ACTION A5. DESCRIPTION OF TARGET ROAD SEGMENTS, IDENTIFICATION OF CROSSING POINTS USED BY ANIMALS AND ANALYSIS OF TRAFFIC VOLUME AND SPEED

ACTION REPORT/2020 – Majella National Park

LIFE SAFE CROSSING
PREVENTING ANIMAL-VEHICLE COLLISIONS

Parco Nazionale della Majella

SUMMARY

OBJECTIVES

Action A5 is one of the preliminary Actions of the Life Project Safe-Crossing and, together with Actions A3 and A4, allows the collection of data necessary to plan the possible interventions needed in the frame of C actions. Specifically, Action A5 is preliminary to Action C1 and its main objective is to identify the road segments with highest AVC risk where to install the innovative AVC-PS devices experimented in the frame of the Life Strade. To achieve this general scope, in the Majella National Park (PNM) the following specific objectives have been pursued:

- Characterization of the selected roads
- Collection of data on road mortality along selected roads
- Assessment of traffic volume and vehicle speed along the selected roads
- Selection of the locations for AVC-PS devices
- Assessment of the use by animals of the crossing points where to install AVC-PS devices

The aim of this document is both to report activities developed and to present results of Action A5. However, to plan interventions to be realized in the frame of C actions, data collected with Action A5 have been evaluated together with results from Action A3 and A4.

STUDY AREA

PNM study area for the Life Safe-Crossing includes both roads inside and outside the Park boundary. Action A5 in PNM was foreseen to be implemented along specific segments of the roads SS487 (inside the Park), SS5, SS17 and SP84(outside the Park). However, given the availability of dedicated personnel and financial resources in the Travel costs, the actual A5 monitoring area has been extended adding new roads (SS84, SP12, SP54, SP55) and adding new segments of SS5, SS17 and SS487 as well (Table 1, Figure 1). A total of 185.3 Km have thus been monitored against the 110 foreseen in the project (Table 1).

Table 1. Roads and km/road actually monitored compared to what foreseen in Action A5 in the Majella National Park, Central Italy.

*** Entire road length**

Road code	Km foreseen in the project	Km actually monitored
SS 5	6.5	14.8
SS17	59.5	59.5
SS 84	0	5.8
SS 487	31.9	41.4
SP 12	0	22.4*
SP 54	0	8.0*
SP 55	0	21.3*
SP 84	12.1	12.1*
Total	**110.0**	**185.3**

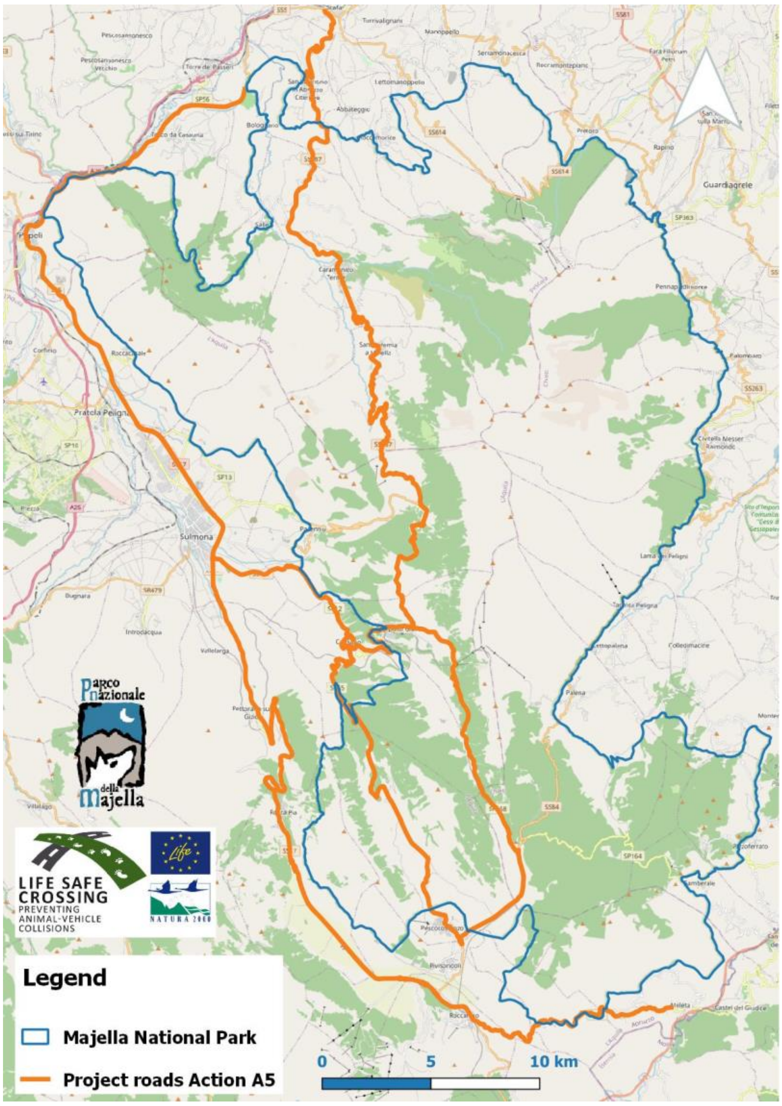

Figure 1. Roads and road segments monitored in the frame of Action A5 in the Majella National Park, Central Italy.

The objectives of implementing Action A5 in an area larger than the one reported in the Project are mainly two:

- to collect the most field data possible in order to better orientate C1 action;
- to obtain suitable data to prioritize interventions and consequently individuate both the ones to be realized during the Project and the ones to be eventually foreseen during the After-Life period.

The choice of the roads to be added is consistent with the rationale followed by PNM to draft the Project proposal which is the need to focus the implementation of interventions in the PNM portions where bear presence signs are concentrated and in the corridors used/to be used by bears to expand its range (Figure 2).

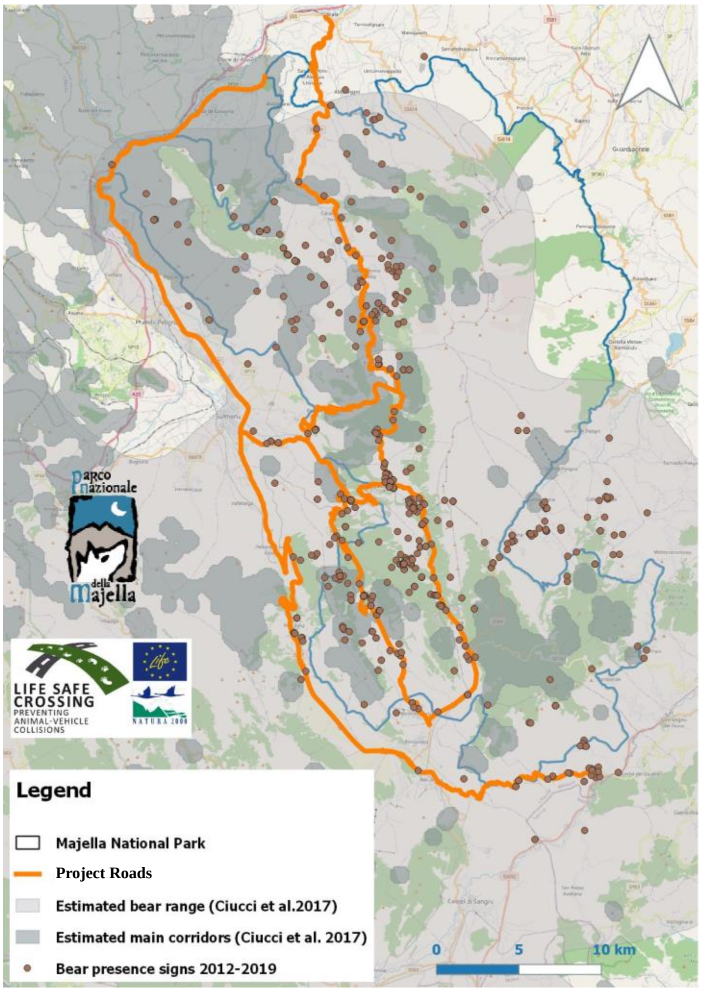

Figure 2. Roads monitored in the Majella National Park Project area in relation to the estimated bear range, the estimated suitable corridors used or to be used by the Apennine brown bear to expand its range and the bear presence signs detected in the PNM monitoring area from 2012 to 2019.

After receiving results from Action A3, no further changes have been done for Action A5 study area as the road segments with AVC/telemetry clusters were already included in the list of stretches to be monitored.

METHODS

The following methods have been applied to achieve each of the above reported specific objectives.

Characterization of the selected roads

According to methods agreed during meeting and exchanges with the partnership and the coordinating beneficiary, the following variables have been collected to characterize roads:

- Number of lanes
- Road transversal section
- Speed limit
- Localization of the wildlife-crossing warning signs
- Land use in the buffer of 400 m from each side of the road
- Localization and length of potential barriers
- Management status of the area crossed by the road

All the variables have been recorded during specific field surveys except for Land use and Management status, that were both GIS-derived. Land use has been assessed using the Corine Land Cover layer.

Given that road characterization was not restricted to 10Km stretches, as foreseen in the Project proposal, but was extended to entire roads (see Figure 1), data on barriers localization and length have been collected in order to elaborate an occlusion profile. This GIS product is a layer where an occlusion value is assigned to each 100m road stretch basing on the barriers observed during the survey. Since the same item (fence, wall, guard rail etc.) can be a barrier for one animal but not for another, the occlusion profile has to be considered a species-specific layer and criteria to assign occlusion values to each specific item need to be set. In PNM bear-specific criteria have been elaborated taking into account not only the presence of adult individuals but also the possible presence of sub-adults and cubs (Table 2).

Table 2. criteria used to assign bear-specific occlusion values to each 100m road segment in order to elaborate the Occlusion Profile of roads for the Apennine brown bear in the Majella National Park Project area.

Item	Occlusion value	Description
Underpass/Overpass	0	No occlusion no road crossing
No barrier/guardrail/wall <1m	1	No occlusion with road crossing
Wall or fence ≥1m and <1.5m	2	Low occlusion
Wall or fence ≥1.5 m and <2m	3	Medium occlusion
Wall or fence ≥2m and <2.5m	4	High occlusion
Wall or fence ≥2.5m/ urban area	5	Total occlusion

For each 100m road stretch, items occupying more than 50% of the length have been recorded separately for right and left sides and then each side has been assigned to the pertaining occlusion values. For each 100m road stretch also speed limit, number of lanes, road transversal section and management status have been recorded. Data collected have thus been used to produce two different GIS outputs:

1. The occlusion profile itself: the highest occlusion value between right and left side (total occlusion value) has been shown on the map.
2. The “road-traps” hotspots: segments having no occlusion or low occlusion on one side and medium/high/total occlusion on the other.

The first output gives an overview of road permeability by animals and allows the individuation of areas where animals can and must cross the road to go from one side to the other. This output is aimed at creating a useful tool to identify potential locations for AVC PS devices installation. The second output highlights road stretches where animals might be “trapped” on the road and thus with high AVC risk. This output is useful to evaluate the possible need of measures to prevent the “trapping” phenomenon.

Collection of data on road mortality along selected roads

To collect data on road mortality, a systematic monitoring has been implemented in all the roads included in the A5 study area (Figure 1). Particularly, the selected roads have been divided into 9 segments (transects) to be monitored individually (Table 3).

Table 3. Transects individuated to systematically monitor road mortality along the roads in the Majella National Park project area.

Road code	Transect code	Transect	Length (Km)
SS487	1	S.Valentino A.C. - Caramanico Terme (SVAC-CT)	11.5
SS487-SP54	2	Caramanico Terme - Campo di Giove (CT-CdG)	26.2
SP12	3a	Cansano – Campo di Giove (CAN – CdG)	5.1
SP12-SS84	3b	Campo di Giove – Pescocostanzo (CdG – PE)	19.1
SP55	3c	Pescocostanzo – Cansano (PE – CAN)	21.2
SS487	4	Sulmona – Cansano (SUL – CAN)	11.3
SS5 – SS17	5	Tocco da Casauria – Corfinio (TC – CORF)	16.3
SS17	6	Corfinio – Roccaraso (CORF – ROC)	47.3
SP84	7	Roccaraso – Ateleta (ROC – ATE)	12.3

Basing on methods reported in the Project proposal and indications received by the coordinating beneficiary, the following protocol has been applied:

Transect monitoring frequency: twice/month alternating monitoring weeks (i.e. first and third weeks transects are monitored, second and fourth week transect are not monitored or vice versa).

Method of inspection: transects were inspected with the car with a maximum cruise speed of 50 Km/h.

Time of inspection: transects were inspected in the morning after the sunrise but before 9:00 in order to maximize the probability to find animals hit during the early morning and to find dead animals before being removed by the road management authority.

Dead animal detection: each dead animal (excluding birds) found during the monitoring has been recorded and data have been collected according to the field sheet provided by the coordinating beneficiary.

Beyond the above-explained systematic monitoring, data on animals found dead on the Project roads have been also opportunistically collected. These kind of data have been recorded as “extra-dead”. Finally, data on animals hit by car but only wounded have been recorded as well (both systematically and opportunistically) being equally representative of the AVC risk.

Assessment of traffic volume and vehicle speed along the selected roads

Methods to assess traffic volume and vehicle speed followed the ones reported in the Project proposal and agreed with the coordinating beneficiary. For each road stretch 1 measurement/season has been planned and each measurement lasted at least 1 week in order to include both working days and week-ends. The instrument used is the Viacount II Traffic Counter, the same used in the Abruzzo, Lazio e Molise National Park.
Logistic constraints, due to battery care needs, positioning and measurements duration, impeded the monitoring of all the roads included in the A5 study area. Basing on A3 results and on the results gathered *in itinere* with the road mortality monitoring, SS5, SS17, SS487(AQ) and SS487(PE) have been monitored using 4 strategic locations (Figure 3).
The Viacount II has been positioned according to the instructions provided and has been programmed in order to achieve data on vehicles coming from both directions.
Data gathered have been also analysed on a season and daily basis and, for this last analysis, the day has been divided in 3 periods according to the method used by the road management authority for National Roads (ANAS): day time 06-20; evening 20-22; night time 22-06.

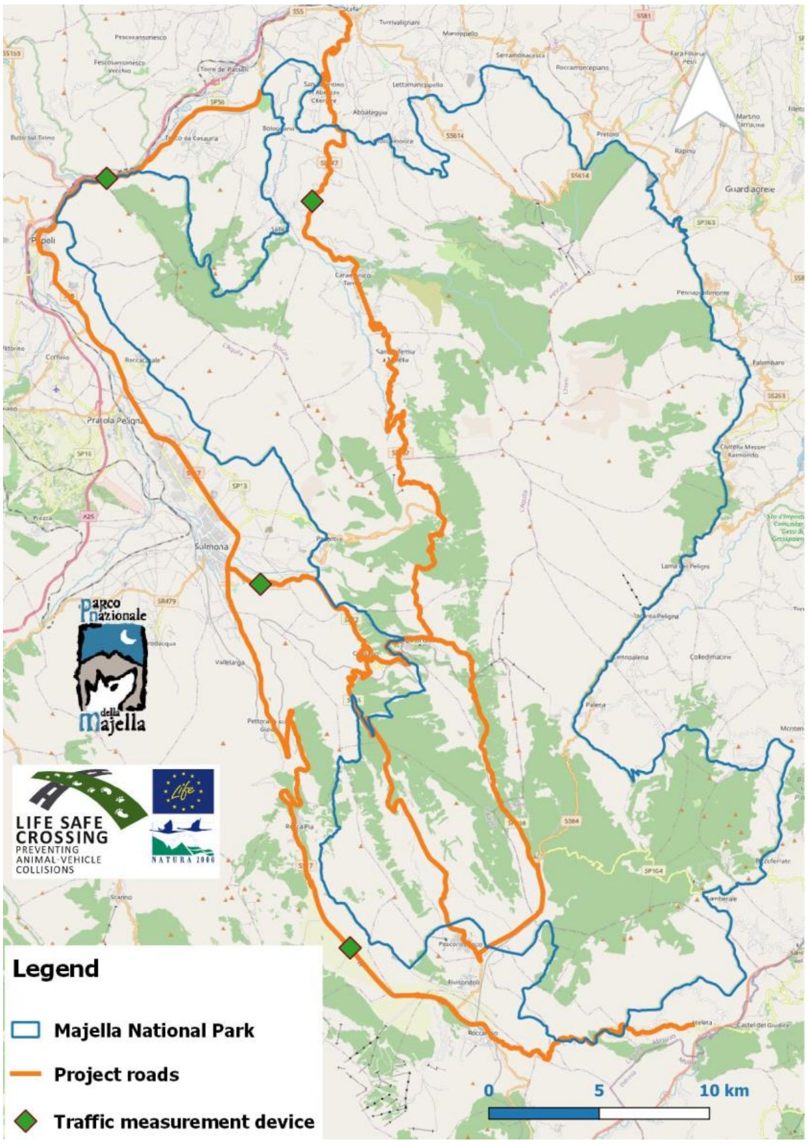

Figure 3. Traffic measurement device locations on SS5, SS17, SS487 (AQ) and SS487 (PE) in the Majella National Park Project area.

Selection of the locations for AVC-PS devices

The selection of locations where to install the AVC-PS devices followed two main steps: road stretches selection and exact location selection (Figure 4).

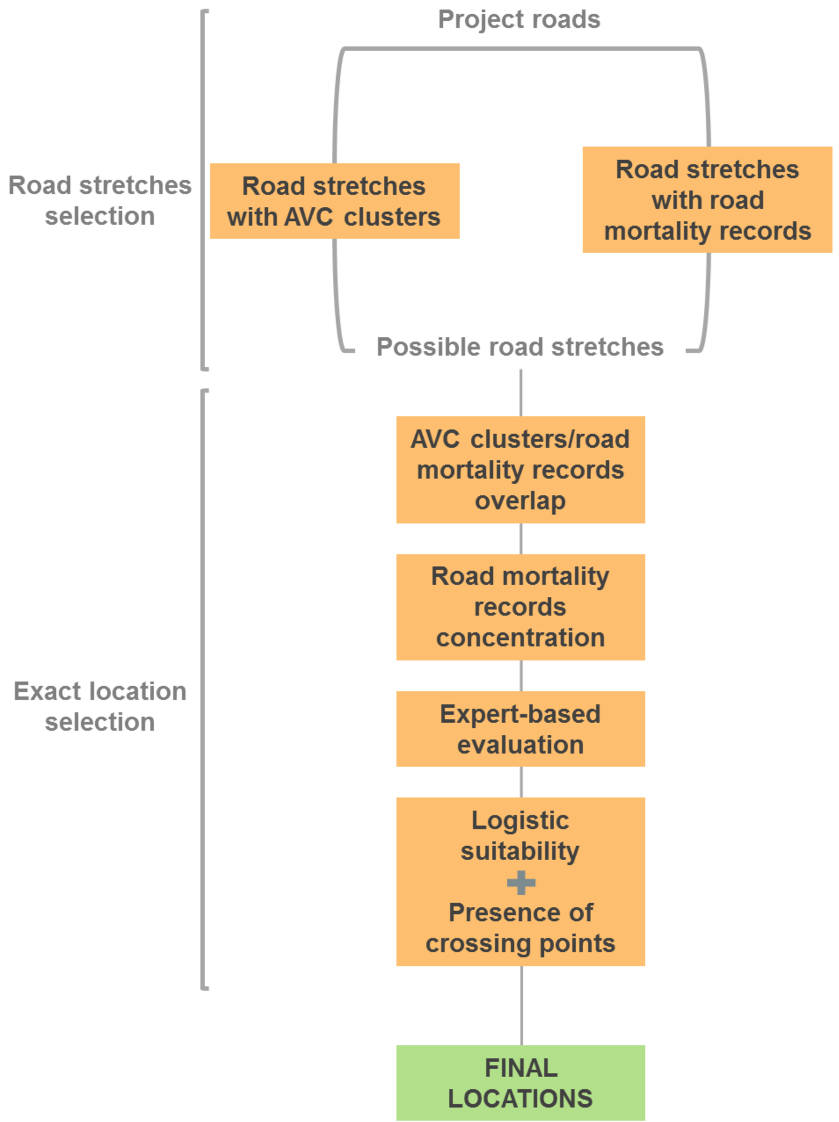

Figure 4. Method followed to select AVC-PS locations in the Majella National Park Project area.

The method used aimed at taking into account both actual AVC mortality risk and logistic constraints of devices installation. Particularly, the following procedures have been applied for each step:

- Road stretches with AVC clusters have been selected basing on the location of the extreme clusters for each road;
- Road stretches with road mortality records have been selected basing on the location of the extreme points for each road;
- Segments with AVC clusters/road mortality records overlap have been individuated;
- Segments with road mortality records concentration have been individuated;

- Additional road segments have been selected basing on an expert-based evaluation aimed at taking into account possible missing data in the A3/A5 databases;
- Field surveys have been developed in the individuated possible segments to find suitable locations where evident crossing paths used by animals were present as well.

Resulting locations have thus been selected for AVC-PS installation and, when possible, they have been monitored with camera-traps in order to assess the amount of use by animals.

Assessment of the use by animals of the crossing points where to install AVC-PS devices

Camera-trap installation in the frame of Action A5 was formerly aimed at monitoring different crossing points in a road segment in order to select the best one where to install AVC-PS devices. However, results of preliminary actions and the logistic requirements for the installation of the device actually constrained location selection, thus giving to camera trapping the main objective to verify the use by animals of the selected crossing points. As a matter of fact, in the PNM AVC-PS locations have been selected accomplishing the criterion of an evident presence of paths used by animals to cross the road so that every selected location is a used crossing point by default. However, camera trap monitoring helped verify this issue and assess how, when and by which species paths are actually used. Beyond monitoring actual use of paths in AVC-PS locations, camera trapping has also been applied to assess the use of other crossing points in order to individuate possible additional measures to be implemented in the frame of the Life or after-Life period.

Data collected with the camera trapping have been entered in the Excel database format provided by the coordinating beneficiary.

RESULTS

Characterization of the selected roads

Road characterization surveys took place both during 2019 and 2020. In summer 2019 localization of all the road signs (Figure 5) and occlusion profiles of the roads formerly included in A5 study area (SS5, SS17, SS487, SP84, see Table 1) have been completed. During 2020, in the frame of the collaboration activated with the Lazio Region for Project replicability, the intern Irene Zuchegna elaborated occlusion profiles for SP12, SP54 and SP55 thus completing the characterization of all the Project roads (Figure 6).

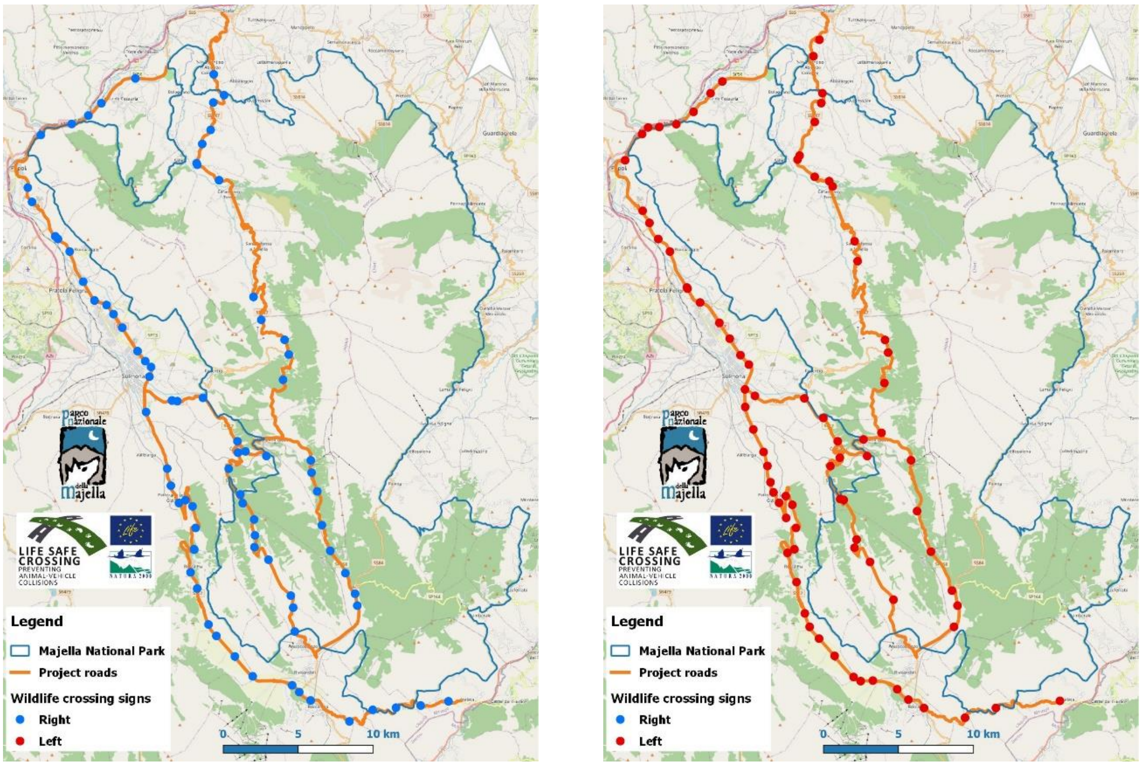

Figure 5. Localization of wildlife crossing road signs in the Project area of the Majella National Park in both directions.

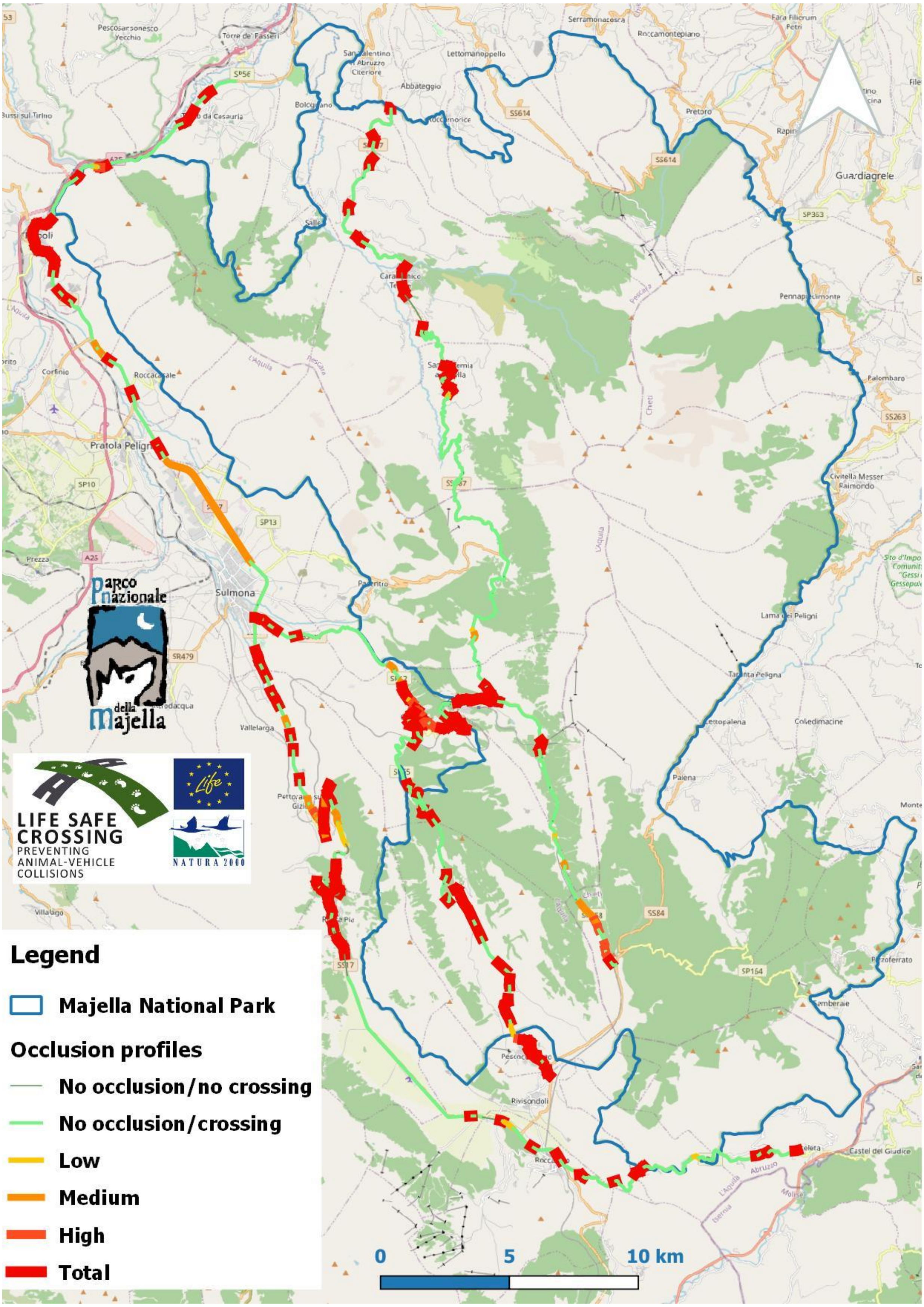

Figure 6. Occlusion profiles elaborated for all the roads monitored in the frame of Action A5 in the Project area of the Majella National Park. Barriers presence has been recorded for each 100m-length segment of each monitored road and then classified according to the total occlusion value.

Considering the overall permeability of the roads, given by the total occlusion value, the SS5, SS487, SP54 and SP84 resulted as the most permeable by bears, having a number of segments classified as no occlusion > 70%. The majority of them are no occlusion/crossing segments, meaning that to go from one side to the other bears must cross the road. Other roads still have number of no occlusion segments representing > 60% of the road so that, generally, all the project roads seem to be permeable to bears (Table 4, Figure 7).

Table 4. Overall permeability of roads in the Majella National Park Project area as resulted with the elaboration of occlusion profiles.

Road code	N segments (%)					
	No occlusion/ no crossing	No occlusion/ crossing	Low	Medium	High	Total
SS5	0	117 (73.1)	1 (0.6)	0	1 (0.6)	41 (25.6)
SS17	41 (8.7)	272 (57.7)	11 (2.3)	74 (15.7)	1 (0.2)	72 (15.3)
SS487 (PE)	25 (8)	247 (78.7)	1 (0.3)	0	5 (1.6)	36 (11.5)
SS487 (AQ)	0	40 (88.9)	0	0	0	5 (11.1)
SP12	9 (3.5)	153 (59.8)	4 (1.6)	15 (5.9)	16 (6.3)	59 (23.0)
SP54	4 (5)	69 (86.3)	1 (1.3)	1 (1.3)	0	5 (6.3)
SP55	2 (0.9)	146 (68.5)	5 (2.3)	0	1 (0.5)	59 (27.7)
SP84	0	109 (89.3)	2 (1.6)	0	0	11 (9)

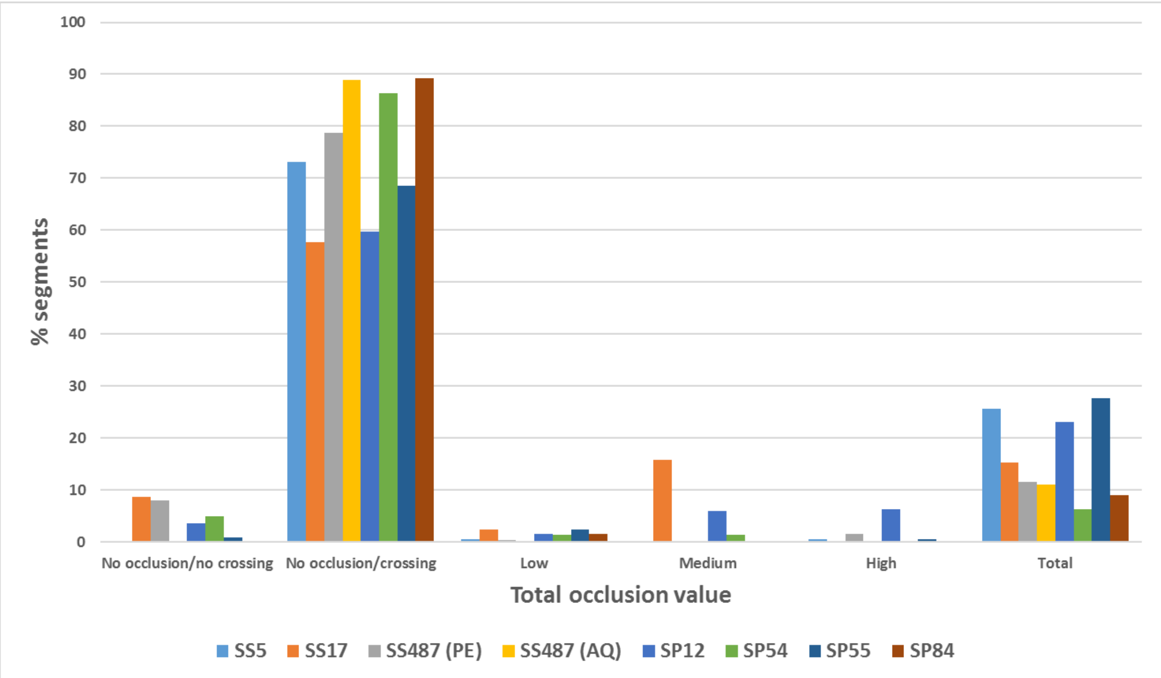

Figure 7. Distribution of the percentage of segments for each total occlusion value of the roads monitored in the frame of Action A5 in the Majella National Park.

All the roads, particularly SS5, SS487, SP54, SP55 and SP84, have a quite bimodal distribution of the total occlusion value with the two modes represented by *No occlusion/crossing* and *Total occlusion* values (Figure 7).

The use of data collected with the occlusion profile also allowed to individuate possible road “traps”.

Table 5. Number and percentage of 100m-segments that represent a trap for bears due to the presence of one permeable road side (occlusion value = 0-2) and one non-permeable road side (occlusion value = 3-5) along the roads monitored in the Majella National Park Project area.

Road code	N segments (%)	Type of barrier		
	Traps	Wall	Urban area	Fence
SS5	29 (18)	4 (14)	24 (83)	1 (3)
SS17	92 (19)	75 (82)	15 (16)	2 (2)
SS487 (PE)	22 (7)	10 (45)	12 (55)	0
SS487 (AQ)	4 (9)	1 (25)	3 (75)	0
SP12	61 (24)	60 (98)	1 (2)	0
SP54	4 (5)	1 (25)	3 (75)	0
SP55	35 (16)	8 (30)	27 (70)	0
SP84	7 (6)	0	7 (100)	0

The road with the highest percentage of traps is the SP12 (24%) followed by SS5, SS17 and SP55 (around 20%) while all other roads have less than 10% of trap road segments. The majority of barriers are urban areas and walls, these last representing more than 80% of total barriers for SS17 and SP12 (Table 5).

Table 6. Summary table of all the variables collected to characterize roads in the Majella National Park Project area. SC = slope combination; F = flat; E = embankment; O = other; NPA = non-protected area; NR = Nature Reserve; NP = National Park.

Road code	**N segments (%)**													
	N lanes			Speed limit				Road transversal section				Management status		
	2	3	4	30	50	70	90	SC	F	E	O	NPA	NR	NP
SS5	156 (97)	4 (3)	-	-	80 (50)	80 (50)	-	91 (57)	69 (43)	-		160 (100)	-	-
SS17	396 (84)	23 (5)	52 (11)	-	123 (26)	296 (63)	52 (11)	255 (54)	167 (35)	32 (7)	17 (4)	458 (97)	13 (3)	-
SS487 (PE)	309 (100)	-	-	-	292 (94)	-	17 (6)	292 (94)	-	2 (1)	15 (5)	19 (6)	-	290 (94)
SS487 (AQ)	45 (100)	-	-	-	-	-	45 (100)	33 (73)	12 (27)	-	-	45 (100)	-	-

Road code	N segments (%)													
	N lanes			Speed limit				Road transversal section				Management status		
	2	3	4	30	50	70	90	SC	F	E	O	NPA	NR	NP
SP12	256 (100)	-	-	-	36 (14)	220 (86)	-	256 (100)	-	-	-	112 (44)	-	144 (56)
SP54	80 (100)	-	-	-	80 (100)	-	-	68 (85)	12 (15)	-	-	-	-	80 (100)
SP55	213 (100)	-	-	113 (53)	4 (2)	-	96 (45)	126 (59)	87 (41)	-	-	95 (45)	-	118 (55)
SP84	122 (100)	-	-	-	122 (100)	-	-	109 (89)	13 (11)	-	-	89 (73)		33 (27)

The majority of the monitored roads have 2 lanes, 50-90 Km/h speed limits, have road transversal section flat or slope combination (Table 6).

Land use assessment in the area occupied by the 400-meter buffer of each monitored road resulted in the presence of 3 land use categories: woodland/semi-natural surface, Agricultural surface and Artificial surface. The first two are the most abundant while Artificial Surface values range between 3% and 11% (Table 7, Figure 8-9).

Table 7. Surface occupied by the 3 different Corine land cover uses present in a 400-meters buffer around each monitored road. WSNS = woodland/semi-natural surface; AgS = agricultural surface; ArS = artificial surface.

Road code	Area (Km^2)			Area (%)		
	WSNS	AgS	ArS	WSNS	AgS	ArS
SS5	6.5	5.2	1.4	50	40	11
SS17	13.4	19.9	2.6	37	56	7
SS487(PE)	9.4	11.5	1.1	43	52	5
SS487(AQ)	0.9	2.9	0.2	23	72	6
SP12	12.2	5.6	0.8	65	30	4
SP54	3.0	3.1	0.2	48	49	3
SP55	5.8	8.5	0.7	39	57	5
SP84	4.1	4.8	0.6	43	50	7
			Mean	**43**	**51**	**6**
			DS	**12**	**12**	**2**

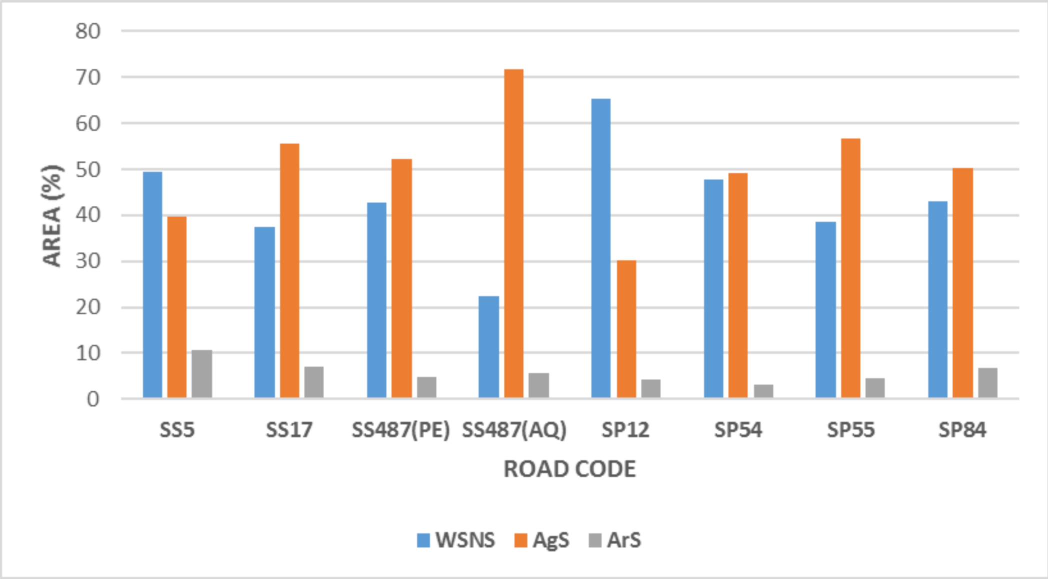

Figure 8. Percentage distribution of the surface occupied by the 3 different Corine land cover uses present in a 400-meters buffer around each monitored road. WSNS = woodland/semi-natural surface; AgS = agricultural surface; ArS = artificial surface.

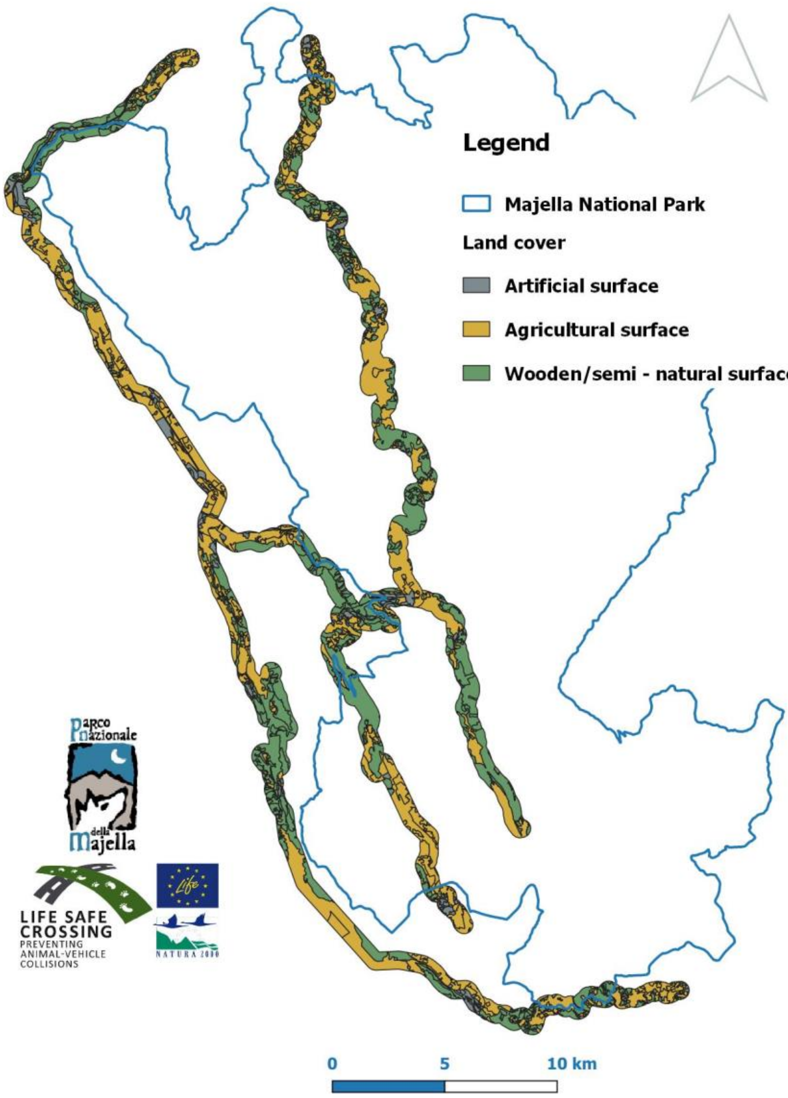

Figure 9. Corine Land Cover in the 400-meter buffer around characterized roads in the Majella National Park Project area.

Even though the occlusion profile is bear-specific while A3 analysis has been conducted using mainly data referring to other large mammals, results of road characterization are consistent with A3 analysis results. AVC clusters fall in segments where animals must cross the roads to go from one side to the other (occlusion value >0) and where the occlusion level is from low to medium. Only three segments refer to occlusion values 4-5(Table 8).

Table 8. Summary table showing the consistency between A3 results and occlusion values elaborated for the Project roads in the frame of action A5 in the Majella National Park.

Road code	N AVC clusters	N segments occlusion profile totally included in the clusters	Occlusion value (N segments)
SS487	4	9	1 (9)
SS5	1	3	1 (3)
SS17	13	30	1 (18) 3 (9) 4-5 (3)

Collection of data on road mortality along selected roads

From 16/07/2019 to 30/09/2020 32 monitoring sessions were available. However, the lockdown imposed by the government to limit the diffusion of the SARS-CoV2 virus from mid-March to May 2020, determined the suspension of the monitoring activity. This decision was due both to the fact that every un-necessary work activity had been suspended and to the fact that monitoring results would have been affected by the absence of traffic determined by the lockdown. A total of 26 usable sessions were thus left to monitor road mortality. During the 26 monitoring sessions actually available, each transect has been monitored a minimum of 23 and a maximum of 25 times (Table 9).

Table 9. Summary results of the systematic and opportunistic (Extra deads) monitoring implemented in the Majella National Park study area to assess road motrtality.

Road code	Transect code	N monitoring sessions implemented	Total km traveled	Animals found dead/wounded	Extra deads
SS487	1	24	276	3	7
SS487-SP54	2	25	655	1	0
SP12	3a	24	122.4	0	0
SP12-SS84	3b	23	439.3	1	2
SP55	3c	23	487.6	1	0
SS487	4	24	271.2	2	4
SS5 – SS17	5	25	407.5	11	7
SS17	6	25	1.182.5	23	20
SP84	7	25	307.5	0	1
		Total	**4.149**	**42**	**41**

A total of 42 animals have been found dead/wounded with the systematic monitoring and 41 with the opportunistic monitoring. Transects 5 and 6 (Tocco da Casauria – Corfinio and Corfinio – Roccaraso) are the ones with the highest number of animals found dead/wounded (Table 9), the first with a mean of 0.44 and the second with a mean 0.92 findings/monitoring session. Data collected opportunistically give a similar result with transects 5 and 6 being the most interested by dead animals but they also give additional information especially on transects 1, 3b and 4 (Table 9).

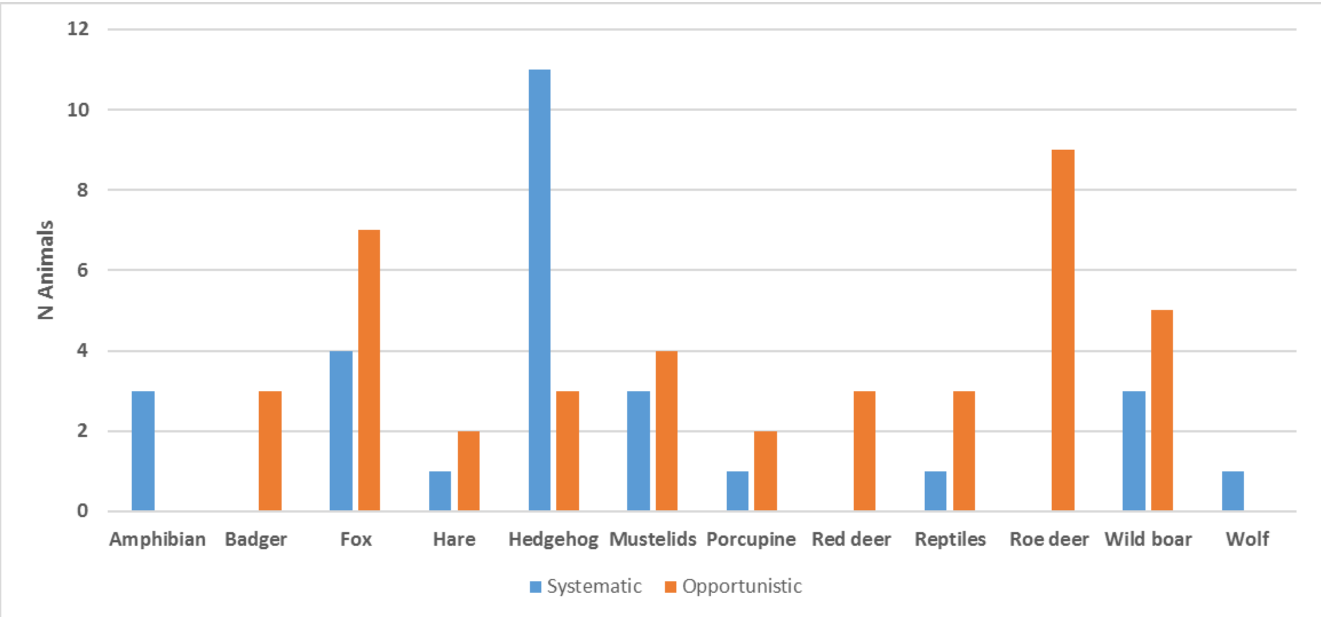

Figure 10. Animals found dead and identified during the systematic monitoring and with the opportunistic monitoring in the Majella National Park Project area.

Out of 42 animals found dead, 28 were actually identifiable while all the 41 animals recorded as extra-deads were attributed to a species. The most abundant species identified with the systematic monitoring is the hedgehog (11; 39%), followed by fox (4; 14%); 3 wild boars (27%) and 1 wolf (3.6%) are the only findings concerning large mammals. The opportunistic monitoring, instead, allowed mostly the collection of information concerning large mammals: out of 41 animals 9 are roe deers (22%), five are wild boars (12.2%) and 3 are red deers (7%). In general, except for hedgehog, amphibians and the only wolf, the opportunistic method resulted in more animals found dead than the systematic (Figure 10).

Results of the distribution analysis of dead animals along the year are consistent between the systematic and opportunistic method. In both cases road mortality has been mostly detected from July to September (Figure 11).

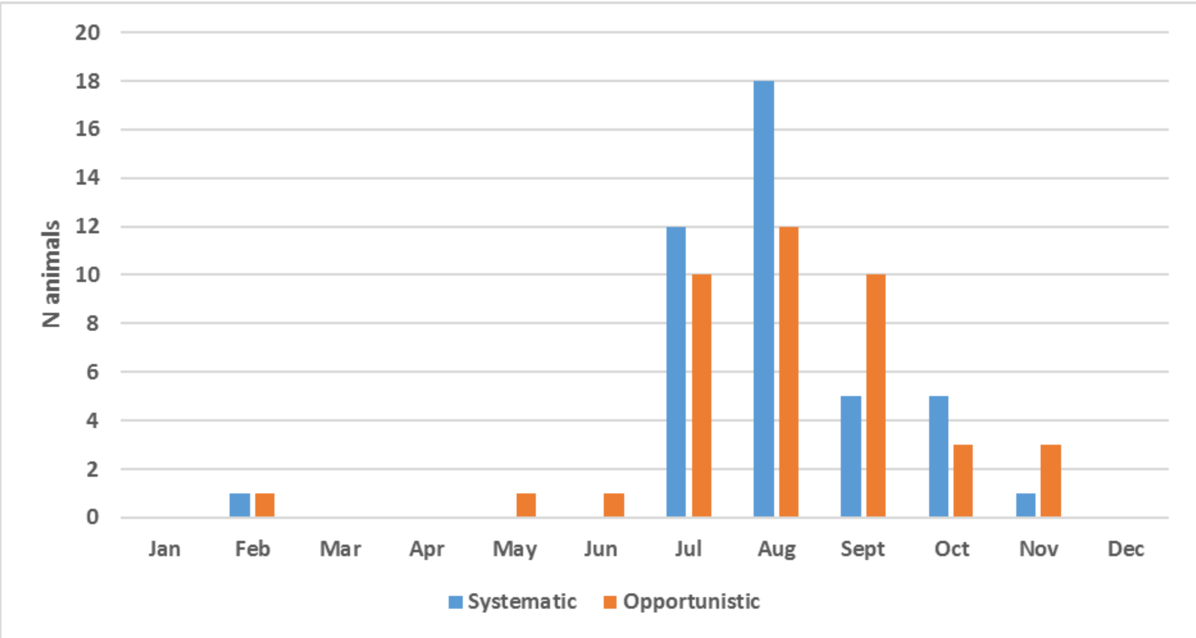

Figure 11. Distribution along the year of road mortality detected using both data of systematic and opportunistic monitoring in the Majella National Park Project area.

Sixty-six out of 83 mortality records have data on road shape and speed limits. Fifteen (23%) records refer to road mortality in curve-shaped roads while the remaining 51 (77%) fall in straight road segments. All the records but one happened in 2 lanes road (the remaining one falls in a 4-lane road segment); 30 (45%) records refer to segments where the speed limit is 50 Km/h, 32 (49%) refers to 70 Km/h speed limit and 4 (6%) to 90Km/h speed limit.

Considering only records concerning large mammals (the ones used to perform the AVC cluster analysis) collected both systematically and opportunistically, so far results of road mortality monitoring are consistent with A3 results. Road mortality resulted as concentrated in the north-western part of the Project area between Sulmona and Popoli along the roads SS17 and SS5 (Figure 12).

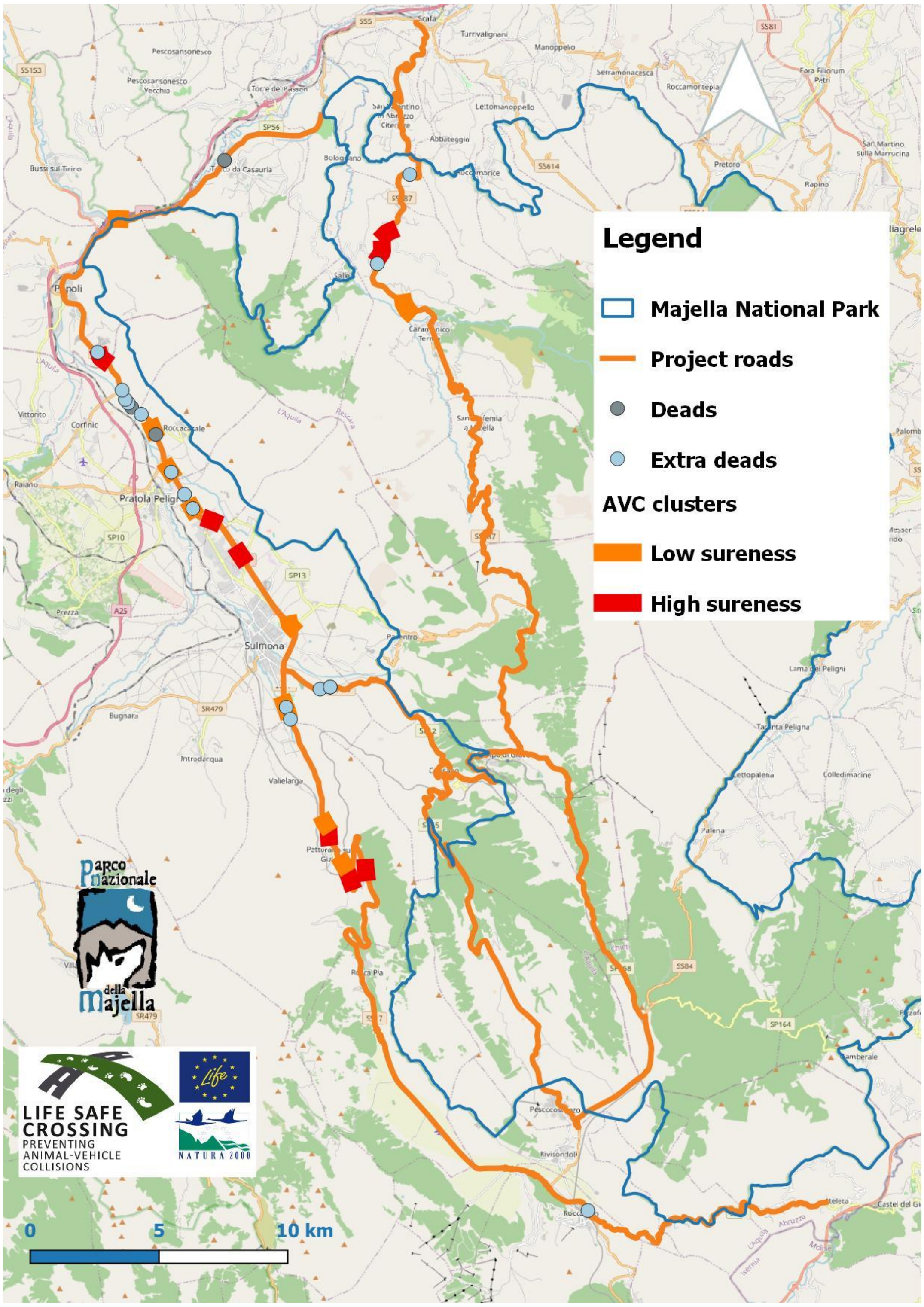

Figure 12. Location of large mammals road mortality records collected both systematically (Deads) and opportunistically (Extra Deads) as compared with AVC clusters locations resulted from A3 analysis for the Majella National Park Project area.

An interesting new situation emerged for the SS487 segment between Sulmona and Cansano where two red deers died in a ~400m segment. The only dead wolf has been found in August 2019 in a segment of SS17 between Roccacasale and Corfinio wich resulted as an interesting new situation as well. Between May and August 2020, 5 additional large mammals died in the same 2.5 Km long segment (4 roe deers and one wild boar) and, particularly, the wolf and 2 roe deers died in a ~350m segment.

Assessment of traffic volume and vehicle speed along the selected roads

From 20/11/2019 to 30/09/2020, 9 monitoring sessions have been implemented during autumn 2019, winter 2019-2020 and summer 2020 (Table 10). The winter session for SS487 (AQ) and the spring 2020 sessions have not been implemented because from mid-March to June, the government imposed severe restrictions to counter the SARS-CoV2 virus diffusion. As for road mortality, traffic volume and speed monitoring was thus suspended both to respect the rule to implement only strictly necessary works and to avoid the collection of data affected by the traffic absence determined by the lockdown.

Table 10. Traffic volume and speed measurements sessions implemented along the selected roads in the Majella National Park Project area.

Road code	Season	year	Monitored From	Monitored To	Analysis from	Analysis To
SS487 (AQ)	Autumn	2019	20/11	02/12	20/11	27/11
	Summer	2020	29/06	07/07	29/06	06/07
SS17	Autumn	2019	13/12	01/01	13/12	20/12
	Winter	2019-2020	13/12	01/01	21/12	28/12
	Summer	2020	15/07	23/07	15/07	22/07
SS5	Winter	2019-2020	22/01	31/01	22/01	29/01
	Summer	2020	04/08	20/08	04/08	11/08
SSS487 (PE)	Winter	2019-2020	13/02	27/02	13/02	20/02
	Summer	2020	15/09	22/09	15/09	22/09

As monitoring duration differs between different locations, to perform data analysis a 1-week period has been subsampled for every location, in order to standardize source data

(Table 10). Results show that the road with the highest traffic volume is the SS5 followed by SS17, and SS487 (both AQ and PE). During summer, the traffic volume augmented for all the roads (Figure 13) with SS487(PE) having the highest summer/other seasons ratio (1.6) followed by SS487(AQ) (1.4), SS5 (1.3) and SS17 (1.2). Highest mean speed values have been recorded for SS5 and SS17; no evident seasonal trend emerged except for an augmentation of mean speed values in summer for the SS17 (figure 14).

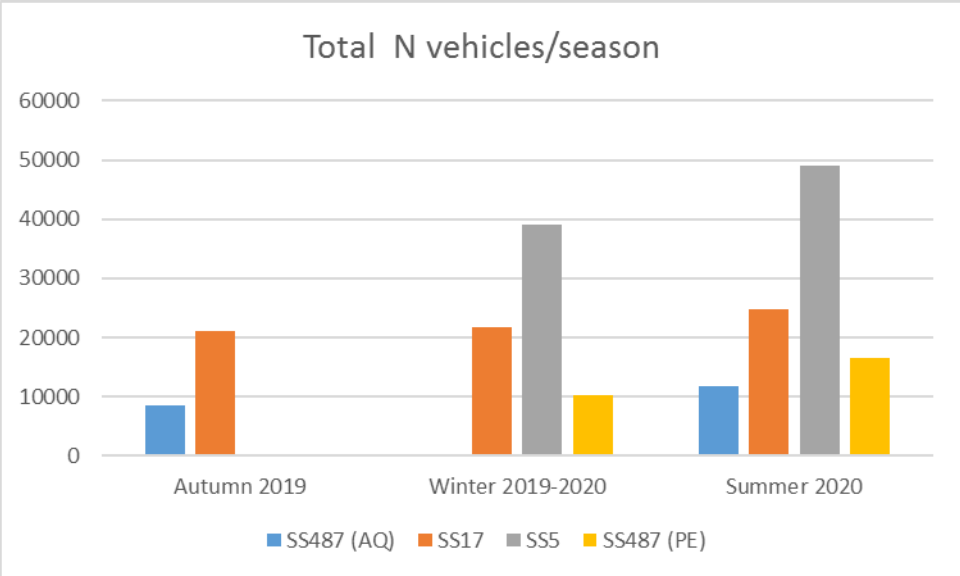

Figure 13. Total traffic volume recorded during a 1-week period referring to three seasons along the selected roads in the Majella National Park Project area.

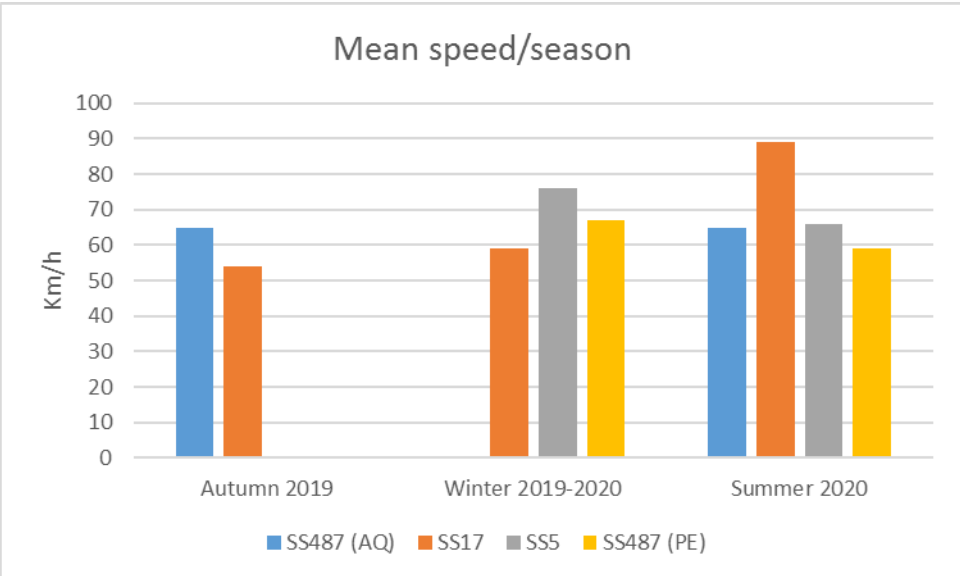

Figure 14. Mean speed values recorded during a 1-week period referring to three seasons along the selected roads in the Majella National Park Project area.

Differences emerged for traffic volume values between working days and week-ends (Figure 15, Table 11). Interestingly, along SS5 and SS17 the difference observed is due to a higher traffic volume during working days while along SS487 (both AQ and PE) the observed situation is the other way around (Figure 15). This result, together with the above-described seasonal trend of the traffic volume, suggests that SS17 and SS5, both located outside the Park boundary, have a traffic volume mainly related to work-dependent movements while SS487 in L'Aquila and Pescara Province, both leading inside the protected area, could be mostly used for touristic purposes.

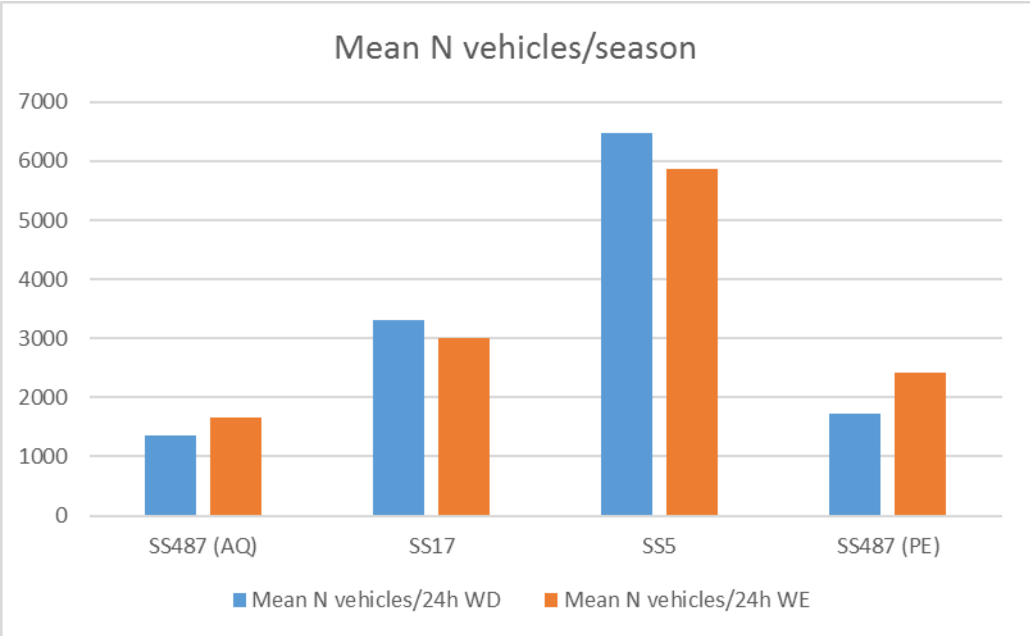

Figure 15. Men number of vehicles/24h for working days (WD) as compared to the same value for week-ends (WE) along the selected roads in the Majella National Park Project area.

The mean maximum speed value does not strongly differ between working days and week-ends but a noticeable augmentation in the absolute maximum speed has been recorded during summer (Table 11). Interestingly along all the roads the highest speed recorded during summer refers to motorbikes while in the other seasons the highest speed is associated only to cars and vans (Table 11). These two last data could be interpreted as a general speed augmentation along the roads during summer due to a general highest motorbike presence during the good season. It is worth noticing that maximum speeds recorded, especially during summer, are from 2 to 4 times higher than the speed limit! Percentage of vehicles traveling above the speed limit ranges from ~30% to the 99% recorded in summer for the SS17 where this value is always the highest during all the seasons (Table 11).

Table 11. Summary table comparing mean vehicles/24h values and mean maximum speed values between working days and weekend in the different seasons. Maximum speed values and %of vehicles above the speed limit are also showed for the different seasons. Data refer to the monitoring implemented along the selected roads in the Majella National Park Project area.

	Autumn 2019					
Road code	Mean N vehicles/24h WD	Mean N vehicles/24h WE	Mean Maximum speed (Km/h) WD	Mean Maximum speed (Km/h) WE	Absolute maximum speed (Km/h)	% vehicles above speed limit
SS487 (AQ)	1171	1330	123	117	138 (car)	31%
SS17	3064	2834	117	114	139 (van)	59%
SS5	-	-	-	-	-	-
SS487 (PE)	-	-	-	-	-	-
	Winter 2019-2020					
	Mean N vehicles/24h WD	Mean N vehicles/24h WE	Mean Maximum speed (Km/h) WD	Mean Maximum speed (Km/h) WE	Absolute maximum speed (Km/h)	% vehicles above speed limit
SS487 (AQ)	-	-	-	-	-	-
SS17	3318	2563	121	118	130 (car)	76%
SS5	5994	4541	139	143	151 (car)	64%
SS487 (PE)	1398	1667	119	119	129 (car)	40%
	Summer 2020					
	Mean N vehicles/24h WD	Mean N vehicles/24h WE	Mean Maximum speed (Km/h) WD	Mean Maximum speed (Km/h) WE	Absolute maximum speed (Km/h)	% vehicles above speed limit
SS487 (AQ)	1557	1988	132	132	150 (motorbike)	32%
SS17	3537	3591	196	211	218 (motorbike)	99%
SS5	6935	7213	131	159	164 (motorbike)	29%
SS487 (PE)	2040	3152	118	120	148 (motorbike)	15%

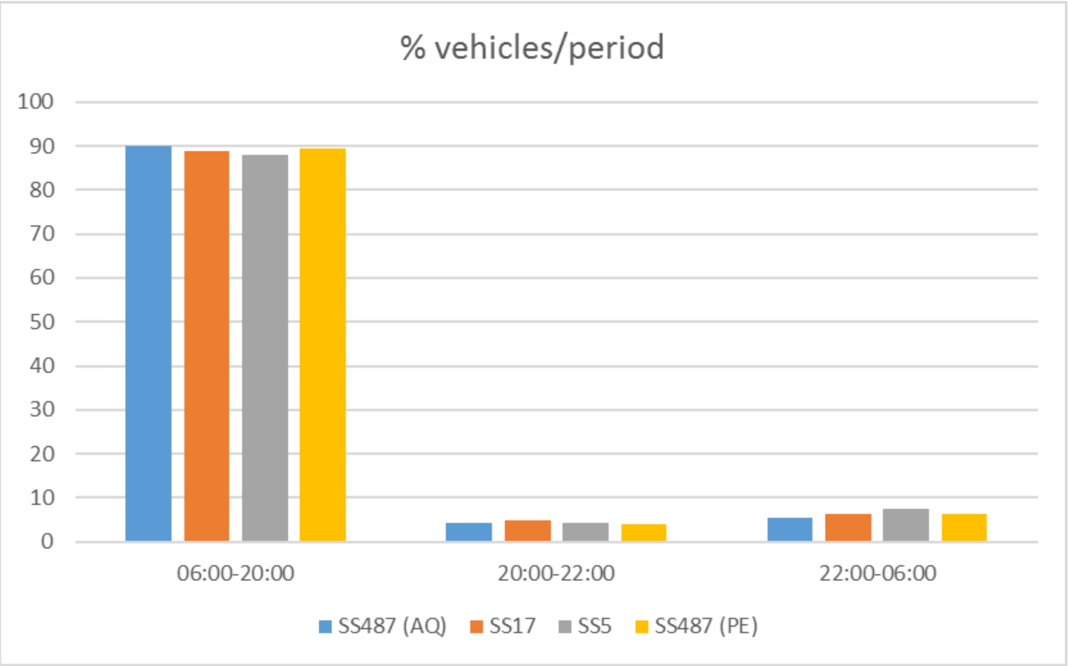

Figure 16. Percentage of vehicles per day period as resulted from data collected along the selected roads in the Majella National Park Project area.

This is most certainly due to the fact that the monitored road segment is a long, high-visibility straight road where the speed limit is 50Km/h.

Results of the distribution analysis of vehicles during the day clearly show that for every monitored road almost 90% of the traffic refers to the daytime (06:00 – 20:00; Figure16) while data on speed distribution during the day show no evident differences in the mean speed recorded in the different periods (Figure 17).

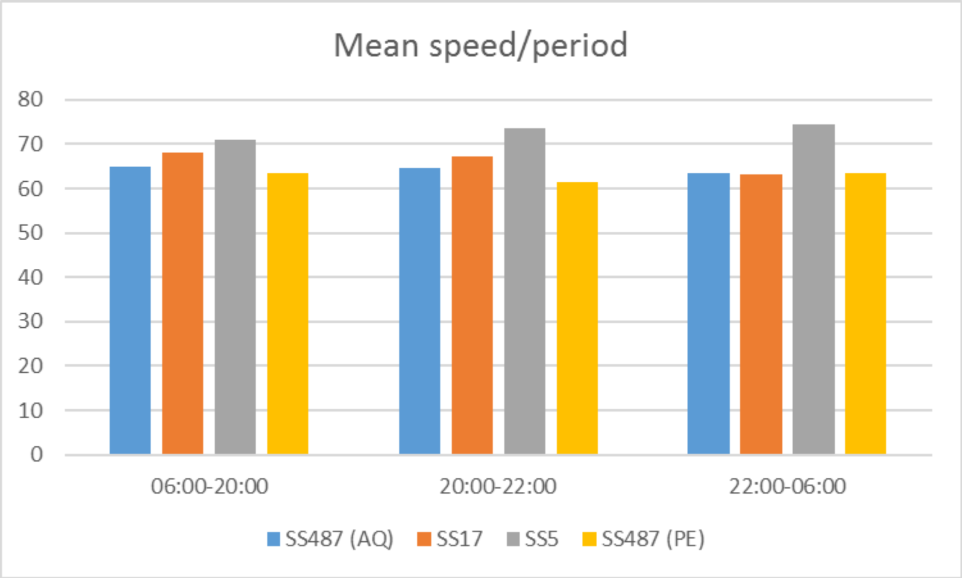

Figure 17. Mean speed of vehicles per day period as resulted from data collected along the selected roads in the Majella National Park Project area.

Selection of the locations for AVC-PS devices

The method applied to individuate AVC-PS locations resulted in the individuation of 3 possible road stretches: 1) Tocco da Casauria – Roccaraso (SS5-SS17); 2) S. Valentino A.C. – Caramanico T. (SS487 – PE); 3) Sulmona – bivio Pacentro (SS487 – AQ). Inside these 3 road stretches 13 road segments have been individuated (Figure 18).

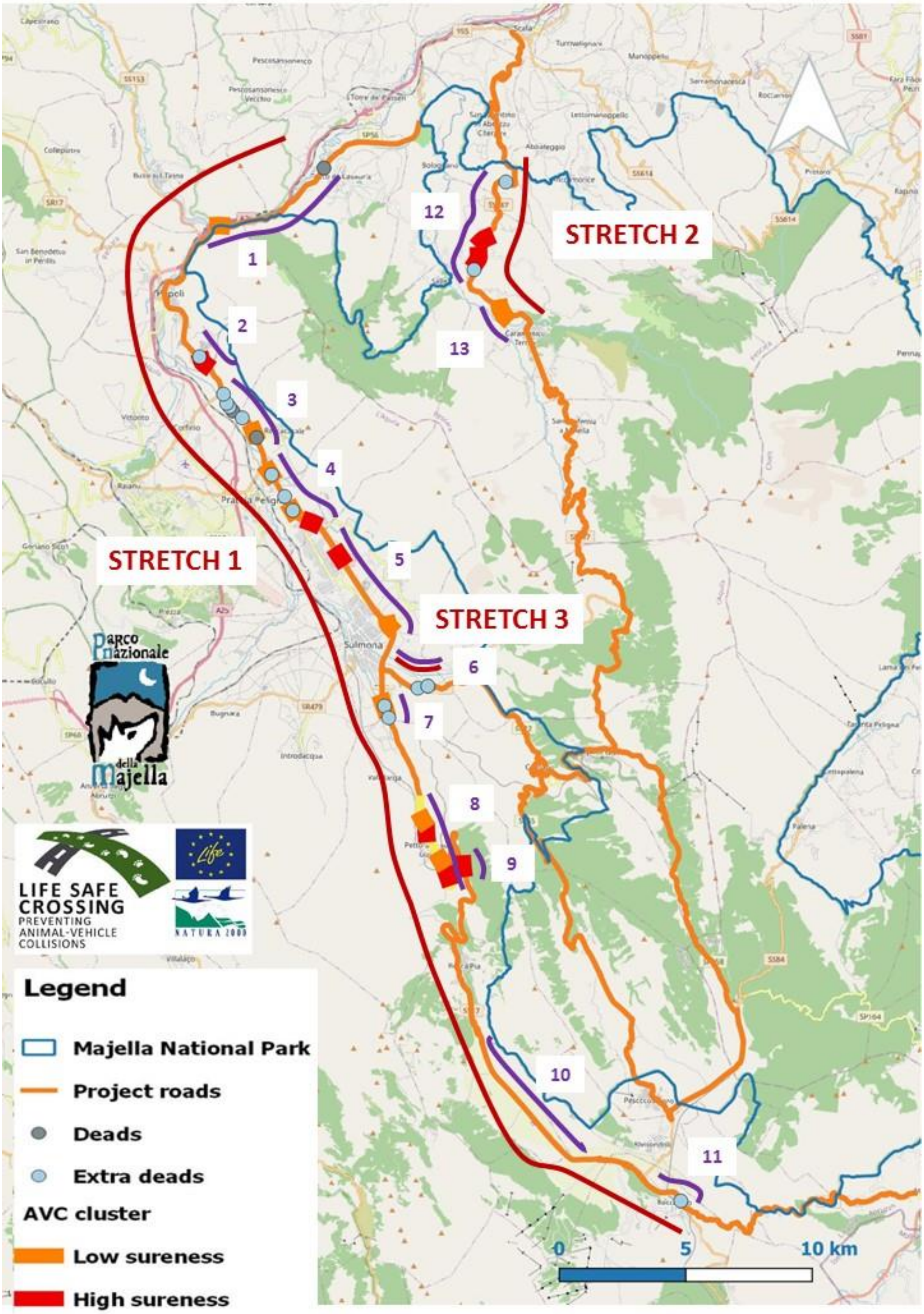

Figure 18. Road stretches (burgundy) and segments (purple) selected to be interested by AVC-PS positioning in the Majella National Park Project area.

Basing on AVC clusters location, road mortality records and expert-based evaluations, 6 possible segments have been selected to be object of field surveys to assess actual location suitability: 2, 3, 8, 9, 10, 12 (Figure 18). Field surveys conducted allowed to confirm the suitability of segments 3, 8, 10 and 12. Segment 9 has been excluded because not accomplishing logistic requisites while segment 2 has been put in standby as the road segment is currently object of a major shape modification by the road management authority (ANAS). Four final locations for AVC-PS have thus been established in segments 3, 8, 10, 12 while the location in segment 2 will be evaluated again after the works will be completed by ANAS. In case segment 2 will not be suitable anymore, segments 1 and 6, evaluated as possible alternatives basing on current knowledge on road mortality risk, road characterization and traffic volume/speed, will be inspected and monitored to evaluate their suitability to host the 5th AVC-PS device (Figure 19).

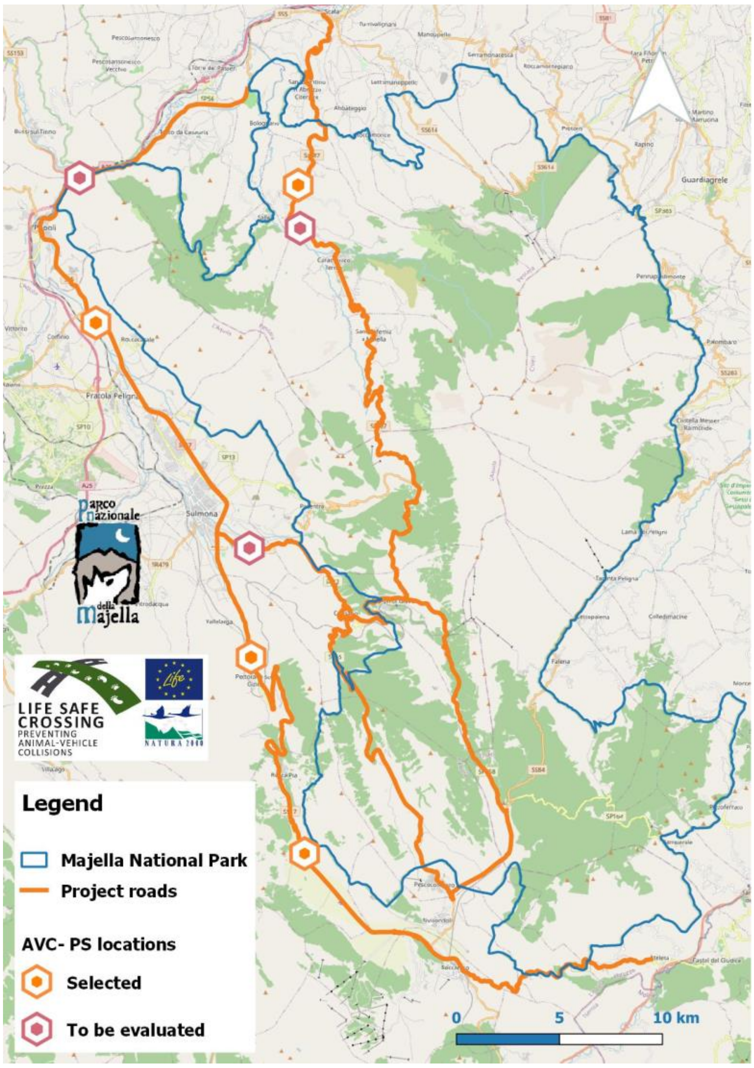

Figure 19. AVC-PS locations selected or to be evaluated in the Majella National Park Project area.

Segment 12 will also be inspected again in order to evaluate the possibility to install a second AVC-PS in this high AVC-risk road stretch.
It is important to report that the selection of segments to be object of AVC-PS installation also took into account results from Action A4. In fact, segments selected are the ones where road mortality is an issue but no existing crossing structures were present. If, on the contrary, suitable existing crossing structures were present (as happened for example in segment 13) their adaptation in the frame of Action C2 has been considered a more adequate mitigation measure.

Assessment of the use by animals of the crossing points where to install AVC-PS devices

From May 2020 to September 2020, 2 out of 4 selected locations for AVC-PS have been monitored with camera traps (Table 12), while two have been excluded due to high theft risk (n.1, AVC-PS SS17 Pettorano sul Gizio) and the absence of supports to install the camera (n.1, AVC-PS SS17 Rocca Pia).

Table 12. Summary table reporting data on crossing points camera trap monitoring implemented so far in the Majella National Park in the frame of the Life Safe-crossing.

*** calculated until 30/09/2020**

LOCATION	DATE OF INSTALLATION	N CAMERA TRAPS	CAMERA SETTING	DATE OF REMOVAL	N.OF WORKING DAYS*	N VIDEOS/ PHOTO	SPECIES
AVC – PS SS487	16/06/2020	2	VIDEO	Still working	106	150	Wolf, roe deer, red deer, wild boar, Porcupine, mustelids, wild cat, badger, fox
AVC-PS SS17 (Corfinio)	17/07/2020	2	VIDEO	Still working	75	156	Wolf, roe deer, red deer, wild boar, Porcupine, mustelids, wild cat, badger, fox, hare
Crossing Point SP12 (Campo di Giove)	30/05/2020	2	VIDEO	01/10/2020	123	14	Roe deer, red deer, hare, wild cat, hedgehog, fox
Crossing Point SP12 (Cansano)	28/08/2020	1	VIDEO	STOLEN	30 minimum	17	Porcupine, badger, fox

Two additional crossing points have been monitoring along the SP12: one in the Campo di Giove territory in a point where a bear crossing event has been observed in May 2020; one in the Cansano territory where a path interrupting a long barrier segment was found. Unfortunately, this last camera trap has been stolen only one month after its deployment (Table 12).

A total of 337 crossings have been recorded, mostly in the selected locations for AVC-PS devices (Table 12, Figure 20).

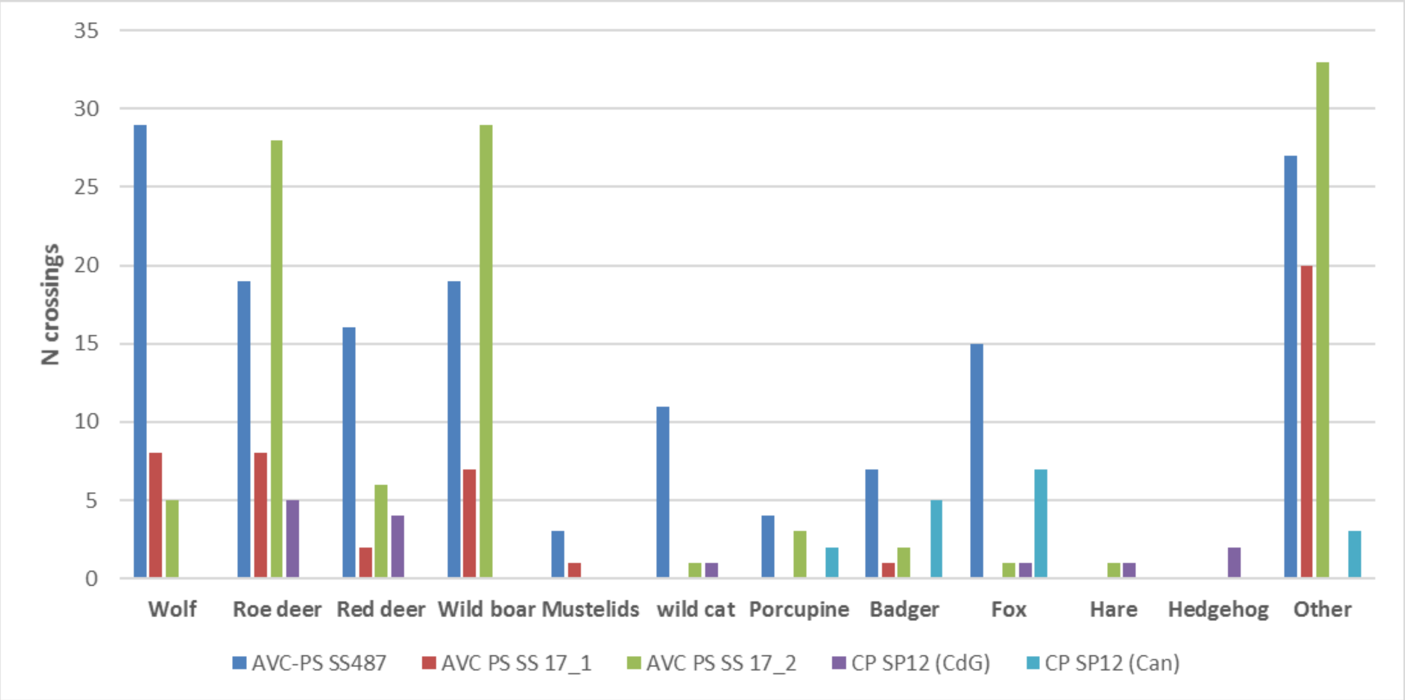

Figure 20. Number of crossings recorded for each camera traps in the locations monitored in the Majella National Park Project area. “Other” refers to domestic or non-identified species.

Considering all the camera traps roe deer is the species most detected (60 crossings) followed by wild boar (55 crossings), wolf (42 crossings) and red deer (28 crossings). Wolves and wild boars have been detected only in AVC-PS locations crossing points where roe deers and red deers have been detected as well. These last two species have been recorded as well only in the crossing point SP12_CdG, a potentially interesting point where monitoring activity had to be suspended due to the starting of a logging activity. It is worth reporting that the wolf is the most recorded species in the AVC-PS location along the SS487 and that in one of the 2 monitored paths of the AVC-PS location along the SS17-Corfinio wolves are the most recorded species together with the roe deer (Figure 20).

The analysis of the distribution of videos during the time period shows that most of the crossings happen during the night time and, to a lesser extent, during the dusk (Figure 21).

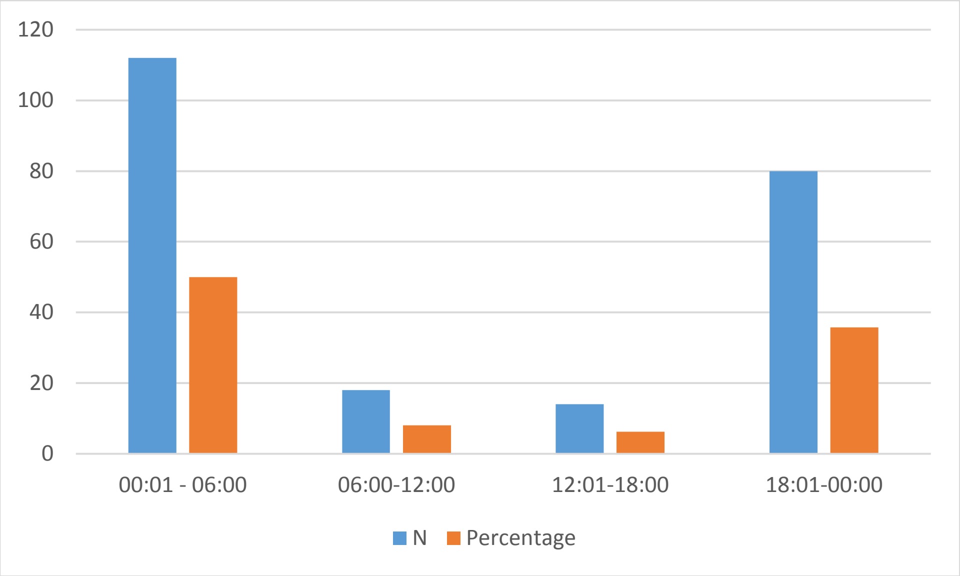

Figure 21. Rough distribution of crossings in the different periods of the day as resulted by the analysis of videos recorded for wild species during the monitoring implemented in the Majella National Park Project area.

Final considerations

Action A5 has been developed according to the Project proposal and there are no major concerns to report. Results obtained are consistent with A3 and A4 results and delineate a scenario quite similar to the one reported in the Project proposal. Roads SS5 and SS17 are the roads with highest traffic volumes and, being both located in suitable areas/corridors for bears, they are most certainly high AVC-risky roads. SS17 is located in a very important corridor to allow bears disperse from the source population of the Abruzzo, Lazio e Molise National Park to the PNM; SS5 is located in one of the biggest estimated corridors, very important to allow bears disperse from PNM to the Gran Sasso e Monti della Laga National Park and, to a lesser extent, the Sirente Velino Nature Park. Inside the Park the SS487 (PE), particularly the road stretch between S.Valentino A.C. (PE) and Caramanico Terme (PE), resulted as the one with the highest AVC risk a situation determined by both the location and the traffic volume that is particularly relevant during the toruristic season and during week-ends. SS17 and SS487 are thus the two roads mostly interested by C1 interventions while SS5 is, unfortunately, hardly suitable for the installation of AVC devices. However, given the recorded data on traffic and speed and

given the absence of existing crossing structures to work on (see report A4), additional efforts will be done to evaluate the possibility to actually install one AVC-PS device.
Beyond the above-reported situation, consistent with the proposal, a new situation seem to be arising along the SS487 (AQ) in a road segment where bears have already been observed crossing the road. This new situation will be monitored during C1 and D1 Actions in order to evaluate the need to implement mitigation measures.
Results of camera-trapping show that the selected AVC-PS locations are used by large mammals and, particularly by wolves. This is a very encouraging result witnessing the high ecological value of the selected locations thus maximizing the probability that the same crossing points are or will be used by bears.
Finally, thanks to A5 implementation a map of the barriers for bears is available and, particularly, a map of the road traps. Even though in the frame of the Life Safe-crossing non barrier mitigation measure implementation is foreseen, it is still important to have this information in order to evaluate the possibility to implement additional measures during the Project or to program interventions to implemented during the after-Life period.