
		4.9.2017	07:14:07 – 4'	2 (doe with fawn)
		9.9.2017	13:47:57 till 14:04:12	2 (doe with fawn)
		11.9.2017	07:18:34	1
		12.9.2017	05:46:31	1
		13.9.2017	07:12:55 – 5'	1 doe
		26.9.2017	20:40:18 – 7'	1 doe
		27.9.2017	20:34:32	1
		30.9.2017	23:16:21	1 doe
		1.10.2017	00:52:08 – 164'	1 doe
		1.10.2017	04:54:02 – 7'	2 (doe with fawn)
		3.10.2017	22.24:50 – 7'	1 fawn
		3.10.2017	22:47:47 – 7'	2 (doe with fawn)
		4.10.2017	23:52:17 – 7'	2 (doe with fawn)
		5.10.2017	00:40:53 – 7'	1 doe
		21.10.2017	07:31:37 – 6'	2 (doe with fawn)
		31.10.2017	23:13.52 – 7'	2 (doe and buck)
8.11.2017	02:01:52	1 doe		
<i>Vulpes vulpes</i>	red fox	21.4.2017	20:52:11	1
		24.4.2017	01:22:14	1
		30.4.2017	01:23:30	1
		14.5.2017	23:25:07 – 10''	1
		8.9.2017	04:02:37 – 7'	1
		15.9.2017	05:13:57	1
		25.9.2017	02:57:48	1
		17.10.2017	19:17:16 – 7'	1
		20.10.2017	03:29:01	1
		30.10.2017	03:28:43 – 5'	1
5.11.2017	03:22:36	1		
<i>Meles meles</i>	European badger	27.4.2017	20:09:18	1
		18.5.2017	20:28:52	1
		13.8.2017	05:51:06	1
		23.8.2017	20:33:32	1
		7.9.2017	19:35:06	1
		9.9.2017	19:37:32	1
		15.9.2017	06:14:34	1
		27.9.2017	23:03:13 – 3'	1
		28.9.2017	19:49:04	1
		1.10.2017	04:47:31	1
8.10.2017	04:21:30	1		
<i>Martes sp.</i>	marten	25.5.2017	01:50:13	1
		31.5.2017	02:15:38	1
		17.8.2017	04:14:26	1
		28.8.2017	03:56:08	1
		22.11.2017	05:17:43	1
<i>Lepus europeus</i>	European hare	7.4.2017	19:57:54	1
		6.5.2017	05:35:23 – 26''	1
		7.5.2017	06:44:33	1
		8.5.2017	07:17:29	1
		10.5.2017	06:06:50 – 55''	1
<i>Sciurus vulgaris</i>	squirrel	23.4.2017	22:57:09 – 49''	1



Figure 36: Brown bear filmed on 17th October 2017 and at Jasnica I.



Figure 37: Red deer stags filmed on 2nd May 2017 and 3rd June 2017 at Jasnica I (year on photo is not correct).



Figure 38: Red deer stags filmed on 16th and 18th August 2017 at Jasnica I.



Figure 39: Red deer hinds filmed on 27th August and 3rd October 2017 at Jasnica I.



Figure 40: Roe deer doe and doe with fawn filmed on 5th May 2017 and 23rd August 2017 at Jasnica I, respectively (year on first photo is not correct).



Figure 41: Roe deer fawn filmed on 24th August and 9th September 2017 at Jasnica I.



Figure 42: Roe deer bucks filmed on 10th and 11th August 2017 at Jasnica I.



Figure 43: Wild boar filmed on 11th October 2017 at Jasnica I.



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Figure 44: European hare and marten filmed on 10th May and 17th August 2017 at Jasnica I (year on the first photo is not correct).



Figure 45: European badger and red fox filmed on 13th August and 30th October 2017 at Jasnica I, respectively.



Figure 46: Red deer stag and roe deer doe filmed on 19th and 28th April 2017 at Jasnica II.



Figure 47: Red deer stag and roe deer buck filmed on 31st July 2017 at Jasnica II.



Figure 48: Wild boar filmed on 19th May 2017 at Jasnica I (above) and Jasnica II (below) (year on the first photo is not correct).

3.5.4 VIDEO SURVEILLANCE IN THE YEAR 2018

Again, in the year 2018, we continued to monitor the animal presence near the sensors of dynamic traffic signs. This year we focused on the third location, Turjak. The filming period lasted from 23rd March to fifth Maj 2018 and from 14th June to 30th July 2018. With the IR camera traps, we again managed to record large number of individuals of different wildlife species in the direct vicinity of the road section where the third dynamic traffic sign was placed. Unfortunately, they did some timberwork at the filming location. Therefore, we managed to record only few animals in the second filming period. The following wildlife species were observed/recorded at Turjak in 2018: brown bear (most likely), roe deer, wild boar, red fox, European badger, marten, European hare and squirrel (Table 15; Figures 51-54).



Figure 49: Installation of IR camera at Turjak, near the road Ljubljana – Kočevje; location where animals, that want to cross the road at this section, usually pas (photo: I. Jelenko Turinek, 2018).



Figure 50: Location of filming with IR camera at Turjak, near the road Ljubljana – Kočevje; here animals, that want to cross the road, usually pas (photo: IR camera, 2018).

Table 15: Wildlife filmed during video surveillance at Turjak in 2018 (23rd March to 9th May and 14th June to 30th July).

Latin name	Name	Date	Time of recording	No. of observed animals
<i>Ursus arctos</i>	brown bear	6.4.2018*	23:25:46*	1*
<i>Capreolus capreolus</i>	roe deer	26.3.2018	22:14:48	1 buck
		28.3.2018	21:38:46	1 doe
		28.3.2018	21:42:52	1
		3.4.2018	20:28:24 – 4'	1 buck
		7.4.2018	05:38:38 – 6'	1 buck
		10.4.2018	19:06:43 – 7'	1 buck
		10.4.2018	19:40:00 – 8'	1 doe
		13.4.2018	19:32:00 – 8'	1 doe
		18.4.2018	05:25:38	1 buck
		20.4.2018	19:47:30 – 7'	1 doe
		21.4.2018	19:38:02	1 doe
		22.4.2018	04:28:54 – 7'	1 doe
		23.4.2018	18:50:03 – 4'	1 doe
		23.4.2018	19:27:41 – 7'	1 doe
		25.4.2018	19:01:15 – 6'	1 buck
		26.4.2018	19:00:59 – 8'	1
		28.4.2018	22:57:04	1
		2.5.2018	22:14:17	1
4.5.2018	06:10:57	1		
5.5.2018	19:31:07 – 3'	1 doe		
8.5.2018	04:14:52	1 doe		
15.6.2018	03:19:08	1		
3.7.2018	23:34:13 – 3'	1 doe		
<i>Sus scrofa</i>	wild boar	31.3.2018	18:43:36	1
<i>Vulpes vulpes</i>	red fox	3.4.2018	04:48:19	1
		4.4.2018	19:47:39	1
		18.4.2018	06:28:19 – 3'	1
		21.4.2018	22:36:19	1
		30.4.2018	01:25:42	1
		1.5.2018	19:08:17	1
<i>Meles meles</i>	European badger	31.3.2018	23:28:12	1
		2.4.2018	21:06:13	1
		3.4.2018	23:33:47	1
		4.4.2018	01:48:11 – 127'	1
		5.4.2018	00:51:50	1
		6.4.2018	23:14:31	1
		8.4.2018	20:47:28	1
		18.4.2018	23:22:30	1
		20.4.2018	00:52:36	1
27.4.2018	23:49:07	1		
<i>Martes sp.</i>	marten	3.4.2018	20:37:27 – 8'	1
<i>Lepus europeus</i>	European hare	9.4.2018	00:02:23	1
<i>Sciurus vulgaris</i>	squirrel	10.4.2018	07:57:46 – 5'	1

Note: * - bad picture, but most likely bear.



Figure 51: Brown bear (most likely) and a small wild boar filmed on sixth of April and 31st March 2018 at Turjak.



Figure 52: Roe deer buck filmed on seventh and 25th April 2018 at Turjak.



Figure 53: Roe deer doe filmed on 13th and 23rd April 2018 at Turjak.



Figure 54: Red fox and a marten filmed on 18th and 3rd April 2018 at Turjak, respectively.

3.6 TRAFFIC RELATED WILDLIFE MORTALITY AT SELECTED MAIN ROAD AND RAILWAY SECTIONS

The traffic related bear mortality at protected main road and railway sections is presented in Table 16 and 17. During five years (from 2011 to 2015), before countermeasures were implemented, nine bears were road killed at relevant sections of main road Ljubljana - Kočevje (locations presented on Figures 13 to 16) which on average amounts 1.8 mortality bear cases per year (Table 16). Afterwards, when acoustic deterrents were installed in 2016 and dynamic traffic signs were placed near the most problematic road sections or “hot spots” (at the end of 2015 and at the end of 2017), the bear mortality on mentioned road sections declined to 1 or 0 bears per year. This means that the reduction to 0.7 road mortality cases per year is so far more than 50 %. One bear was road killed near Žlebič in 2016 (Figure 56) and another in 2017 (Figure 57). Both mortality cases happened south from the dynamic traffic sign system, so not in the area of this system, which indicates to the effectiveness of the dynamic traffic signs.

In the period 2011 to 2015, before installation of acoustic deterrents, 15 mortality cases (on average 3 per year) of brown bears were registered at relevant railway sections between Ljubljana and Pivka (locations presented on Figures 9 to 11). At the end of 2015, countermeasures were implemented, and the result was favourable, since the reduction of the bear railway mortality was more than 50 %. Before, the railway mortality was 0 to 8 bears per year, after the implementation, the mortality was 0 to 2 animals per year (1.3 on average); see Table 17. In 2016, two bears were killed on the railway section Rakek - Postojna and one in 2017 (Figure 58). At the second protected railway section only one bear was killed and that was in 2018 (Table 17; Figure 59).

Table 16: Traffic related bear mortality at protected sections of main road Ljubljana – Kočevje (Al Sayegh Petkovšek *et al.* 2015, 2016, 2017; OSLIS, 2017; ZGS, 2018).

Year	2011	2012	2013	2014	2015	2016	2017	2018
Rašica -Turjak (Figure 14)	0	1	0	1	0	0	0	0
Ortnek - Žlebič (Figure 13)	0	1	0	0	0	1	1	0
Jasnica (Figure 15)	1	1	0	0	1	0	0	0
Novo Lozine - Kobljarji (Figure 16)	0	1	0	2	0	0	0	0
SUM	1	4	0	3	1	1	1	0

Table 17: Traffic related bear mortality at protected sections of railway Rakek – Postojna and Postojna – Prestranek (Al Sayegh Petkovšek *et al.*, 2015, 2016, 2017; OSLIS, 2017; ZGS, 2018).

Year	2011	2012	2013	2014	2015	2016	2017	2018
Postojna – Prestranek (Figure 10, 11)	0	6	2	4	0	0	0	1
Rakek – Postojna (Figure 9)	1	2	0	0	0	2	1	0
SUM	1	8	2	4	0	2	1	1

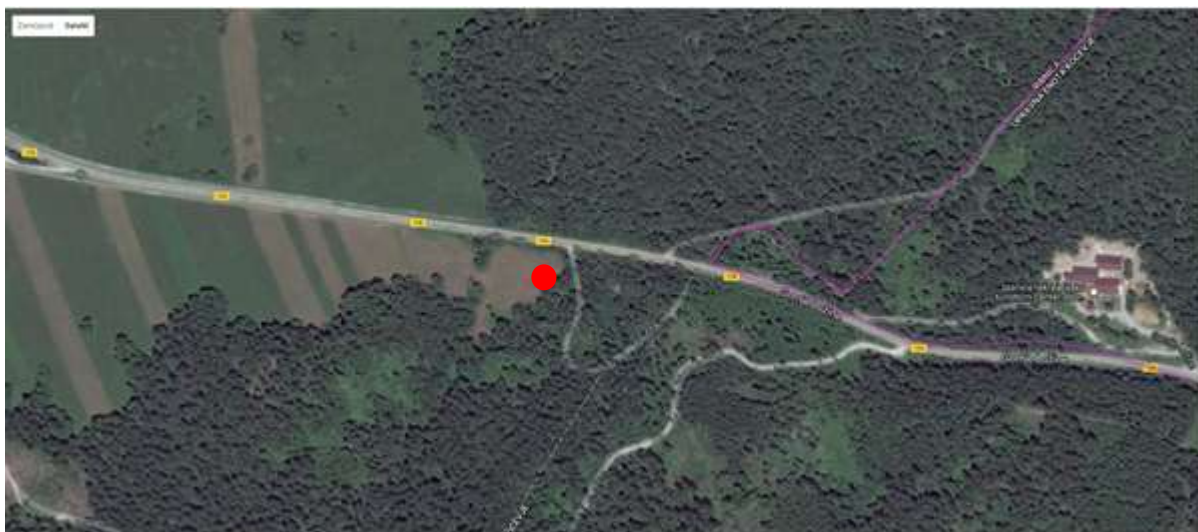


Figure 55: Location of traffic related bear mortality near Jasnica (main road Ljubljana – Kočevje) in 2015 – BEFORE acoustic deterrents were installed. Red dot means the location of found bear/carcass.



Figure 56: Location of traffic related bear mortality at Ortnek, Žlebič (29th September 2016) – with acoustic deterrents protected section of main road Ljubljana – Kočevje. Red dot means the location of found bear/carcass.



Figure 57: Location of traffic related bear mortality at Ortnek, Žlebič (26th October 2017) – with acoustic deterrents protected section of main road Ljubljana – Kočevje. Red dot means the location of found bear/carcass.



Figure 58: Location of traffic related bear mortality near Rakek (9th August and 10th December 2016 and 4th May 2017) – with acoustic deterrents protected section of the railway Rakek – Unec. Red dot means the location of found bear/carcass. Green dot means the bear mortality case at NOT protected railway section.



Figure 59: Location of traffic related bear mortality near Rakitnik, Prestranek (24th February 2018) – with acoustic deterrents protected section of main road Ljubljana – Kočevje. Red dot means the location of found bear/carcass.

4 CONCLUSIONS

Based on this report of the monitoring of the effectiveness of mitigation measures done to prevent bear vehicle collision the following conclusions are made so far:

- (i) In year 2016, the reduction of speed of vehicles, which pass activated dynamics signs, was app. 8 km/h at both measuring locations (Ortnek: 77.1 km/h vs. 69.4 km/h and Jasnica: 87.6 km/h vs. 79.4 km/h). In 2017, this reduction was even more pronounced: 7 km/h at Ortnek and 18 km/h at Jasnica (Ortnek: 75.9 km/h vs. 69.0 km/h and Jasnica: 87.2 km/h vs. 69.1 km/h). In the first half of the year 2018, this reduction was app. 6 km/h at Jasnica and 5.5 km/h at Turjak, respectively (Jasnica: 84.9 km/h vs. 79.3 km/h and Turjak: 72.2 km/h vs. 66.6 km/h). The observed reduction of speed of vehicles in years 2016, 2017 and 2018 confirms the positive impact of activated dynamic signs on driver's behaviour.
- (ii) IR cameras were placed at Ortnek and Jasnica near sensors coupled with dynamic signs from March to October 2016 and from April to November 2017. The following wildlife species were recorded: brown bear, wild boar, red deer, roe deer, red fox, European badger, marten, European hare and squirrel. Brown bear was first observed in the year 2015 (before installation of dynamic signs) at Ortnek on one occasion. Than in 2016 it was observed twice very close to the main road at Jasnica. On the same location (Jasnica) it was one time again observed in 2017. In 2018, brown bear was also observed very close to the road at Turjak. Video surveillance in last four years (2015, 2016, 2017 and 2018) confirmed that the selected sections of the main road and locations, where dynamics signs were placed, had been properly selected. Especially in Jasnica we filmed a high number of wildlife in the vicinity of the road.
- (iii) All together three traffic related bear mortality were recorded at protected sections of railway Rakek – Postojna; namely two in year 2016 and one in year 2017. One casualty was also at protected section of railway Postojna – Prestranek in 2018. In year 2016 one traffic related bear mortality was recorded at the main road Ljubljana Kočevje (near Ortnek) and one in 2017. In the period before installation of acoustic deterrents (from 2011 to 2015), 9 mortality cases (1.8 per year) of brown bears were registered at relevant sections of main road Ljubljana - Kočevje and 15 mortality cases (3 per year) of brown bears at relevant railway sections between Ljubljana and Pivka. This means that the reduction to 0.7 road mortality cases per year and to 1.3 railway mortality cases per year is so far more than 50 %. Therefore, the effectiveness of mitigation measures at state roads and railway is in accordance with our expectations.

5 REFERENCES

- Al Sayegh Petkovšek, S., Pokorny, B., Pavšek, Z., Jerina, K., Krofel, M., Ličina T., 2015. Action plan for the implementation of mitigation measures for reducing road mortality of brown bear in Slovenia. Action plan prepared within A.4 action of the LIFE DINALP BEAR (LIFE13 NAT/SI/000550): 40 p.
- Al Sayegh Petkovšek, S., Pavšek, Z., Pokorny, B., 2015. Monitoring of the effectiveness of mitigation measures in Slovenia. Action D2: Evaluating (monitoring) of the effectiveness of mitigation measures implemented to prevent traffic related bear mortality; LIFE DINALP BEAR (LIFE13 NAT/SI/000550): 19 p.
- Al Sayegh Petkovšek, S., Pavšek, Z., Pokorny, B., Jelenko Turinek, I., 2016. Monitoring of the effectiveness of mitigation measures in Slovenia. Action D2: Evaluating (monitoring) of the effectiveness of mitigation measures implemented to prevent traffic related bear mortality; LIFE DINALP BEAR (LIFE13 NAT/SI/000550): 39 p.
- Al Sayegh Petkovšek, S., Pavšek, Z., Pokorny, B., Jelenko Turinek, I., 2017. Monitoring of the effectiveness of mitigation measures in Slovenia. Action D2: Evaluating (monitoring) of the effectiveness of mitigation measures implemented to prevent traffic related bear mortality; LIFE DINALP BEAR (LIFE13 NAT/SI/000550): 48 p.
- Grebenc, M., 2015. Obdelava podatkov zajetih z napravo za štetje prometa Via count II. Intermatic d.o.o., Ljubljana.
- Kos, I., 2015. Podatki o povožu divjadi LD Velike Poljane.
- Bojc, T., 2015. Podatki o povožu divjadi LD Dolenja vas.
- OSLIS, 2017. Osrednji lovski informacijski sistem. Gozdarski inštitut Slovenije.
- ZGS, 2018. Povož medvedov v letih 2016, 2017 and 2018. Zavod za gozdove Slovenije.