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Who Uses Forest Roads? Has the COVID-19 Pandemics Affected Their Recreational Usage? Case Study from Central Slovakia

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Abstract: Forest roads are necessary to provide access to forests and are also used by users other than forest owners and the timber industry. Their usage for recreation and hiking has been increasing in the last years. From 1/2020 to 12/2020, we performed research on traffic loads and the use of forest roads at an area of the University Forest Enterprise of Technical University in Zvolen. For this purpose, we selected two localities, namely Včelien = A locality and Štagiar = B locality. We monitored transport intensity at selected localities with images obtained from two identical Trail Spromise S308 cameras. We examined the impact of lockdown periods during the COVID-19 pandemics on forest recreation in the year 2020 with the Kruskal–Wallis ANOVA. Multiple comparisons of *p* values showed there were no differences in the recreational usage of forest roads between the lockdown periods and periods without restrictions. We found that recreation activities peaked in summer and spring. Recreation and transport at selected localities did not have a negative impact on animal occurrence, as the regression and correlation analysis revealed only a low negative relationship with r = 0.029. When considering the number of passages, roads were used for recreation and other non-forestry purposes at approximately 36%. From the perspective of the weight load, recreation accounted for about 10%.

Keywords: forest roads traffic; public recreation; COVID-19 lockdown; number of passages; wild animal occurrence

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1. Introduction

Forest roads are necessary to provide access to the forest for general management, maintenance, timber extraction, and recreation [1,2]. The construction of forest roads needs detailed planning [3,4] and represents the single highest capital investment by the owner. However, forest roads also have other users than forest owners and the timber industry [5]. They are used by private persons who own summer cottages situated nearby, berry pickers, hunters, fishermen, and people performing other leisure activities in forest areas. As the time-off of people increases, the personal need of private persons to use forest roads is also growing [6]. Increasing numbers of people from developed countries spend their leisure time in forests [7].

Over the last decade, recreational activities have changed from passive forms to more active forms. Consequently, the demand for forest recreation infrastructure to serve more active forest recreational activities has increased [8,9]. Traffic frequency on certain forest roads can be very high due to some non-forestry activities [10]. Forest roads with heavier traffic loads must comply with higher demands on quality, maintenance, transportability [11]. In spite of the fact that according to the Act on forests No. 326/2005 [12], vehicle access to Slovak forests is forbidden for the public without a permit issued by the Forest Administration or the forest manager, the restrictions are frequently disregarded or violated. Hence, the usage of forest roads by the general public has been gradually increasing. The need for recreation in forest ecosystems was manifested in the years 2019 and 2020, when the COVID-19 pandemics occurred [13–15]. At the end of 2019, a novel virus, called a severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), causing severe acute respiratory problems expanded globally from Wuhan, China [16]. The World Health Organization (WHO) officially declared the coronavirus disease 2019 (COVID-19) as a pandemic on 11 March 2020. Due to its rapid spread around the Globe, different government restrictions were used in countries around the world. At national levels, government reactions to curb or slow the progress of COVID-19 have involved, including limitations to travel abroad and/or across domestic countries, temporary shut-down of non-essential businesses, and restrictions of human movement during periods of lockdown to various degrees and duration (stay at home) [17]. For Slovak citizens, the most difficult was the introduction of lockdown, allowing only journeys to work, to see a doctor, and to ensure necessities of life, while the vast majority of people remained working from home. During the year 2020, two lockdown periods were declared, the first one from 16 March 2020 to 6 May 2020 (lockdown 1), and the second one between 24 October and 31 December 2020 (lockdown 2). During both lockdown periods, all recreation centres and facilities were closed, and the only exception apart from going to work, doctor, and ensuring necessities of life was a stay in nature within the district of permanent residence. Lockdowns and social isolation may lead to a wide range of psychiatric comorbidities, including anxiety, panic, depression, and trauma-related disorders [18]. Stays in nature as the only allowed movement during a lockdown have a significant positive impact on the mental health of people [19,20]. Since people had possibilities to spend their free time either at home or in nature within their district, we expected increased movement of people in nature close to their homes.

Therefore, in our study, we focused on the comparison of forest road usage for recreation and operational works. We were interested in the increase in recreational usage of forest roads in the lockdown periods in comparison to periods without lockdown. We expected a considerable increase in recreational activities in forest areas and on forest roads of the University Forest Enterprise during lockdown periods. We also focused on the evaluation of the traffic weight load of roads by operational activities and recreation.

Despite the benefits that recreation provides people with, recreation in nature can have a negative impact on biological communities. Recreation is a major threat to plant and animal species [21]. The impact of recreation on animals can differ, including behavioural reactions, such as increased vigilance, changes in spatial and temporal use of habitats, decrease in abundance, occupancy, or physiological stress, reduced reproductive success [22]. Several studies present a reduction of wildlife occurrence in the vicinity of paths and roads [23,24] due to recreation [25–27]. We evaluated the impact of road usage on the occurrence of free wildlife (large mammals), where we expected a negative correlation between the forest road usage and the occurrence of wildlife in two parts of the University Forest Enterprise in Zvolen, Slovakia.

The main goals of the paper were to (1) evaluate transport structure on forest roads and their traffic load; (2) compare the usage of forest roads for the purposes of forest management and recreation; (3) analyse the impact of COVID-19 pandemics and the resulting periods of lockdown on the recreational use of forest roads.

2. Material and Methods

We monitored the traffic on two road parts of the University Forest Enterprise of Technical University in Zvolen from 1/2020 to 12/2020. The University Forest Enterprise (UFE) of Technical University in Zvolen is a facility that serves research, teaching, and forest management. The enterprise covers an area of 9724 hectares at elevations from 250 to 1206 m a.s.l. The UFE area is managed with close to nature forestry methods following the rules of sustainable forestry with special attention on stabilising forest ecosystem resistance [28]. The annual cut in the year 2020 was 36,991 m^3. The total length of paved haulage roads at the UFE is 462 km, and the density is 47.5 m ha^{-1} [29]. Hence, the road density at UFE is substantially denser than the national average of 19.94 m ha^{-1}. The position of the enterprise near the town of Zvolen (42,092 inhabitants) and larger villages, such as Budča (1356 inhabitants), or Kováčová (1603 inhabitants), where spas are located, predetermines the territory used for relaxing and recreation (Figure 1).

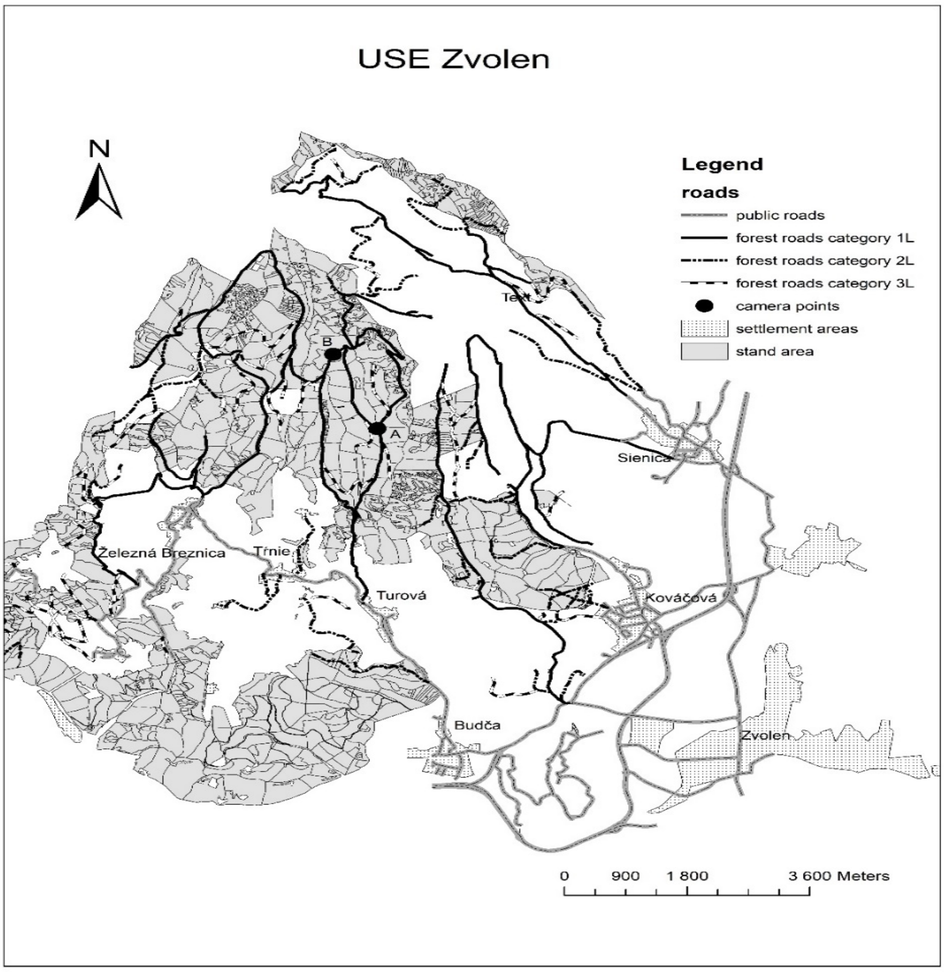

Figure 1. Study area of University Forest Enterprise Zvolen. (Note: Forest road category 1L: transport roads enabling year-round operation thanks to their spatial arrangement and technical components. Roads have the surface layer made of various construction materials and drainage facilities. The minimum width of a lane is 3.0 m, the free road width is at least 4.0 m. The maximum longitudinal slope of the road crown is 10% (in extreme cases 12%). Forest road category 2L: transport roads enabling at least seasonal operation (favourable climatic conditions) based on their spatial arrangement and technical components. Depending on the bearing capacity of the underlying soils, it is recommended to use the road surface with operational reinforcement or to use a simple dusty surface and drainage facilities. The minimum width of a lane is 3.0 m, the free width of the road is at least 4.0 m. The maximum longitudinal slope of the road crown should not exceed 12%. Forest road category 3L: skidding roads used for skidding and extraction of timber, usable by skidders, special skidding and extraction machines. Under favourable conditions, timber transport is possible. Road surface can have operational reinforcement, partial operational reinforcement, or no reinforcement. The minimum free road width is 4.0 m).

We investigated the traffic load and usage of forest roads at two UFE localities called Včelien = A locality and Štagiar = B locality situated within an area of Budča I. forest district, which covers 3954 ha of forests. We selected the localities considering traffic intensity. One locality (A) represented a bottom part of the valley used by most traffic, while the second one (B) was situated in a remote part of UFE under the mountain ridge. The coordinates of the two localities are as follows: A (48.6334028° N, 19.0477781° E) and B (48.6394506° N, 19.0356439° E). Locality A is situated 3.8 km from the closest village of Turová (425 inhabitants), and locality B is situated 4.6 km from this village. The roads at both localities are of category 1L according to the Slovak technical standard STN 736108. These roads enable year-round operations thanks to their spatial arrangement and technical components, they are paved with the surface layer made of various construction materials and drainage facilities. Timber must not be used dragged on these roads, and forwarders must not use tyre chains while driving on them. The road at locality A consists of 10 cm asphalt concrete layer (aggregate ø 0–32 mm) on top of 10 cm base layer of aggregates (ø 32–63 mm), and the road at locality B has a 10 cm layer of aggregates (ø 0–32 mm) on top of a 10 cm base layer of aggregates (ø 32–63 mm). Regional weather patterns, which could have affected the recreational activities in the analysed periods of the year 2020, are presented in Figure 2 and Table 1.

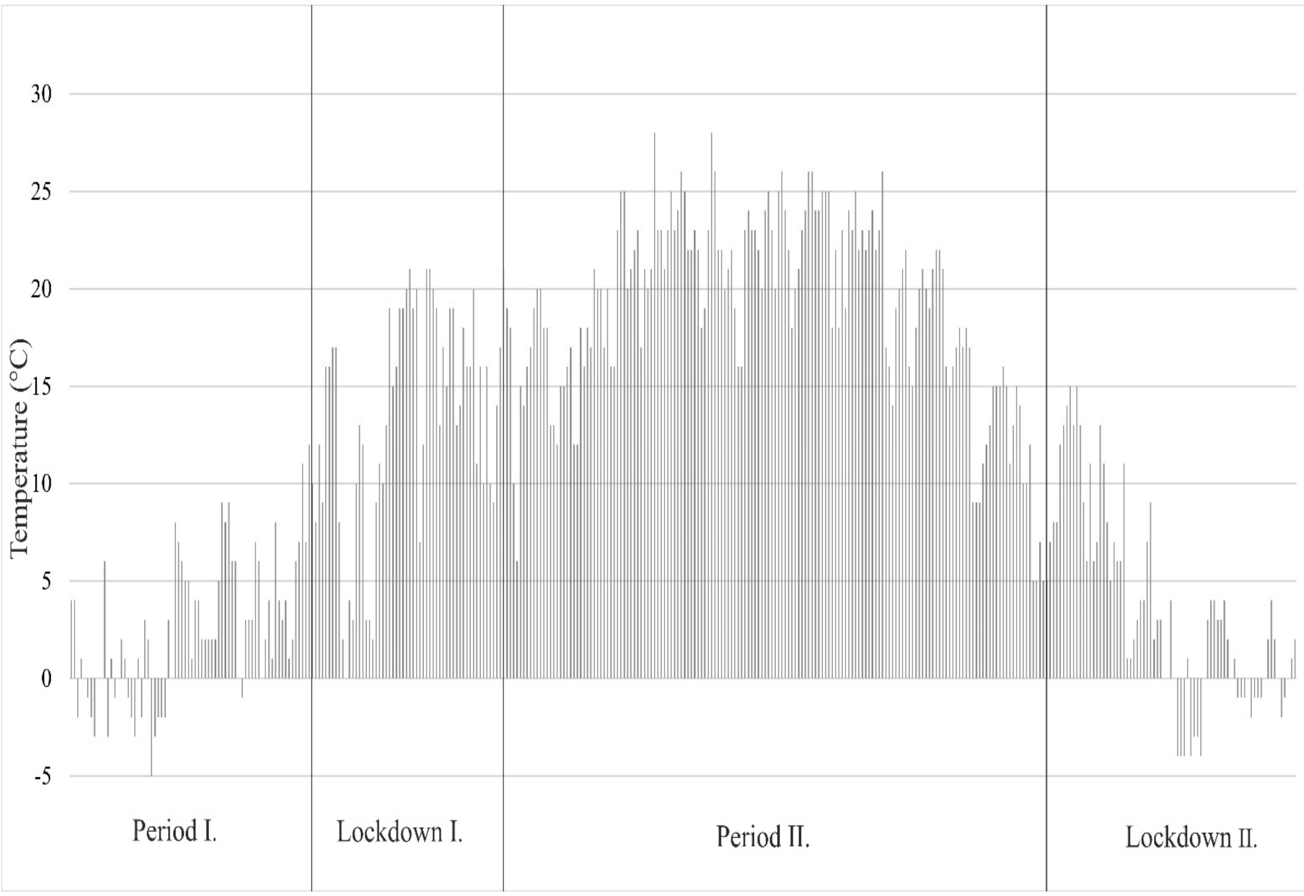

Figure 2. Daily air temperature in the individual periods of the year 2020in USFE Zvolen [30].

Table 1. Weather description in individual periods in the year 2020.

Period of Year/Number of Days of Period	Weather	Number of Days in Period (% of Days from Period)	Daily Mean Air Temperature (°C)
Period I./75	Snowfall	1 (1.5)	2.8
	Rainfall	10 (13.5)	
	Cloudy	26 (34.7)	
	Sunny	38 (50.7)	
Lockdown I./52	Snowfall	1 (1.9)	13.4
	Rainfall	1 (1.9)	
	Cloudy	4 (7.7)	
	Sunny	46 (88.5)	
Period II./170	Snowfall	0 (0)	18.6
	Rainfall	25 (14.7)	
	Cloudy	72 (42.4)	
	Sunny	73 (42.9)	
Lockdown II./69	Snowfall	5 (7.2)	3.2
	Rainfall	4 (5.8)	
	Cloudy	24 (34.8)	
	Sunny	36 (52.2)	

We monitored traffic intensity at selected localities based on images obtained from two identical Trail cameras Spromise S308 (Spromise, Shenzen Chaonuo Technology Co. Ltd., Guangdong, China. The following data were displayed in photographs: date, time, temperature, a moon phase, battery status.

Trail cameras were placed in protective covers on trees at a height of approximately 3 m above the road surface with an approximate 45° angle of the lens axis to the longitudinal axis of the road, at a perpendicular distance from the road edge of 2 m (B locality), or 5 m from the road (A locality). These distances were suitable from the point of the motion sensor range and for capturing sufficient road space to avoid cases that the camera does not detect the monitored object, especially faster-moving vehicles. The power supply of cameras was provided by an external lead-acid battery EMOS GT6-4 (EMOS SK s.r.o.) with a snap-in capacity of 6 Ah. We set the sensor resolution of cameras to 3MPx and the sensor sensitivity to the normal one (15 m). Image-taking was set in such a way that after the camera had registered a movement, it captured 2 images with a time lag of 3 s, and further images were taken only after 30 s. DATA SDXC 32 GB Ultra Class 10 UHS-II memory cards were used to store and transfer data. Them, we copied captured images to a computer, where we sorted them using Total Commander 9.51. Duplicates and empty images were deleted. Subsequently, we renamed the remaining images so that the name of each image contained the following information: period number, period interval, location, image sequence number, and abbreviation of an object captured in the picture. Afterwards, we created a database in MS Access containing all the data and performed data filtering according to predefined parameters (locality, object type, date, time). From the analysed images, we derived total, daily, and monthly summaries of forest road usage at individual localities and together. At each locality, we monitored the number of passages of each recorded object. We divided vehicles into several categories: motorcycles, personal cars up to 1.2 t, SUV cars up to 2 t, buses, single trucks, trucks with trailers, universal wheeled tractors (UWT), and skidders. In the case of trucks, we also recorded if the truck was loaded or not. In the case of loaded trucks, we recorded the type of load, i.e., wood or something else, to determine the share of timber transport on the overall road usage. Each type of vehicle was assigned its mean weight category according to Table 2 to enable the assessment of traffic load. Mean values were obtained by averaging weights of vehicles in individual categories that occurred on the monitored roads during the study period. In the case of empty single trucks, we used a mean weight of 11.2 t, which was obtained by averaging the weights of empty single trucks recorded on the roads: single truck T 815 (13 t), Praga V3S (5.470 t), Scania R500 (15.1 t), Volvo RH12 (11.3 t). For loaded single trucks, a weight of 23.2 t was applied. In the case of empty trucks with trailers we used the value of 17.4 t, which was derived by averaging the weights of trucks recorded on the roads: Scania P450 (19.5 t), Scania G550 (21.4 t), and SCANIA G400 (11.3 t). Loaded trucks with trailers were assigned the weight of 40 t because, in Slovakia, the maximum possible weight of the vehicle on the road is 40 t following the Regulation of the European Council no. 2015/719 from 25 April 2015, which amended the Regulation of the European Council no. 96/53 ES from 25 July 1996. For skidders, we used the mean weight of multiple skidder types (LKT 81 T, LKT 81 ITL, HSM 805 HD) without the load because loaded skidders are forbidden to move on roads of 1L category.

Table 2. Weights of vehicles according to a vehicle type.

Vehicle Type	Weight (t)
Personal car	1.2
SUV car	2.0
Single truck empty	11.2
Single truck loaded	23.2
Truck + trailer empty	17.4
Truck + trailer loaded	40
Uwt	5.0
Skidder	10.0
Bus	7.5
Motocycle	0.3

We recorded the passage of tourists, cyclists, and large mammals, namely red fox (*Vulpes vulpes*), wolf (*Canis lupus*), Eurasian lynx (*Lynx lynx*), roe deer (*Capreolus capreolus*), red deer (*Cervus elaphus*), brown bear (*Ursus arctos*). To assess the impact of COVID-19 pandemics, we divided the year 2020 into periods based on restrictions, i.e., from 1 January 2020 to 15 March 2020, when the movement of population was unrestricted (period I.), from 16 March 2020 to 6 May 2020, when there was lockdown (lockdown 1), from 7 May 2020 to 23 October, when the free movement of citizens was allowed (period II.) and from 24 October to 31 December 2020, when the movement of citizens was restricted (lockdown 2). We compared daily frequencies of recreational activities during the lockdown periods and periods without lockdown. The recreational usage of roads included the occurrence of pedestrian tourists, cyclists, motorbikes, and personal cars. Forestry personnel of the University Forest School Enterprise uses only SUV cars; hence, the occurrence of all SUV cars was assigned to forestry operations.

Statistical analyses were performed in STATISTICA 12.0 programme. Data normality was examined with the Shapiro–Wilk test, which showed that the data are not normally distributed ($p = 0.000$ for $\alpha = 0.05$). Hence, to compare the recreational use of roads in the specified periods of lockdown with the periods with unrestricted movement, we applied the Kruskal–Wallis test, which is a one-way ANOVA on ranks, and the multiple comparisons of mean ranks of recreation activities for all pairs of groups (Period, Season). Further data processing, their overview, and graphs were performed in MS Excel.

3. Results

Over the whole monitored period starting from 1 January 2020 to 31 December 2020, we recorded 4575 objects on roads at both localities, out of which 2569 were motor vehicles, 791 cyclists, 493 tourists, 642 wild animals, and 80 employees. At A locality (Včelien), we collected 3507 records in total, consisting of 2133 motor vehicles, 725 cyclists, 341 tourists, 249 wild animals, and 59 employees of UFE. At B locality (Štagiar), we recorded 1068 objects, including 436 motor vehicles, 393 animals, 152 tourists, 66 cyclists, and 21 employees of UFE.

First, we evaluated the impact of lockdown on recreation. We expected an increase in recreational use of forest roads in lockdown periods. To examine the differences between the periods, we performed a Kruskal–Wallis ANOVA. The overview of the results of this analysis is shown in Figure 3.

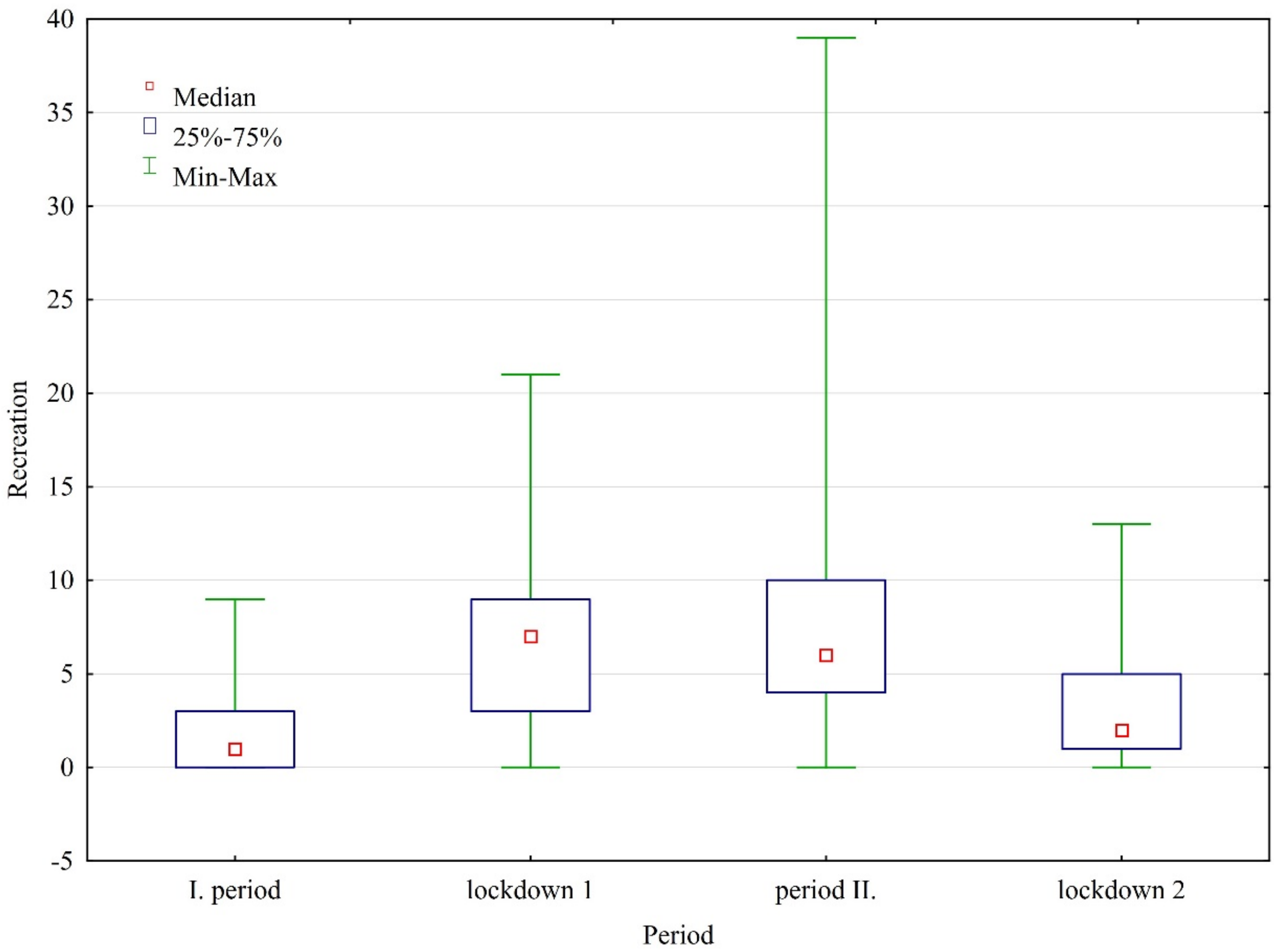

Figure 3. Kruskal–Wallis ANOVA comparison of median values of the daily number of recreational activities in periods of lockdown and of unrestricted movement, $p = 0.000$.

According to the Kruskal–Wallis ANOVA results, there were significant differences between periods. Based on the graph, we can state that the highest median value of recreational activities was recorded during lockdown I. and period II. In addition, we performed multiple comparisons of p values to evaluate differences between periods. The overview of the test is presented in Table 3.

Table 3. Multiple comparisons of mean ranks of recreation activities for all pairs of groups (Period). p Values are two-sided significance levels with a Bonferroni adjustment.

Dependent Variable: Recreation	**Multiple Comparison of p Values (Bilateral). Recreation Independent (Grouping) Variable: Period Kruskal–Wallis Test: H (3, N = 366) = 93.74552, p = 0.0000**			
	I. Period R: 99.947	**Lockdown I. R: 221.98**	**II. Period R: 226.14**	**Lockdown II. R: 140.79**
I. period		**0.000000 ***	**0.000000 ***	0.124510
Lockdown I.	**0.000000 ***		1.00000	**0.000206 ***
II. period	**0.000000 ***	1.00000		**0.000000 ***
Lockdown II.	0.124510	**0.000206 ***	**0.000000 ***	

* bold in table = statistically significant differences.

According to multiple comparisons of mean ranks of recreation activities for all pairs of groups, there were significant differences between analysed periods, namely between lockdown 1. and lockdown 2, but not between lockdown 1 and period II., or lockdown 2 and period I. The test also revealed significant differences between lockdown 1 and period I. and between lockdown 2 and period II. These results indicate that lockdown did not substantially change the recreational use of forest roads in the investigated region. The analysis of the recreational use in periods with the unrestricted movement of people and with lockdown showed that it is necessary to examine the impact of the seasons of the year on recreation. Hence, we divided the year into four seasons: spring, summer, autumn, and winter. The period between 20 March 2020, and 20 June 2020, was assigned to spring, the period from 21 June to 22 September 2020 was identified as summer, the period between 23 September 2020 and 20 December 2020 as autumn, and the periods from 1 January 2020 to 19 March 2020 and from 21 to 31 December 2020 as winter. The differences in the frequency of recreational activities between the seasons were tested with Kruskal–Wallis ANOVA (Figure 4). The results of ANOVA showed significant differences in median frequency of recreational activities between the seasons, while recreational activities in forests were most frequent during the summer and spring and the least frequent in winter. To compare the seasons, we performed multiple comparisons of the mean ranks of recreation activities for all pairs of groups (Table 4).

Table 4. Multiple comparisons of mean ranks of recreation activities for all pairs of groups (Season). p Values are two-sided significance levels with a Bonferroni adjustment.

Dependent Variable: Recreation	**Multiple Comparison of p Values (Bilateral). Recreation Independent (Grouping) Variable: Season Kruskal–Walis Test: H (3, N = 366) = 107.4222, p = 0.0000**			
	Winter R: 108.63	**Spring R: 224.07**	**Summer R: 249.68**	**Autumn. R: 145.62**
Winter		**0.000000 ***	**0.000000 ***	0.118027
Spring	**0.000000 ***		0.582798	**0.000003 ***
Summer	**0.000000 ***	0.582798		**0.000000 ***
Autum	0.118027	**0.000003 ***	**0.000000 ***	

* bold in table = statistically significant differences.

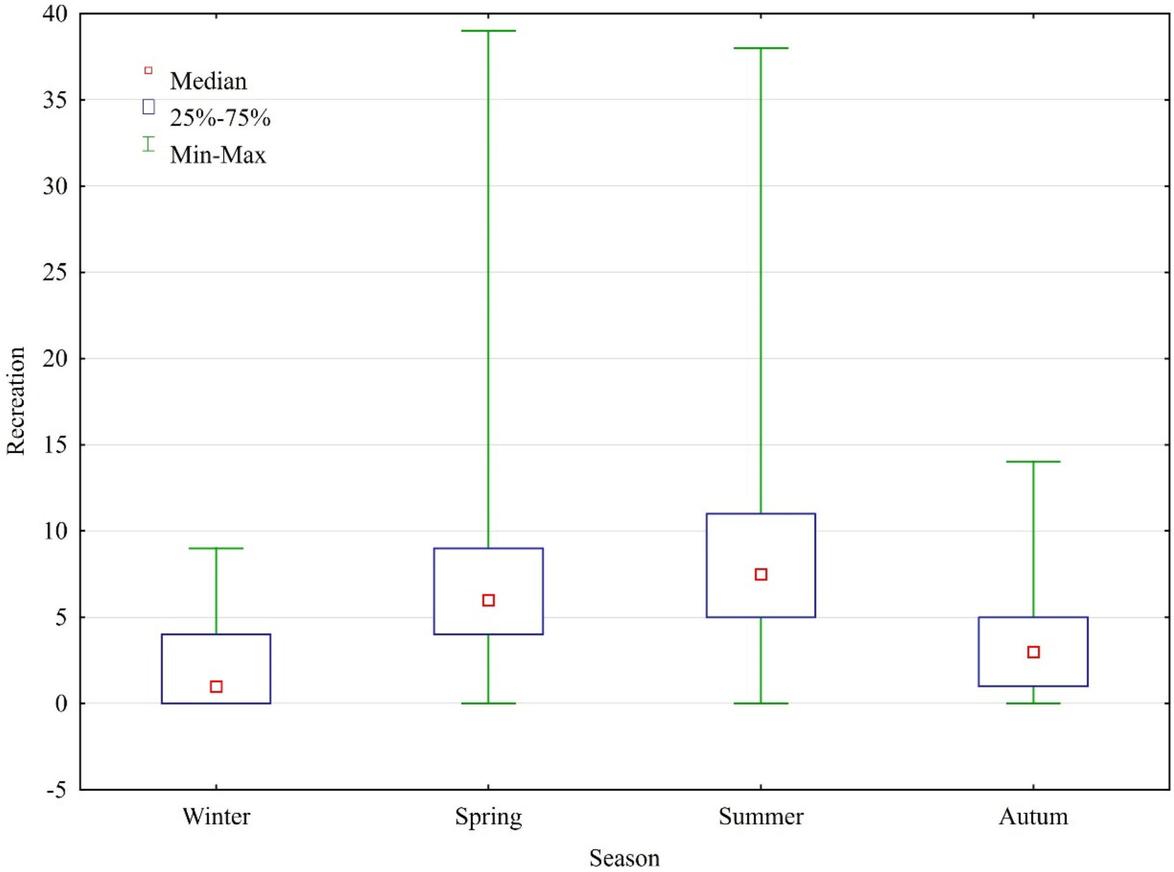

Figure 4. Kruskal–Wallis ANOVA comparison of median values of the daily number of recreational activities in individual seasons, p = 0.000.

Based on the statistical test, the differences between the recreation frequency in the winter and the spring or the summer were significant, while the difference between the winter and the autumn was not significant. No significant difference was revealed between the spring and the summer.

Subsequently, we analysed the relationship between the usage of forest roads and the occurrence of wild animals. Increased traffic frequency and recreational use of roads caused a reduction of wildlife occurrence at localities monitored by trail cameras. Hence, we expected a negative correlation between them. The results of the regression and correlation analysis are presented in Figure 5.

The analysis revealed a very loose negative relationship between the characteristics, which indicates that the movement of people and motor vehicles did not have a significant impact on the occurrence of wild animals on the roads.

The next part of the results is focused on the operational and recreational traffic load of selected road parts by motor vehicles. Absolute and relative frequencies of passages of individual vehicle types in the year 2020 are shown in Figures 6 and 7. During the year 2020, the most common vehicles at A locality were SUV cars (988 passages), followed by personal cars with a weight below 1.2 t (707 passages) and trucks (234 passages). The smallest number of passages was recorded for a category of buses (16 passages).

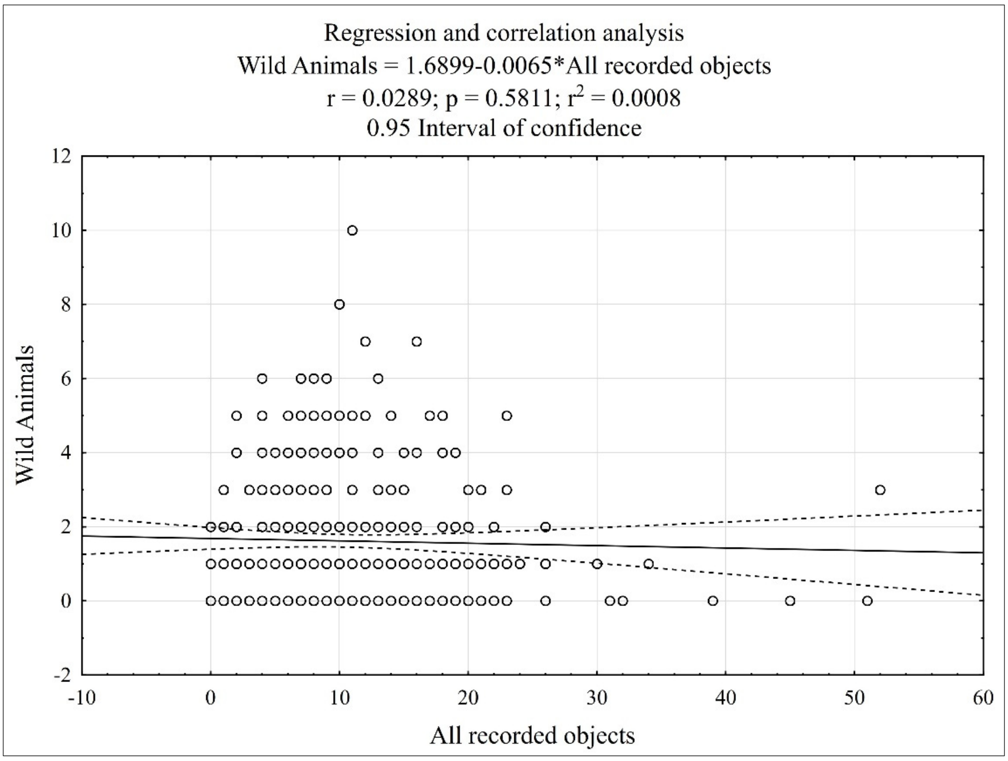

Figure 5. Regression and correlation analysis between daily frequencies of wild animals and all other objects recorded on the roads except animals (* in a figure caption is a multiplication sign).

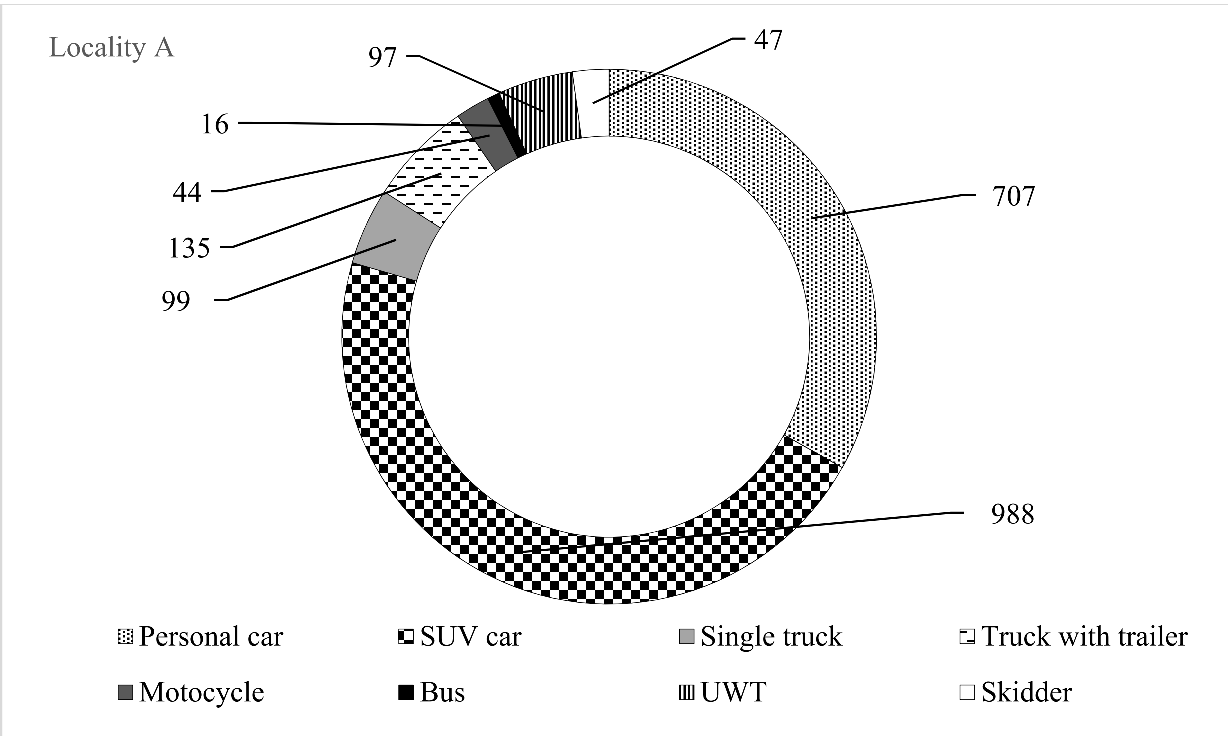

Figure 6. Absolute and relative frequencies of passages of individual vehicle types at A locality in the year 2020.

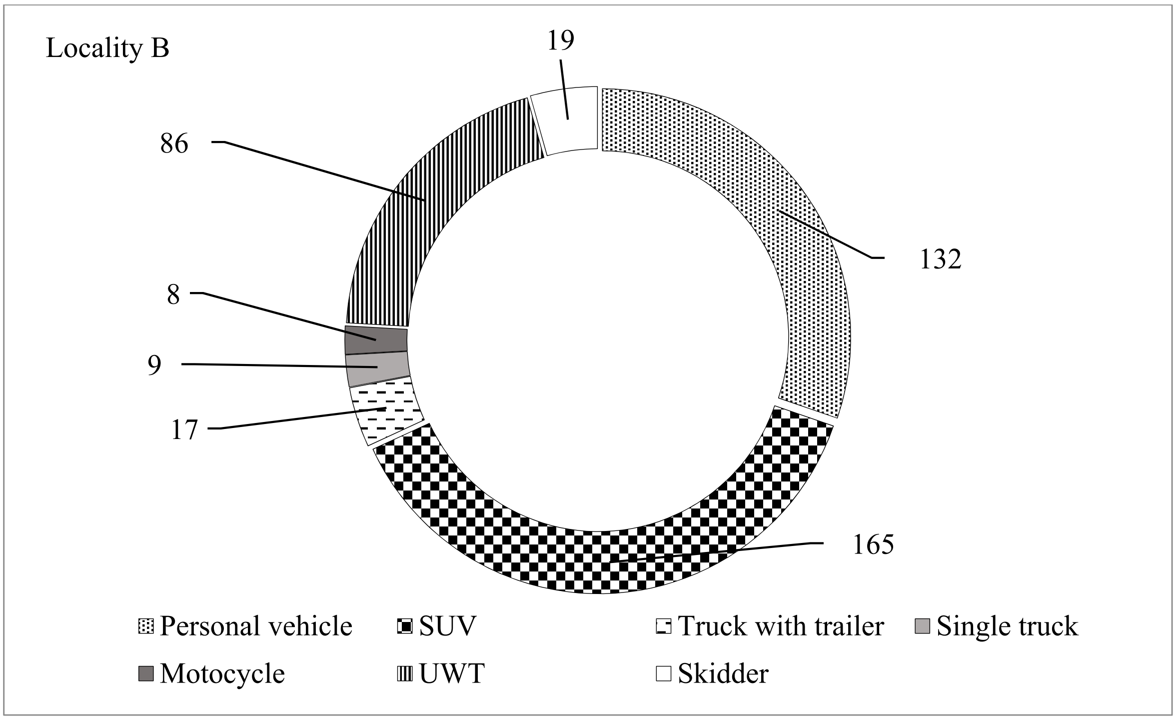

Figure 7. Absolute and relative frequencies of passages of individual vehicle types at B locality in the year 2020.

This is by 80% lower than the number of passages at A locality. During the year 2020, the most common vehicles at B locality were SUV cars with a weight below 2 t (165 passages), followed by personal cars with a weight below 1.2 t (132 passages), and universal wheeled tractors (86 passages). The smallest number of passages was found in the case of motorcycles (8 passages).

To evaluate the traffic load on forest roads, we determined the average weights of individual vehicle types. Average weights were derived based on particular vehicle types observed on the monitored forest roads (Table 2).

By multiplying the number of passages of individual vehicle types and their average weights, we calculated traffic loads on forest roads (Tables 5 and 6).

The total annual traffic load at A locality there was 9238.8 t. Trucks accounted for the highest proportion of the overall traffic load (567.6%, or 5326.2 t), followed by SUV cars (1.976 t) and personal cars up to a weight of 1.2 t (848.4 t). The highest traffic load was observed in August (1257.2 t) and May (1.131 t), while the lowest one was in January (359.4 t).

Similarly, we determined the traffic loads for B locality. At the second locality, the overall traffic load was 1.614 t in the year 2020. Trucks (503.2 t) and UWT (430 t) represented the highest share of the traffic load. The highest traffic load was observed in November (271.0 t) and March (239.4 t). The lowest traffic load was documented in October 2020 (41.2 t). The comparison of the two localities showed that the traffic load at B locality was 82.5% smaller than at A locality.

In forestry, forest roads are primarily constructed for forest management activities and wood transport; that is why they are called transport roads. Due to this, we focused on determining wood share in traffic load. At A locality, wood represented 60.2% of all truck loads and 27.8% of all passages of trucks. In total, 1.172 t of wood was transported along the road at A locality in the year 2020.

Table 5. Traffic load at A locality in the year 2020.

	Personal Car	SUV Car	Motocycle	Bus	UWT	Skidder	Single Truck Empty	Single Truck Loaded	Truck with Empty Trailer	Truck with Loaded Trailer	Sum
January	8	85	0	0	2	2	0	4	1	1	
February	20	105	0	0	4	1	0	0	6	4	
March	48	76	0	0	5	1	3	0	12	6	
April	57	57	14	0	4	3	2	5	8	8	
May	56	51	2	0	9	1	6	7	9	13	
Juny	100	91	14	0	19	1	3	2	3	6	
July	76	61	7	0	23	1	0	1	8	4	
August	99	128	4	0	8	25	11	9	8	3	
September	133	112	2	16	17	2	1	2	9	1	
October	59	78	1	0	4	3	8	13	6	7	
November	42	73	0	0	0	4	3	3	9	0	
December	9	71	0	0	2	3	8	8	2	1	
∑ Number of passages	707	988	44	16	97	47	45	54	81	54	
Number of trucks with timber load	0	0	0	0	0	0	0	28	0	37	
Weight of timber load (t)	0	0	0	0	0	0	0	336	0	836.2	∑ = 1172.2
Vehicle weight according type (t)	1.2	2	0.3	7.5	5	10	11.2	23.2	17.4	40	
Total annual traffic load (t)	848.4	1976	13.2	120	485	470	504	1252.8	1409.4	2160	∑ = 9238.8

At B locality, wood occurred in 62.5% of all loaded trucks and 19.2% of all passages of trucks. In total, 70.6 t of wood was transported along the road at B locality. The presented results indicate that although forest roads had been primarily constructed for wood transport and forest management, they were used for timber transportation only to a minimum extent. To evaluate the usage of forest roads by public or other purposes than forest management, we divided vehicles as follows: vehicles used for forest management and forestry works (personal SUV cars, single trucks, trucks with trailers, UWT, skidders), vehicles used by the public (personal cars up to 1.2 t, buses, motorcycles). We divided personal cars into the groups shown above because UFE provides its employees only with SUV cars. Motorcycles, personal cars with a weight of up to 1.2 t, and buses are not used by UFE. From the perspective of the number of passages, the usage of roads for recreation and other non-forestry purposes was approximately 34% (average from both localities) (Figure 8). If the passages are assessed from the point of traffic loads caused by different vehicle types (Figure 9), the load due to recreation or other than forestry usage was only approximately 10.3% (average from both localities).

Table 6. Traffic load at B locality in the year 2020.

	Personal Car	SUV Car	Motocycle	Bus	UWT	Skidder	Single Track Empty	Single Track Loaded	Truck with Empty Trailer	Truck with Loaded Trailer	Sum
January	3	9	0	0	1	0	0	0	2	0	
February	11	15	0	0	4	0	0	0	0	0	
March	3	11	0	0	30	0	0	2	1	0	
April	9	12	2	0	12	7	0	0	0	0	
May	28	11	1	0	12	1	0	0	1	0	
Juny	14	12	3	0	5	0	0	0	2	0	
July	17	15	2	0	2	0	1	3	0	0	
August	14	15	0	0	2	2	1	2	0	0	
September	5	9	0	0	0	0	0	0	0	1	
October	6	17	0	0	0	0	0	0	0	0	
November	17	27	0	0	0	4	0	0	9	0	
December	5	12	0	0	18	5	0	0	1	0	
∑ Number of passages	132	165	8	0	86	19	2	7	16	1	
Nuber of trucks with timber load	0	0	0	0	0	0	0	4	0	1	
Weight of timber load (t)	0	0	0	0	0	0	0	48	0	22.6	∑ = 70.6
Vehicle weight according type (t)	1.2	2	0.3	7.5	5	10	11.2	23.2	17.4	40	
Total annual traffic load (t)	158.4	330	2.4	0	430	190	22.4	162.4	278.4	40	∑ = 1614

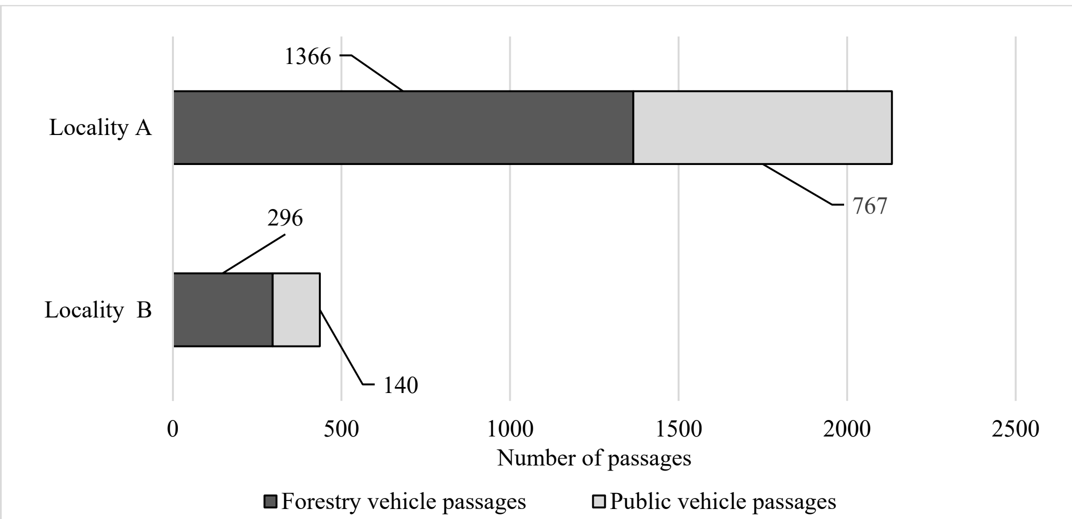

Figure 8. Comparison of annual numbers of passages of forestry practice and public.

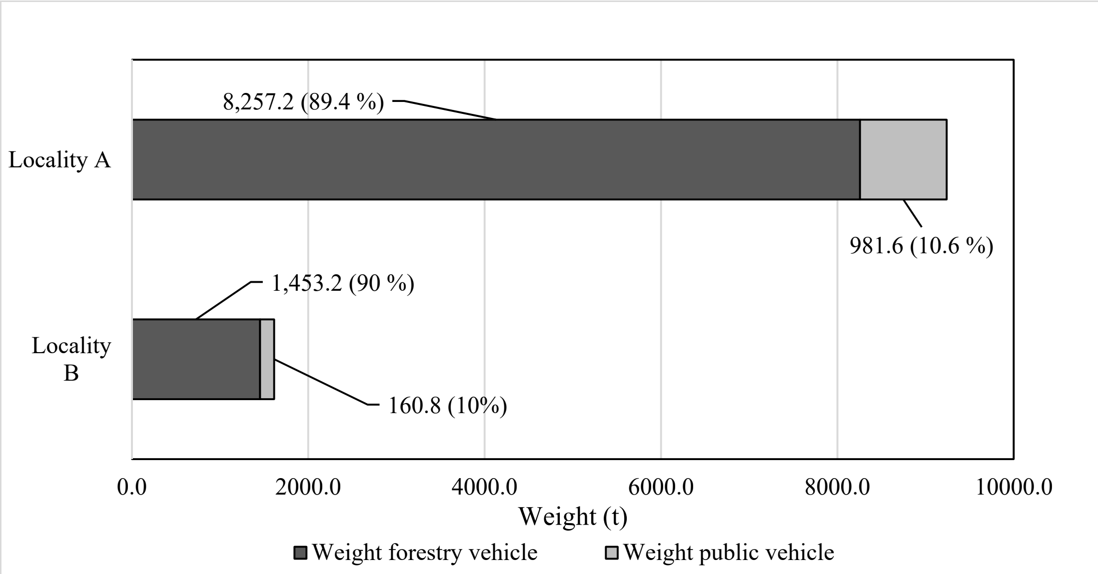

Figure 9. Comparison of traffic loads from passages of forestry practice and public vehicles.

4. Discussion

Several authors pointed out that one of the main factors affecting recreational activities in forests is the distance from the place of recreation [13,15,31]. Based on this knowledge, we analysed recreational activities in forests close to settlements in Central Slovakia and examined the impact of COVID-19. We did not reveal any significant increase in recreational activities during the periods of lockdown. This result can be because inhabitants of Zvolen town or other larger settlements went for a walk or a bicycle ride in town parks, green areas located within their settlements, or cyclo-paths with built infrastructure. Such a behaviour has been documented by, e.g., [15], who found increased outdoor recreation, particularly at sites that offer multiple cultural ecosystem service benefits. In their study, Turku citizens used the green infrastructure in the city intensively during the COVID-19 spring. According to the inhabitants, the urban nature near their residence is very important for recreation. Approximately 70% of people visited areas within or in the vicinity of the city's official recreation sites. Further exploration revealed that the majority, over 80%, of sites were visited with a similar frequency or more often compared to pre-COVID-19 times. The authors of [32] estimated that outdoor recreational activity increased by 291% during lockdown relative to a 3 yr average for the same days in Oslo. Pedestrian activity increased in city parks, peri-urban forests, as well as protected areas. During the lockdown period, the recreational use of green spaces intensified within residential areas and city parks nearly as much as in the forested zone. The authors highlighted the value and importance of inner-city green spaces. Similarly, [33] state that travel and physical distancing restrictions have an impact on the recreation patterns of the urban population. In New Zealand, [34] found an increase in outdoor walking on local streets and tracks during the lockdown period. In our case, the monitored localities A and B are situated 13.7 and 14.5 km from the town of Zvolen, respectively. The vicinity of villages Budča and Turová do not have to cause the increase in recreational activities in forests because their inhabitants live in houses with gardens. Hence, their need for outdoor recreation is lower in comparison to urban population, who live in flats with no gardens.

In the case of wildlife, we expected a negative correlation between its occurrence and the number of passages of all monitored objects (vehicles and people), since it is known that the presence of humans in a wildlife habitat may result in animals avoiding parts of their normal range [35]. The regression and correlation analysis pointed out that recreation and traffic in our research area did not have a significant impact on the occurrence of wild animals. The reason behind this may be the fact that forest roads rarely used by humans (in our case, 10.8 objects per day) may act as corridors for terrestrial animals and plants [36]. At monitored localities, we observed a dominant occurrence of motor vehicles (2569 per year). The number of people that went for a walk or a bike ride was only 1284 per year, i.e., less than half of the number of recorded vehicles.

The authors [22] state that the non-motorised visits had greater negative effects on wild animals than motorised visits. A smaller number of hikers and cyclists were not too disturbing for wild animals in the investigated area. Motorised activities are often expected to be more harmful to animals because of vehicle speed and noise, but results of [22] suggest the opposite across a wide range of locations and taxa. Researchers [25] studied the responses of bighorn sheep to hikers, mountain bikers, and vehicles. They found that sheep exhibited a greater probability of flushing, longer distances moved, and longer response durations when disturbed by hikers compared to mountain bikers or vehicles. The study [37] shows that wolves used forest roads to travel fast and far across their home ranges but spent relatively little time on roads, especially during the time of highest human activity. Typically, pedestrians induce a more intense wildlife response than do motorised vehicles, perhaps because animals react most to the human form [26,38].

Forests in Slovakia cover vast areas and create extensive landscape complexes. Hence, it is necessary to construct roads of different types and qualities to ensure forestry management and transport of material. Dobre [10] dealt with the utilisation of forest roads for forest management in Slovenia. He performed his research in eight forest enterprises, four in public forests and four in private forests. The author of [10] concluded that in public forests, the greater part of traffic (60%) represents the transport of people. The traffic resulting from the removal of timber is about 30% and increases with forest yield. The passages due to transport of material and equipment represent about 8%. From the point of the type of vehicles for people transport, cars represent 80% of traffic, and vans the remaining 20%. A substantial proportion of wood (66%) is transported from the forests by trucks with trailers and 34% by single trucks. Annually, 865 vehicles enter 1,000 ha of public forests with an annual cut equal to 4 m^3/ha. In private forests, the prevailing vehicle type is a car (41%), followed by tractors (35%), trucks (20%), and vans (4%). In private forests, 1200 arrivals of vehicles per year were recorded for an area of 1000 ha and an annual cut of 4 m^3/ha [10]. Our study recorded 4575 recorded objects per year at an area of Budča I. forest district, which covers 3954 ha of forests, which means 1157passages per 1000 ha and an annual cut of 3.80 m^3/ha.

Dobre [10] also monitored passages in intra-annual periods. In public forests, the work continues throughout the year, while the number of passages is reduced in winter. In private forests, seasonal changes are evident. Two maxima are observed. The first one is in spring from March to the end of May, while the second one is from September till the end of November. Our study observed maximum numbers of passages in August and September (A locality) or in November and May (B locality). In Slovenia, timber transport represents 87% of the total amount of transported material in public forests and 76% in private forests, with the annual cut equal to 4 m^3/ha. Other researchers [11] describe the usage of forest roads in Slovenia and reveal the changes in their use.

Forest roads must be adapted to social demands; nowadays, they should provide many non-production services due to the modern lifestyle. The consequences of these trends will be visible as traffic increases on forest roads. A higher share of non-forestry uses of forest roads will require higher standards of transportability, road equipment, and maintenance [39]. Nevertheless, forestry-related use of forest roads remains the most important and represents 40% of all uses of forest roads, followed by hunting (17%) and farm opening (13%). In our study, the roads were used for forestry purposes at approximately 66%, and the remaining 36% represented recreation and other purposes.

Authors [40] performed a similar study in the southern parts of Slovenia. From 440 ha of forests, they gravitated wood to a selected forest road (12,000 m^3 of a 10-year harvesting volume). The transported quantity reached 3500 t/year at the connection to the public road. The results seem high, but if we divide the values by the number of days suitable for forest work (180 days/year), we attain only 19 t/day, i.e., less than one vehicle per day. The ratio of wood transported by trucks and tractors with semi-trailers was estimated −85% by trucks and 15% by tractors with semi-trailers. The authors state that this traffic load by wood transport is low. The relationship between forestry and tourism describes [41]. The existence of forest roads owned by forest subjects is one of the benefits for the use of public recreation. When considering the increasing use of forests and forest roads for recreation, it is necessary to pay attention to this area also from the point of forest road maintenance.

5. Conclusions

It is probable that due to the COVID-19 pandemics, periods of lockdown and restrictions will continue to occur in the future. Hence, surveys such as the one presented in our work are becoming more important, particularly from the point of creating space and conditions for recreation by citizens. In the investigated area, we did not reveal a higher frequency of visitors during the periods of lockdown. Forestry operations and recreation did not have a negative impact on the occurrence of wild animals at the monitored forest roads. The observed intensity of operation and recreation did not cause the reduction of the occurrence of large mammals in the surrounding of the monitored parts of forest roads.

When analysing the traffic load of forest roads, we found that the prevailing portion of vehicles (64%) that used roads at the monitored area were related to forestry management, which was not substantially affected by the pandemics as the activities were performed outside. Approximately 36% of all monitored passages were for other purposes. UFE did not own these vehicles. Forest management vehicles represented 90% of traffic load on monitored roads, while the remaining 10% originated from other uses. The greatest part of the traffic load resulted mainly from the transport of wood and other materials by trucks, which are substantially heavier than personal cars. In total, we observed 359 trucks at both localities, which indicates approximately one truck per day at either of two localities. Hence, we can state that the traffic load of monitored localities caused by trucks was low. Apart from motor vehicles, forest roads were used for recreation by many tourists and cyclists, equal to 1284 persons per year. The results revealed that the monitored parts of forest roads were primarily used for forestry management. Nevertheless, recreation and other uses cannot be overlooked as 36% of vehicles represented other non-forestry forms of use.

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