

INTERDISCIPLINARY DOCTORAL SCHOOL

Faculty of Silviculture and Forest Engineering

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**Analysis of damage dynamics and  
human-bear conflicts generated  
by the conservation of the *Ursus  
arctos* species in the Centre  
Development Region of Romania**

SUMMARY

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BRAȘOV, 2024

### **Topic of the doctoral thesis**

Within this research, a comprehensive analysis of bear population management and human-bear conflicts in the Centre Region of Romania, over two specific time intervals, was desired, in order to present the effects of conservation of the *Ursus arctos* species.

To ensure an objective interpretation of the findings, the study necessitated an extension to include data from various European countries. Thus, a comparative analysis was conducted, juxtaposing the data from the Centre Region with that of nations such as Sweden, Slovakia, Croatia, Bosnia & Herzegovina, and Slovenia.

Beyond this, the scope of the research expanded to include an assessment of logging activities and artificial reforestation in the forest areas of the Centre Region of Romania, whereas human-bear conflicts in Romania are most often associated with forest harvests and loss of bear habitat.

### **The fields in which it integrates**

The thesis is in the field of forestry (plant and animal resources engineering) and contains elements regarding the brown bear population size, harvest and/or intervention quotas, bear mortality, as well as details regarding the activities performed in their habitat. It also includes information on brown bear attacks, data on reporting bears' presence, and information regarding the prevention and combating of bears' actions.

### **Objectives of the research**

In order to reach the intended goal, it was necessary to accomplish the following set of objectives:

- a) Determining the level of intervention in the brown bear population in the Centre Region of Romania.
- b) Evaluation of the ecological, economic, and social effects of bear overpopulation in the study area
- c) Identification of the relationship between forest area size, harvested wood volumes, and afforested areas in relation to human-bear incidents.
- d) Comparison of harvest bears and the number of human-bear conflicts in Europe with those in the Centre Region of Romania

### **Structure of the thesis**

The doctoral thesis is structured as follows:

Introduction

Chapter 1. Current state of knowledge on the taxonomy, range, biology, ecology, ethology, conflicts and methods of prevention of human-bear conflicts and management of the brown bear (*Ursus arctos* L.)

Chapter 2. Aim and research objectives

Chapter 3. Material and research methods

Chapter 4. Results

Chapter 5. Discussions

Chapter 6. Conclusions. Original contributions. Dissemination of results. Future research directions

Bibliography

## **Research methodology**

The research period from 2010 to 2023 was divided into two intervals. The first interval (i1) comprises the years 2010-2016 and involved the period of approval of the *Ursus arctos* species' harvest quota and administering complementary food. The second interval (i2) comprises the years 2017-2023, which saw the harvest quota approval and complementary feed administration discontinue. Only limited prevention or intervention was permitted, and bears posing a threat to public safety could be shot under imposed restrictions.

### **1. Field phase**

To confirm the presence of conflicts caused by bears, assess their impact, identify factors affecting compliance with compensation procedures for the damaged persons, and identify measures to prevent or mitigate such incidents, on-site damage was documented and evaluated in various communes in Braşov County. Participating in these activities gathered qualitative data on the locations and causes of human-bear conflicts, types of injured persons, and information on human-bear coexistence.

Qualitative data were also gathered through direct observations conducted within the natural habitat of brown bears in Braşov County. These observations took place at five hunting areas during the months of April to July and September, and the information was taken following participation in brown bear species assessment actions. The purpose was to gain insights into the methodology used to estimate the bear population and to compare the results reported by officials with those provided by hunting areas managers.

The direct observations involved counting bears found at wild boar feeding areas or estimating the number of bears based on footprints and images captured by managers' video cameras. This allowed valuable information about bear behavior and the evaluation methods employed in Romania to be gathered. It also provided insights into the centralization of the evaluation results.

Overall, participation in these activities not only enabled understanding of bear behavior but also highlighted the evaluation procedure, the period of evaluations, and the method used for bear population estimation in the region.

In order to verify the accuracy of the data submitted by the public institutions and people who have had direct encounters with brown bears, as well as to understand the methodology used to carry out these activities, participation in the immediate intervention actions provided by Ordinance No. 81/2021 was carried out. During these operations, three activities were witnessed, including capturing and relocating three bears with cubs located on Stejărişului and Nisipului streets in the Municipality of Braşov. The results of these observations provided information about the factors that influence the presence of bears in urban areas, as well as the pros and cons of the intervention methods specified in Ordinance No. 81/2021.

Starting from the records found in the scientific studies revised for this thesis, observations were made in different zones of the forest area in the Centre Region of Romania to determine the impact of loggings on the habitats and the *Ursus arctos* species as well as their correlation with human-bear conflicts. Observations were conducted in several production units during the spring, summer,

and fall seasons to gather qualitative information from different altitudes and times of the year. This approach provided data on the influence of logging on bear habitats, the type of vegetation that develops due to clear-cutting or mesh connections, the results of artificial regenerations, and the factors that disturb the tranquillity of the species under study.

## 2. Office processing

### 2.1 Working method for establishing the legal status of the *Ursus arctos* species and the methods of preventing or combating damage at the European level and in Romania

The information-gathering process involved querying legislative databases, consulting 31 national and international regulations, and 12 brown bear management and action plans. Additionally, bear population size and natural habitat data were collected to calculate bear density.

The study also looked into approved harvest quotas for *Ursus arctos* in countries with over 500 bears, then continued with the assessment of bear damage in countries where a period similar in length to that of the Centre Region of Romania was identified (e.g., Slovenia, Slovakia, Croatia, Bosnia & Herzegovina, and Sweden). Finally, the study evaluated approved harvest quotas and bear damage in the Centre Region, comparing them with other European countries.

### 2.2 The methodology for determining the evolution and the mortality of bear packs

After gathering data on the actual count and optimal number of brown bears from the national assessment studies and the number of deceased bears from the "National Register of Captures and Accidental Killings" and local authorities, the information was classified into specific categories based on years and counties.

The research framework assessed the mortality of the *Ursus arctos* species, considering cases such as harvesting by hunting associations, collisions with cars or trains, and unknown causes of death. This organization allowed for observing changes in the bear population across the Centre Region of Romania.

After completing the brown bear mortality data collection, a cross-reference analysis was performed on bear individuals' numbers approved for harvesting by the central public authority for environmental protection. The percentage of bears extracted by harvesting from the number of existing bears within the study area was then calculated.

Additionally, the normalization of the actual bear packs to the bear's optimal population number was calculated based on the bears individuals evaluated in the year 2023. The formula used to calculate the harvest quota necessary for the normalization of the bear population was the one provided in Order No. 478/2002 for the situation when the real number is higher than the optimal one ( $I > 1.00$ ):  $Hq = Ai + 0.25x(Rn - On)$

The elements used in the formula above represent:

- $Hq$ = harvest quota
- $Ai$ = medium annual natural increase
- $Rn$ = real bear number
- $On$ = optimum bear number

### **2.3 The research method for the presence of the brown bear and ways to prevent or combat some incidents**

If bears are spotted in a town, people can call "112" for assistance. Emergency service dispatchers notify authorities to take action according to Ordinance nr. 81/2021. The authorities' actions were extracted from the Special Telecommunications Service database and the "National Register of drive-away, tranquilization and relocations or extractions by euthanasia or shooting of bear individuals", classified and recorded by county, year, and sex category of bear individuals.

In addition, an analysis was conducted to compare the frequency of calls with the frequency of conflicts and harvested bears.

### **2.4 The research methodology for the dynamics of bear-human conflicts**

The data collection process involved soliciting information from 415 town halls and extracting necessary data from damage files. Data was also obtained from various environmental protection agencies and individuals affected by bear-related damage or injury. In addition, a review of scientific papers was conducted for further insights.

Conflicts with bears were categorised into damages to crops/livestock/bees and attacks on people in the Centre Development Region of Romania. The collected data was organised by county and year of conflict to calculate the frequency and annual average of conflicts. Then, a comparative analysis of localities with human-bear incidents was carried out, and a list of the most affected communes was drawn up.

Data on bear attacks, including location, age range, gender of the individuals injured, and the type of activity performed at the time of the attack, were also compiled. Additional damage and the number of harvested bears were compared.

### **2.5 The collecting method of economic and financial data resulting from human-bear incidents**

As part of the study, information regarding compensations for damage caused by bears to people's property from 2012-2023 was collected. Data for 2010 and 2011 were not available.

Since no data regarding the moral damages paid to the injured persons for the first analyzed interval was found, only the information from the second interval was collected. The amounts paid for injured persons were divided into court costs and moral damages in RON and EURO. The information was extracted from final court sentences.

To carry out the study, were also collected informations on payments to hunting area managers and veterinarians for the services provided based on Government Emergency Ordinance No. 81/2021. The amounts paid were collected separately for each county of the study region and presented in graphical form by year and county. The values specified in the study were those approved for settlement by the responsible public authority.

## 2.6 The research methodology for information on the dynamics of the forest area

Relevant data was extracted from the National Institute of Statistics reports. The research concentrated specifically on the data of the period from 2010 to 2022 and followed the extraction of the informations on the size of the forest area surface, then the volume of harvested wood and the afforestation carried out in the studied region.

The gathered data was subsequently compared with information on instances of human-bear conflicts to assess and understand any potential correlations between the two.

## Results

### 1. Optimal bear number and evolution of the brown bear in the Centre Development Region of Romania

The lowest value of bear real pack in the Centre Region of Romania in the period 2010-2023 was 4,055 individuals and was recorded in 2010. The highest number of bears evaluated during the researched period was 8,723 individuals and was recorded in 2023 (Figure 1).

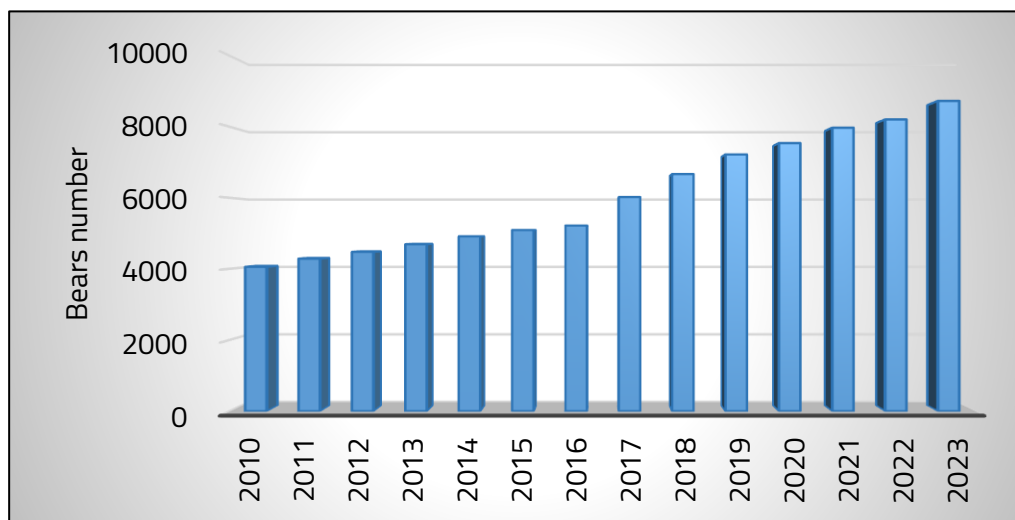


Figure 1. Brown bear population size according to assessment studies

The optimal numbers of bears for which there is natural habitat in the research region are 1,437 individuals. According to the data in Figure 2, the optimal bear number is 99 individuals in Alba county, 187 in Sibiu, 234 and 240 individuals in Covasna and Mureş counties, 338 and 339 individuals in Braşov and Harghita counties.

In 2023, the bear population in Alba County totalled 399 individuals, and that of Harghita County was 2,394 individuals.

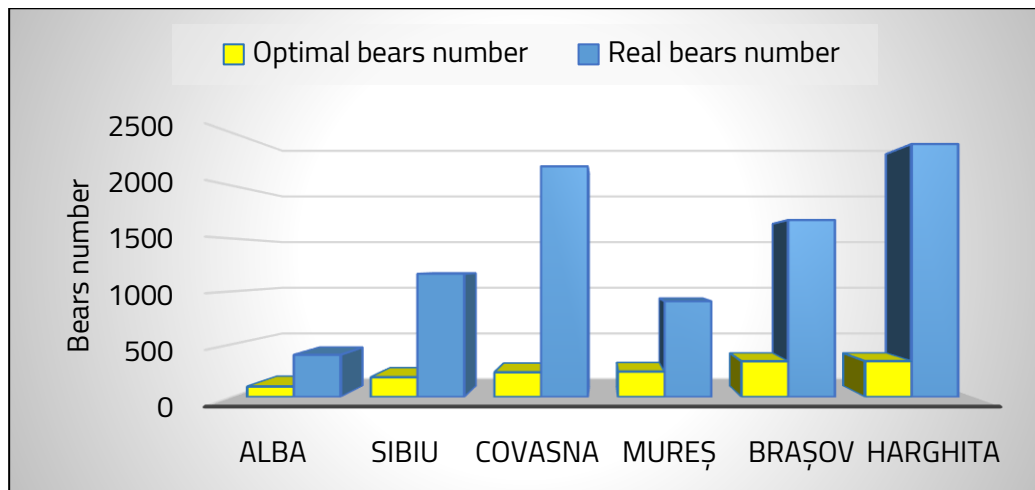


Figure 2. Comparison of optimal and actual bears number from the counties of the study area in the year 2023

The annual average of the 2010-2016 interval was 4,676 bear individuals, and the annual average of the 2017-2023 interval was 7,476 individuals (Figure 3). The number of bears in interval (i1) was about 60% lower than that in interval (i2).

The lowest number of bears, evaluated in the period 2010-2023, was recorded in Alba County, and the highest in Harghita County, according to Figure 4.

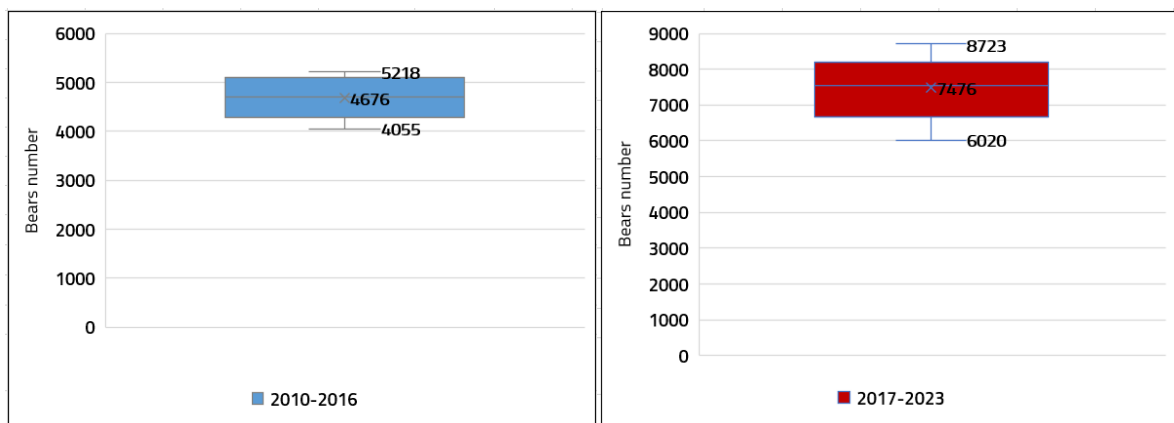


Figure 3. The annual mean of bears recorded in the two intervals (i1 and i2) in the studied area

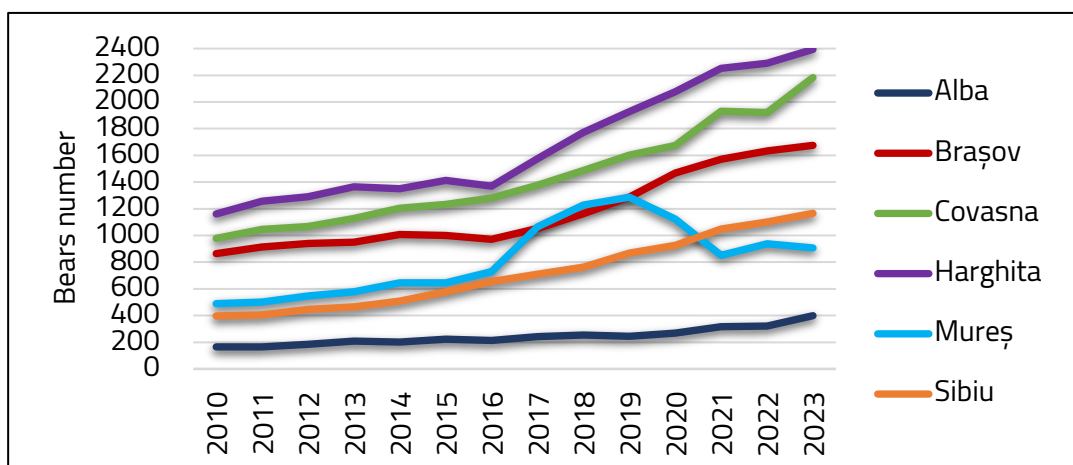


Figure 4. The size of the bear population in the counties of the Centre Region of Romania

In the interval 2010-2016, in Alba, the annual average of bears was 194 individuals, and in the interval 2017-2023 it was 292 individuals (Figure 5). In Harghita, the annual average of the interval (i1) was 1,315 individuals, and of the interval (i2) was 2,041 individuals.

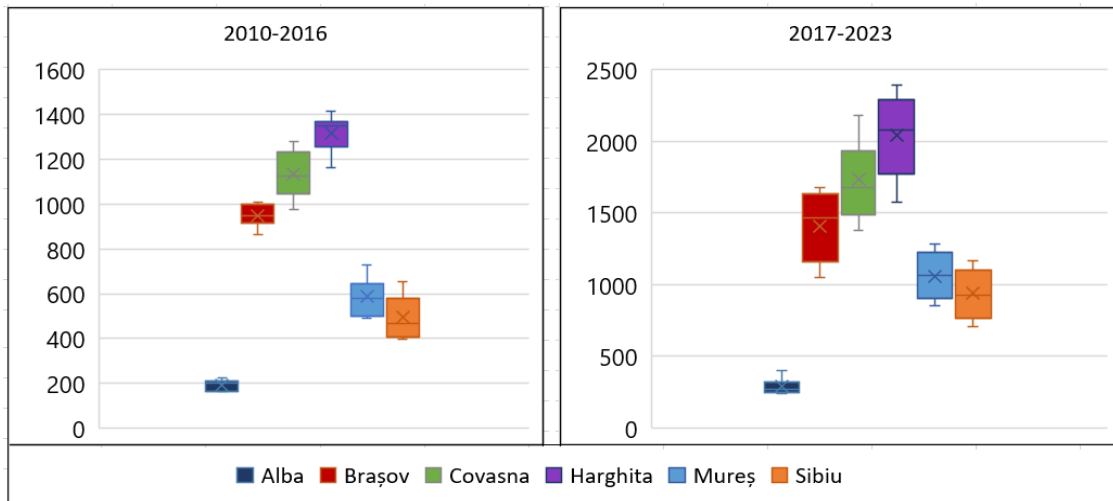


Figure 5. Annual average of bears in each county in the researched region

## 2. Brown bear mortality recorded on the territory of the Centre Region of Romania

Based on the level of prevention and intervention granted, game managers extracted by shooting several bears. In the first analyzed time interval, 119 individuals (year 2011) was the lowest number of bears harvested, and 219 individuals (year 2014) was the highest. In the second analyzed interval, as shown in Figure 6, 15 individuals (year 2021) was the lowest number of extracted bears, and 72 individuals (year 2022) was the highest.

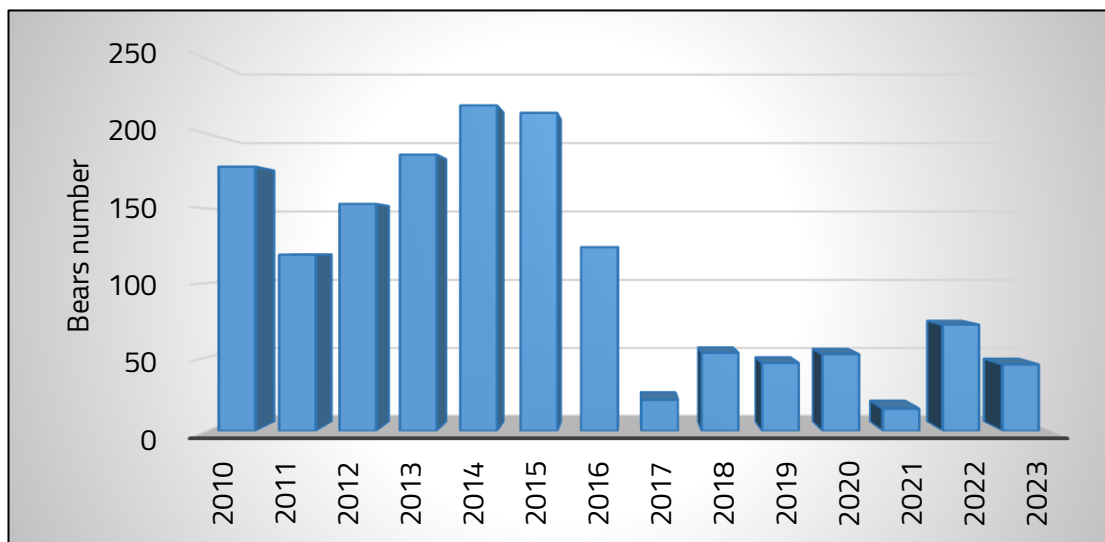


Figure 6. Number of bears shot in the study area

In the period 2010-2016, a number of 66 bears were identified that died as a result of natural causes or as a result of anthropogenic factors. Of this total, according to Figure 7, the highest number was recorded in 2014 (n=28), and the source of most cases was car accidents.



Railway accidents were the cause of the death of 14 bears in the research region during the above-mentioned interval; 8 bears died for unknown reasons, 6 bears were accidentally (in self-defense) shot during hunting parties organized for another species, and two bears were found caught in the snares.

In the period 2017-2023, in the territorial radius of the area under study, 335 cases of bears found dead were recorded, the highest number (n=80) being recorded in 2023. A total of 197 deaths occurred as a result of bears colliding with vehicles in traffic, 77 individuals were hit by the train, and 59 bears died of unknown causes. In this analyzed interval, one case of a dead bear was recorded, following his capture with snares.

The number of bears found dead in the first interval represents 16%, and the number in the second interval is 84% of the total number of dead bears in the research area.

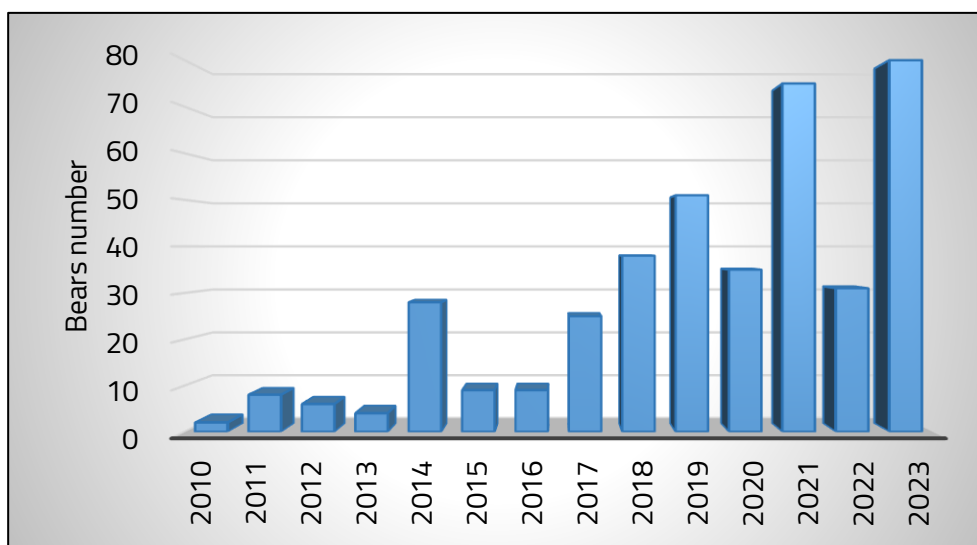


Figure 7. Bears deceased from natural or anthropogenic causes

### 3. Results of actions to prevent and/or combat human-bear conflicts

In the interval (i2), the harvesting of bears was also done based on the provisions of Emergency Ordinance No. 81/2021, and between July 2021 and December 2023, 42 brown bears were shot and/or euthanized (Figure 8).

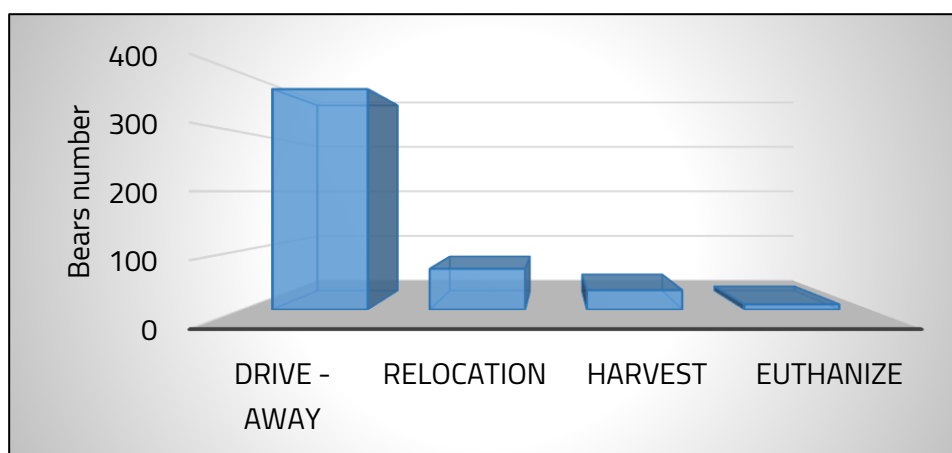


Figure 8. Actions carried out based on Ordinance No. 81/2021, in the period 2021-2023

Also, based on the normative act indicated above, 69 bear individuals were relocated to more distant hunting areas, within a hunting area adjacent to the current one or in sanctuaries, and 373 bears were chased away.

Based on the data in Table 1, the highest frequency of drive-away actions (44%) occurred in Braşov County. In Harghita County, bear relocation (42%) and harvesting (64) were carried out most frequently compared to all other counties in the studied area.

Table 1. Frequency of actions carried out pursuant to Ordinance No. 81/2021 in the Centre Region of Romania

County	Drive-away percent	Relocation percent	Harvests percent	Euthanize percent
Alba	3%	0	0	0
Braşov	44%	23%	3%	44%
Covasna	4%	10%	27%	22%
Harghita	33%	42%	64%	11%
Mureş	12%	20%	0%	11%
Sibiu	3%	4%	6%	11%

#### 4. Evaluation of the dynamics of bear individuals approved for harvesting and those deceased in the Centre Development Region of Romania

According to the data collected, 1,259 bears were reported dead in the interval (i1). The harvest level approved by the relevant ministry was 1,198 bear individuals, and 1,193 individuals were extracted from this quota. The remaining difference (n=66) comes from the number of individuals deceased from other causes.

In interval (i2), 681 was the number of bears that died in the counties of the study region. During this time frame, an intervention level of 466 bears was allocated, of which game managers harvested 304 bears. In addition to this last value, pursuant to Ordinance No. 81/2021, game managers were also harvested the 42 bear individuals mentioned in Figure 8. The difference of 335 dead bears comes from the number of individuals who died from non-shooting causes.

Of the total number of bears harvested in the study area, 78% were harvested in interval (i1) and 22% in interval (i2), as shown in Figure 9.

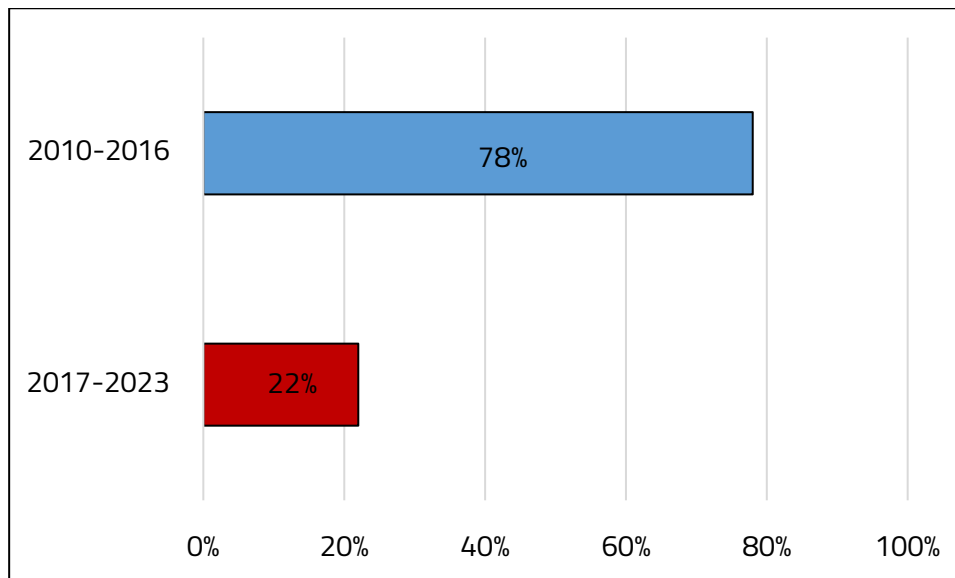


Figure 9. The proportion of extracted by shooting bears in (i1) and (i2), from the total number of bears harvested

### 5. Normalization of the real number of brown bears evaluated within the radius of the study area

In the counties under study, the actual packs of brown bears exceed the optimal level for which there is a natural habitat, which is why a simulation of their normalization was considered necessary.

The natural growth of the *Ursus arctos* species used for the calculation was 10%. Thus, starting from a real number of 8,723 individuals, a natural increase of 872 individuals resulted in the first year of the simulation performed. This share has gradually declined in subsequent years, and, according to the data in Table 2, in the period 2037-2052, the value of the share will be below 200 bear individuals, reaching 144 bears in 2052.

The normalization calculation of the brown bear herds indicates a maximum harvest quota of 2,694 individuals in the first year and a minimum quota of 144 individuals in the last year. After adjusting the bear's actual population, the resulting annual average of extractions would be 484 bear individuals.

Table 2. Harvest quota calculation to adjust bears number to the optimum level

Year	Real bear number (Rn)	Optimum bear number (On)	Natural growth		Rn/On	Rn-On	Harvest quota	Potential bear number
			%	(piece)				
2023	8723	1437	10%	872	6.07	7286	2694	6902
2024	6902	1437	10%	690	4.80	5465	2056	5536
2025	5536	1437	10%	554	3.85	4099	1578	4511
2026	4511	1437	10%	451	3.14	3074	1220	3743
2027	3743	1437	10%	374	2.60	2306	951	3167
2028	3167	1437	10%	317	2.20	1730	749	2735
2029	2735	1437	10%	274	1.90	1298	598	2411

Table 2. Harvest quota calculation to adjust bears number to the optimum level (continued)

Year	Real bear number (Rn)	Optimum bear number (On)	Natural growth		Rn/On	Rn-On	Harvest quota	Potential bear number
			%	(piece)				
2030	2411	1437	10%	241	1.68	974	485	2168
2031	2168	1437	10%	217	1.51	731	400	1985
2032	1985	1437	10%	199	1.38	548	336	1848
2033	1848	1437	10%	185	1.29	411	288	1745
2034	1745	1437	10%	175	1.21	308	252	1668
2035	1668	1437	10%	167	1.16	231	225	1610
2036	1610	1437	10%	161	1.12	173	204	1567
2037	1567	1437	10%	157	1.09	130	189	1535
2038	1535	1437	10%	154	1.07	98	178	1511
2039	1511	1437	10%	151	1.05	74	170	1493
2040	1493	1437	10%	149	1.04	56	163	1479
2041	1479	1437	10%	148	1.03	42	158	1469
2042	1469	1437	10%	147	1.02	32	155	1461
2043	1461	1437	10%	146	1.02	24	152	1455
2044	1455	1437	10%	146	1.01	18	150	1451
2045	1451	1437	10%	145	1.01	14	149	1448
2046	1448	1437	10%	145	1.01	11	148	1445
2047	1445	1437	10%	145	1.01	8	147	1443
2048	1443	1437	10%	144	1.004	6	146	1442
2049	1442	1437	10%	144	1.003	5	145	1441
2050	1441	1437	10%	144	1.003	4	145	1440
2051	1440	1437	10%	144	1.002	3	145	1439
2052	1439	1437	10%	144	1.001	2	144	1439

## 6. Dynamics of damage caused by bears to material goods

The total number of damages recorded in the period 2010-2023 was 12,271. Of the total damages, the smallest (n=73) represents the number of damages caused by the brown bear in 2010 (Figure 10) and had a share of 1% of the total damages.

The highest value (n=1,949) represents the damage caused in 2021, which accounted for 16% of the total damage caused by the brown bear during the period under investigation.

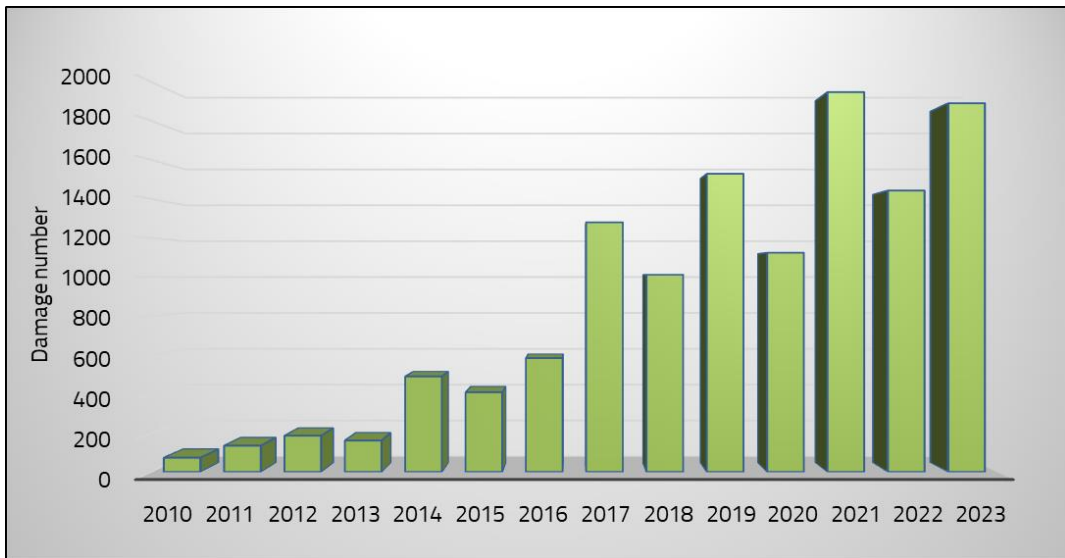


Figure 10. The situation of damage caused by bears in the Centre Region of Romania

According to Figure 11, the annual average of bear damage to people's property in the region under study was 291 cases from 2010 to 2016. In the period 2017 to 2023, damages recorded an annual average of 1,462 cases.

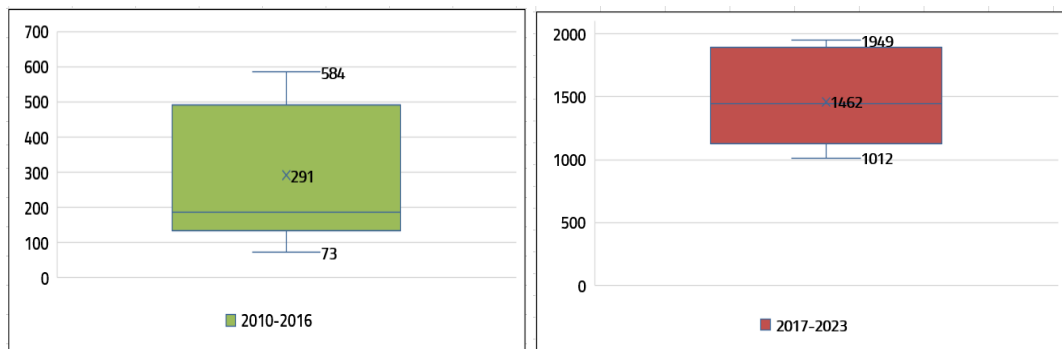


Figure 11. Annual average brown bear damage to people's property

Of the total number of damages reported in the Centre Region of Romania, 17% were recorded in the first time period analyzed and 83% in the second time period (Figure 12).

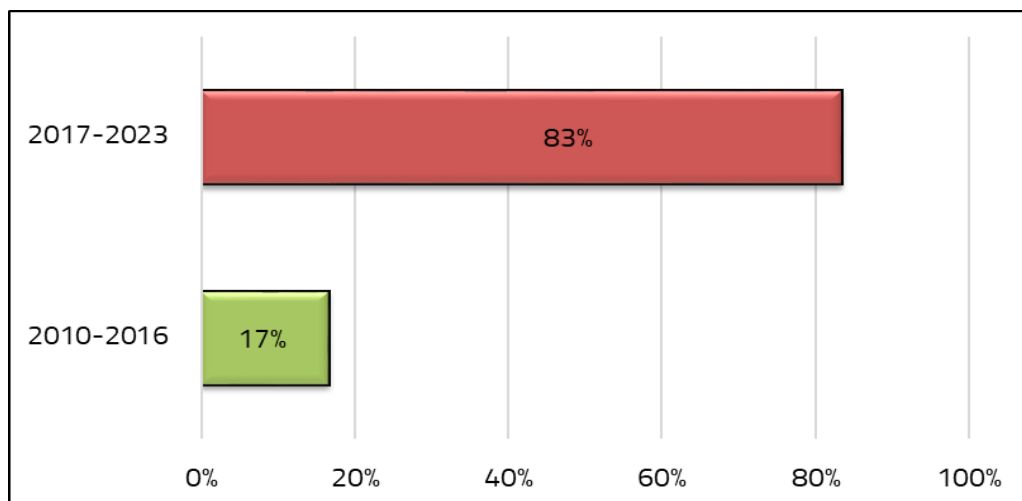


Figure 12. The proportion of damage recorded in intervals (i1) and (i2), from total bear damage

The damage analysis was also carried out individually for each county of the region. On this occasion, it was found that 341 damages were recorded in Alba County, and 3,815 damages to people's property were identified in Harghita County during the period under investigation (Figure 13).

Close to the amount of damages reported in Harghita County was Mureş County, with a value of 3,194 cases.

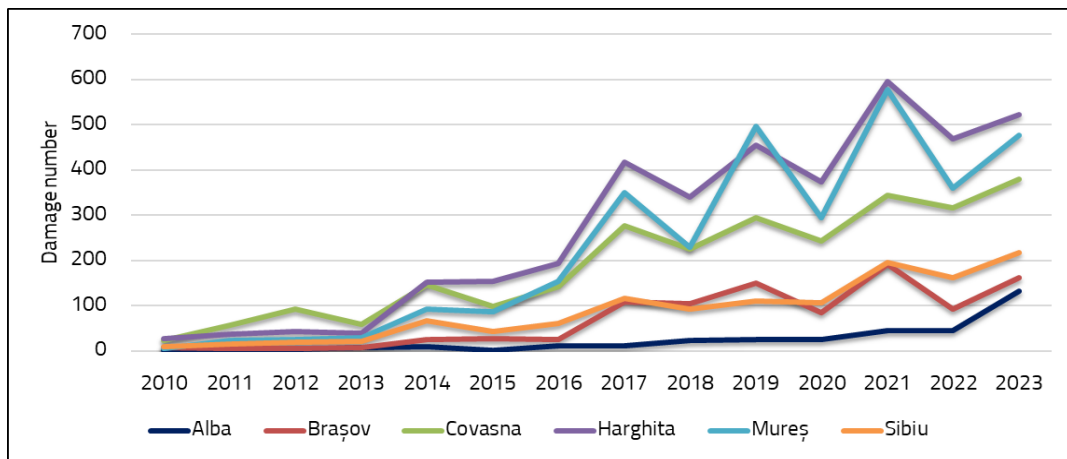


Figure 13. The damage caused by the brown bear in the counties of the Centre Region

The annual average of damage caused by bears to domestic animals or agricultural crops in Alba County was 5 cases in (i1) and 44 in (i2), and the average of cases in Harghita County was 92 cases in (i1) and 453 in (i2), according to Figure 14.

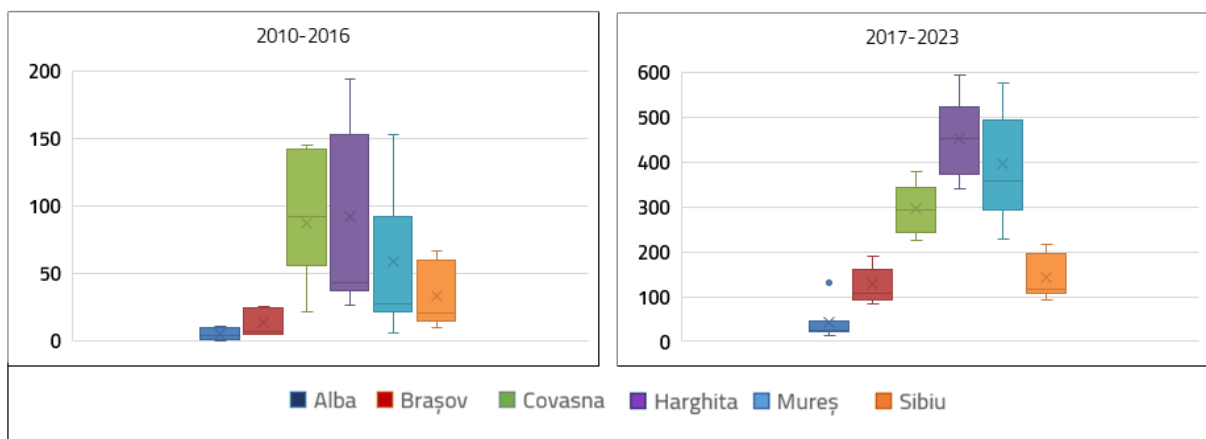


Figure 14. Annual average of material damage in each county in the researched region

In the period 2010-2016, in Covasna, Harghita and Mureş counties, the frequency of damage caused by bears was higher between 2014 and 2016. In the period 2017-2023, in addition to the previously mentioned counties, as well as in Sibiu and Braşov counties, the damage was recorded at a higher frequency throughout the examined period.

Damages recorded in the years 2021-2023 in Alba County (Table 3) also show an increased frequency, but the highest frequency was recorded by damages produced by bears in Harghita County in the interval (i2).

Table 3. Frequency of property damage recorded during the study period

Year	Alba	Braşov	Sibiu	Mureş	Harghita	Covasna
2010	1	7	10	6	27	22
2011	0	5	15	22	37	56
2012	4	5	18	24	43	92
2013	8	7	21	28	39	58
2014	10	25	67	92	151	145
2015	2	26	43	87	153	98
2016	11	24	60	153	194	142
2017	12	109	117	349	417	277
2018	22	105	92	228	340	225
2019	25	150	110	496	454	295
2020	24	85	107	294	373	242
2021	45	191	195	578	596	344
2022	45	93	161	360	468	317
2023	132	162	218	477	523	380

### 7. Analysis of damage dynamics according to the number of harvested bears

In the time (i1) interval 1,193 bears were harvested and 2,038 damages occurred. In the second time interval 346 bears were harvested and 10,233 material damages were recorded.

The annual average of the bears extracted by shooting in the interval (i1) was 56% higher than those extracted in the interval (i2), and the annual average of the damages in the first interval 67% lower than those in the second analyzed interval.

The lowest number of damages was recorded in 2010, when 178 brown bears were harvested that year. According to Figure 15, the year 2021 was the year in which damages recorded the highest increase in the analyzed period and also, in that year, the lowest intervention quota in the analyzed period was approved.

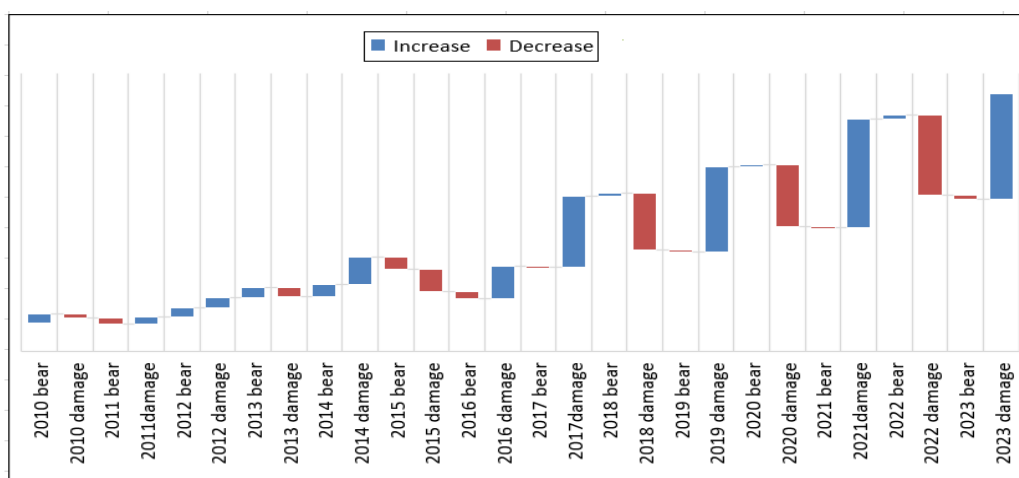


Figure 15. Variation of damage produced by bears according to the number of bears extracted by shooting

### 8. The dynamics of brown bear attacks in the Centre Region of Romania

The total number of attacks recorded from 2010-2023 was 234. From the total value of attacks, the smallest (n=2) represents the number of attacks produced by the brown bear in 2010 (Figure 16) and had a share of 1% of the total value.

The highest value (n=45) represents the attacks produced in 2021, which accounted for 19% of the total of this type of incidents produced by the brown bear during the period under investigation.

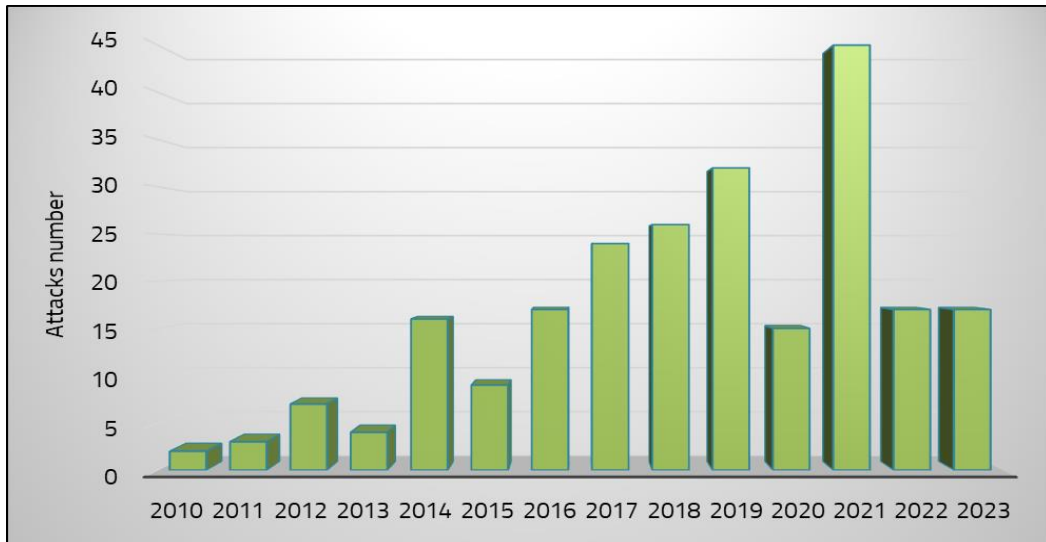


Figure 16. The situation of bear attacks in the research region

As with material damage, the attacks were divided into two ranges. Thus, in the period 2010-2016, the attacks recorded on people from the region under study averaged 8 cases per year, and 25 cases from 2017-2023 (Figure 17).

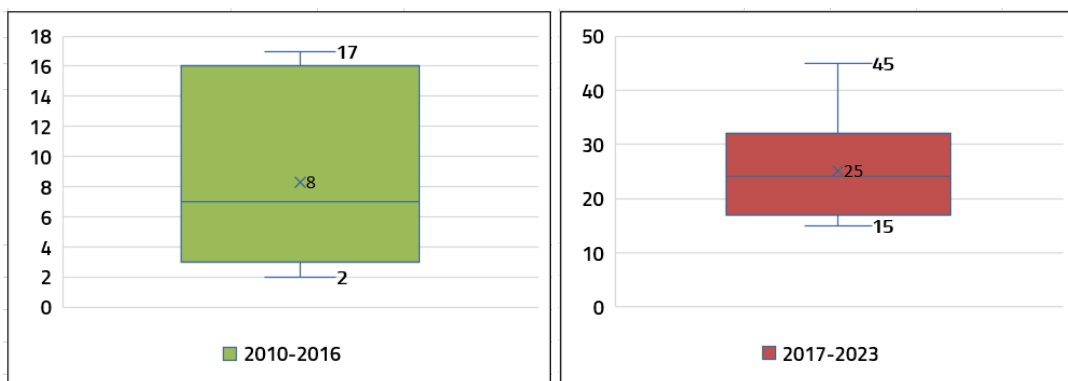


Figure 17. Annual average of bear attacks during the period in the study area

Of the total number of bear attacks in the Centre Region of Romania, 25% were recorded in the first time interval analyzed, and 75% in the second time interval, as shown in Figure 18.



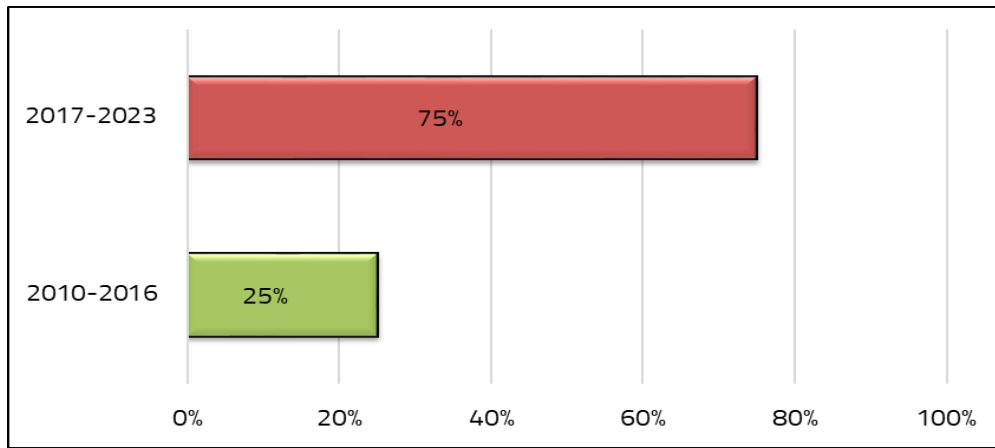


Figure 18. The proportion of attacks produced in the analyzed time intervals out of the total number of bear attacks

Only one case of bear attacks in Alba County was recorded during the period under investigation (Figure 19). In contrast, 104 attacks on people were reported within Harghita County.

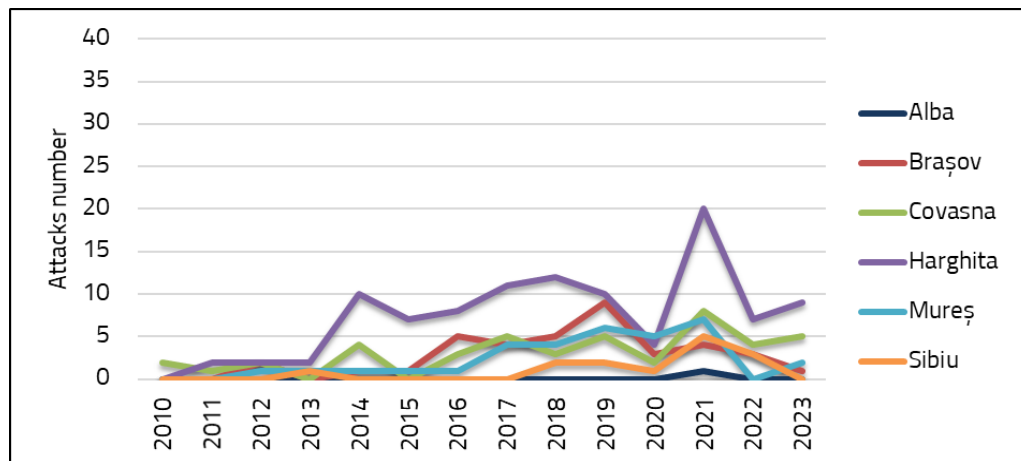


Figure 19. Distribution of attacks in the period 2010-2023

Bear attacks on people in Alba and Sibiu counties registered an annual average of 0 cases and 0.14 cases in (i1) interval and 0.14 cases and 2 cases in (i2) interval.

According to Figure 20, the average of attacks produced in Braşov and Mureş counties in the interval (i1) was 1 case/year, and of those produced in the interval (i2), it was 4 cases/year.

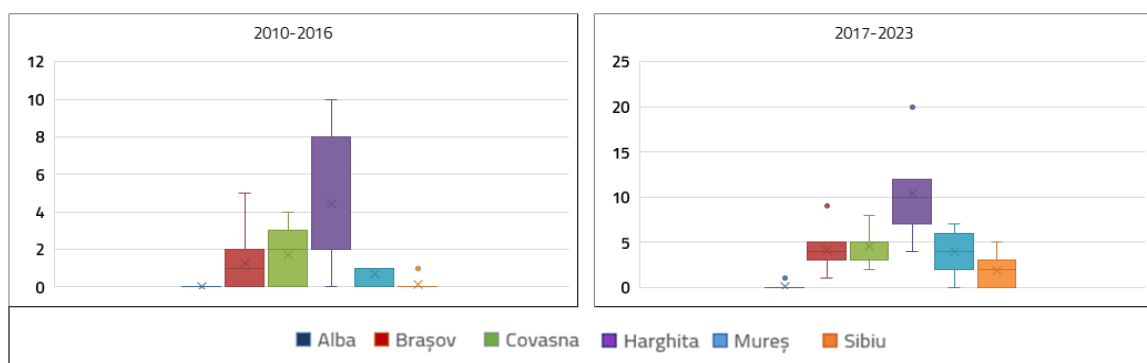


Figure 20. Annual average of bear attacks in the counties of the studied region

In Covasna County, the attacks launched on people in its territory averaged 2 cases/year between 2010 and 2016 and 5 cases/year between 2017 and 2023.

The average of cases in Harghita County was 4 cases/year in (i1) and 10 cases/year in (i2).

Between 2010-2016, the frequency of bear attacks was higher in 2014 and 2016, in Covasna County and between 2014-2016, in Harghita County. The frequency of attacks in these counties continued to increase during the period 2017-2023, and in 2021, the highest level of the frequency of attacks was recorded.

In Braşov County, a higher frequency of attacks on people was recorded in 2016 (Table 4), which was maintained until 2019, when the attacks reached the highest frequency in the analyzed period.

Brown bear attacks in Sibiu and Mureş counties had the highest frequency in the second interval (i2) analyzed, more precisely in 2021.

Table 4. Frequency of attacks recorded in the years 2010-2023

Year	Alba	Sibiu	Mureş	Braşov	Covasna	Harghita
2010	0	0	0	0	2	0
2011	0	0	0	0	1	2
2012	0	0	1	2	2	2
2013	0	1	1	0	0	2
2014	0	0	1	1	4	10
2015	0	0	1	1	0	7
2016	0	0	1	5	3	8
2017	0	0	4	4	5	11
2018	0	2	4	5	3	12
2019	0	2	6	9	5	10
2020	0	1	5	3	2	4
2021	1	5	7	4	8	20
2022	0	3	0	3	4	7
2023	0	0	2	1	5	9

Out of the 415 communes in the territorial radius of the Centre Region of Romania, bear attacks were recorded in 25 communes in the interval (i1) and 95 communes in the interval (i2). As a result of these events, 223 people were injured and needed medical care, and 11 people died.

In Alba County, no cases were reported in the first time period analyzed, and in the second, only one case was reported, in the year 2021, which took place within the radius of the Cenade locality, and the person was injured.

In Harghita County, in the interval (i1) within the radius of 12 communes, there were bear attacks, and in the interval (i2), 40 communes reported the existence of attacks within their administrative-territorial radius. This type of conflict resulted in the injury of 100 people and the death of 4 people in Harghita County (Table 5).

The people attacked in the research areas were mostly men, but there were also cases where women (n=6 cases) or children (n=7 cases) were attacked.

Table 5. The situation of the communes in the researched region where attacks were recorded

County	Communes total no.	Localities no. with attacks in (i1) interval	Localities no. with attacks in (i2) interval	No. of injured persons	No. of deceased persons	Attacked persons category (man, woman, child)
Alba	78	0	1	1	0	man
Braşov	59	3	16	35	3	men, women, child
Covasna	45	4	14	43	1	men, child
Harghita	67	12	40	100	4	men, women, children
Mureş	102	5	17	30	3	men, woman
Sibiu	64	1	7	14	0	men, children
<b>Total</b>	<b>415</b>	<b>25</b>	<b>95</b>	<b>223</b>	<b>11</b>	

According to Table 6, the attacks recorded in the interval (i1) were bear attacks on people in the forest when picking forest fruits, gathering soil or woody products, hunting, or at work. During this time period, bear attacks on people near the den were also reported, along with attacks whose location was not specified.

In the interval (i2), the people most frequently attacked by bears were those who were in the sheepfold, on communal pastures or agricultural land, those who were at the edge of the forest or on mountain trails, fishing, or the people in front of the block, in their own gardens or yards.

Among men, the most frequently attacked were shepherds and then farmers. The women were doing agricultural work or were in the yard, and the attacked children were tending the animals or standing in front of the houses/blocks.

Table 6. Area and time frame of brown bear attacks

Attack location	Alba	Braşov	Covasna	Harghita	Mureş	Sibiu	Interval
At the sheepfold		x	x	x	x	x	i1, i2
On the pasture with the cows				x			i2
Harvesting corn/potatoes		x		x		x	i1, i2
In the yard or garden				x	x		i2
To mow the hay			x	x			i2

Table 6. Area and time frame of brown bear attacks (continued)

Attack location	Alba	Braşov	Covasna	Harghita	Mureş	Sibiu	Interval
At hunting or fishing				x	x		i1, i2
Recreation through the forest		x	x	x	x		i1, i2
In the front of the house/on the street		x	x	x			i2
Collecting mushrooms, hazelnuts, soil, woody products, medicinal plants		x		x			i1, i2
Unspecified locations	x	x	x	x	x	x	i1, i2
Near the holiday house				x			i2
Near bears den				x			i1
At work in the forest				x			i1, i2

### 9. Analysis of attack dynamics according to the amount of damage produced

During the time interval (i1), bears in the research region produced 2,038 damages and 58 attacks on people. In the second time interval (i2), there were 10,233 material damages and 176 cases of people injured by bears.

The annual average of brown bear damage in the interval (i1) was lower than that reported in the interval (i2), and the annual average of attacks recorded in the first interval was 50% lower than those in the second analyzed interval.

The lowest number of attacks and the least amount of damage were recorded in 2010. According to Figure 21, year 2021 was the year in which the attacks registered the highest increase in the

analyzed period, and also in that year, the highest number of damages to personal property was reported.

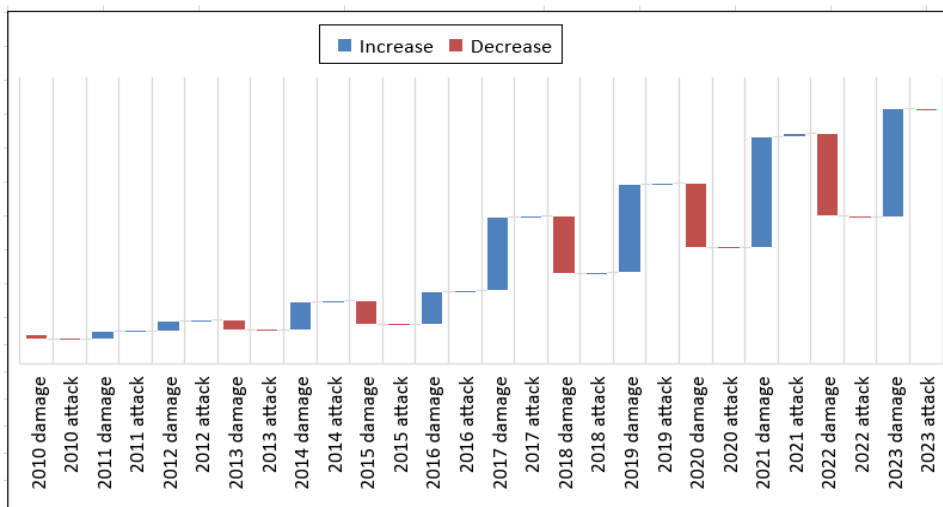


Figure 21. Variation of attacks according to bears damage

### 10. The dynamics of notifications regarding the reporting of bear presence in risk areas and human-bear incidents in the Centre Region of Romania

During the research period, local residents of the research area or people in the region's counties made 13,354 phone calls announcing emergencies related to events between humans and bears.

According to Figure 22, the lowest number of calls (n= 36) was made in 2013 and represents 0.3% of the total number of calls made, and the highest number (n=4,246) was registered in 2023 and accounted for 32% of the total number of phone calls made by people in the studied region.

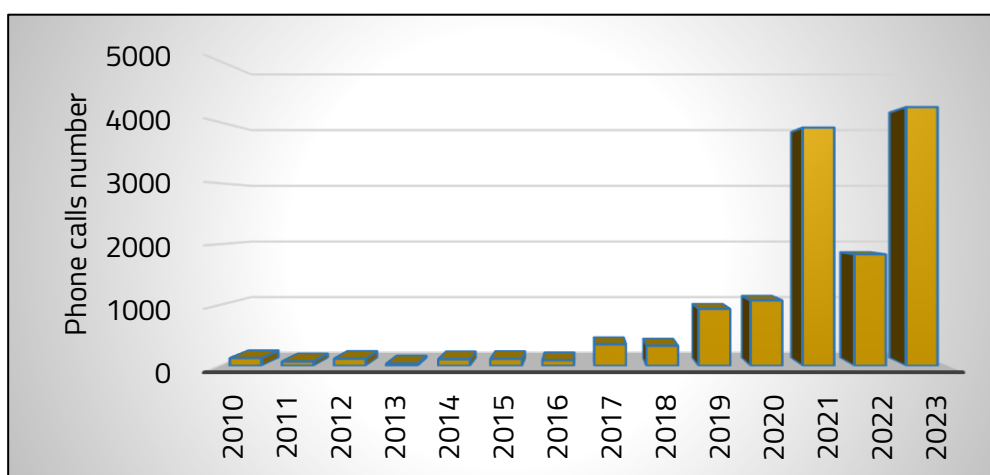


Figure 22. The situation of phone calls made to the single number 112 in the studied area

In the 2010-2016 period, 670 people called the emergency number to report events involving the *Ursus arctos* species, with an annual average of 96 calls.

In the period 2017-2023, from the Centre Region of Romania, 12,684 phone calls were registered, with an average of 1,812 calls per year (Figure 23).

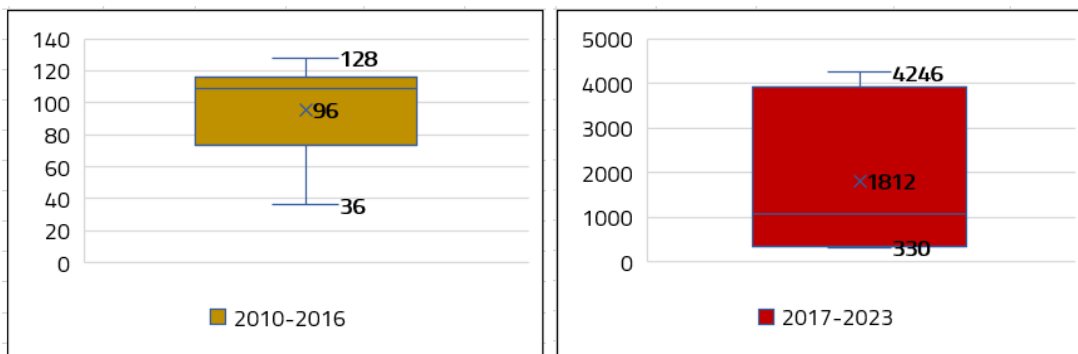


Figure 23. Annual average of 112 emergency calls

Out of the total number of calls made to 112 by people reporting bear-bear incidents or the presence of bears, 5% were made between 2010-2016 and 95% between 2017-2023 (Figure 24).

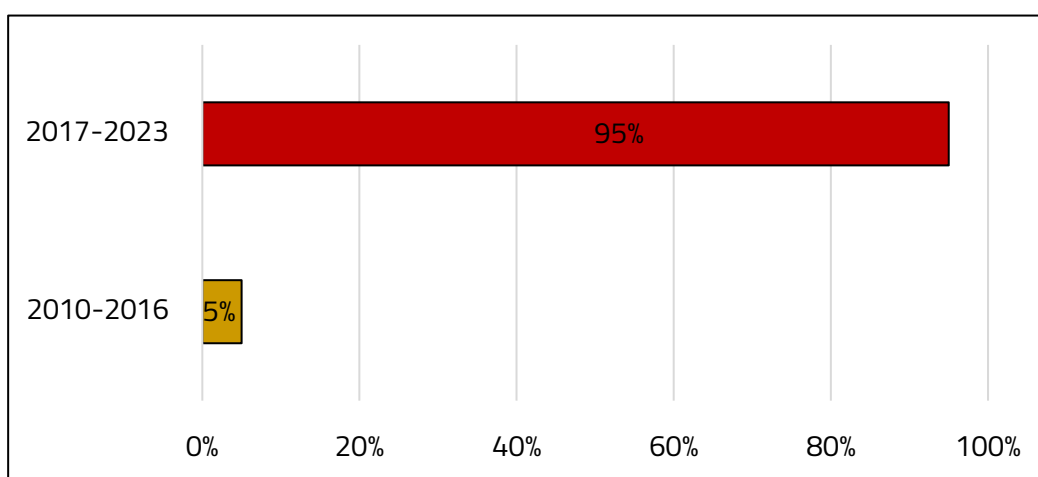


Figure 24. The proportion of phone calls made in the analyzed intervals (i1) and (i2) from the total number of recorded calls

Phone calls to number 112 were made both in (i1) and (i2). Of the total number of calls made by different people, the lowest number (n=179) was made from Alba County, and the highest (n=5,717) was made from Braşov County (Figure 25).

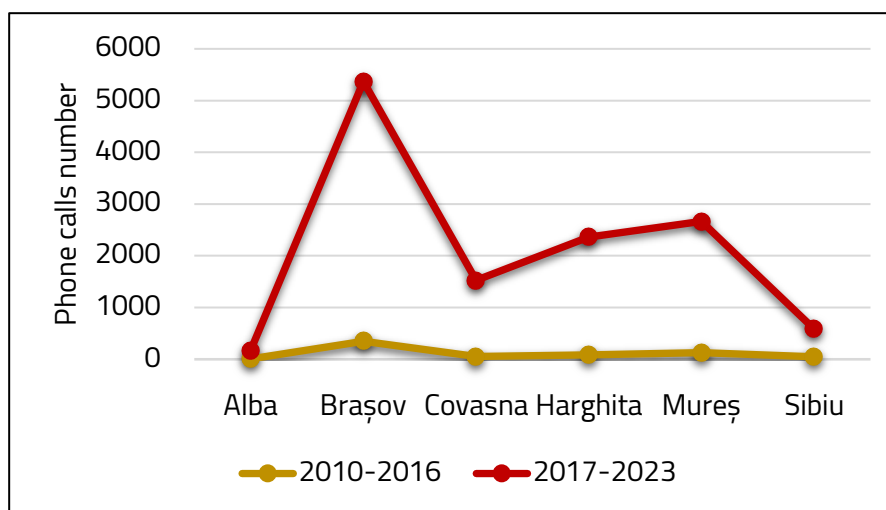


Figure 25. Distribution of calls made to the emergency number 112 by county

### 11. Analysis of the dynamics of emergency calls, depending on the number of damages produced and the number of bears harvested

In the period 2010-2023, a number of 13,354 people in the Centre Region called the emergency number to report the presence of bears in atypical areas or to request help as a result of bear attacks. The managers of the hunting areas harvested a total number of 1,539 brown bears, during the above-mentioned period.

Emergency number 112 was called, in the first interval (i1) of the analyzed period, by 670 people, and also, in this interval, 1,139 bear individuals were harvested, and 2,096 conflicts were registered.

In the interval (i2) of the examined period, 12,684 phone calls were registered, 346 bear individuals were harvested by shooting, and 10,407 conflicts were reported.

The lowest number of calls received by the emergency service in the period 2010-2016 was recorded in 2013, the year in which 186 bears were harvested from the territorial radius of the Centre Region of Romania, and the number of bear-human incidents was 165 cases (Table 7).

The highest number of calls to the 112 service in the period 2017-2023 was recorded in 2023. In that year, 74 bear individuals were extracted, and 1,909 material damages and bodily injuries were reported in the Centre Development Region of Romania.

Table 7. Comparison of the frequency of 112 calls with that of conflicts and extracted bears

Year	Harvested bears no.	112 phone calls no.	Conflicts no.
2010	178	128	75
2011	119	73	138
2012	153	116	193
2013	186	36	165
2014	219	109	506
2015	214	115	418
2016	124	93	601
2017	21	353	1305
2018	53	330	1038
2019	46	935	1562
2020	52	1076	1140
2021	15	3911	1994
2022	85	1833	1461
2023	74	4246	1909

The annual average of the three elements analyzed in Figure 26, recorded in the interval (i1), was 96 phone calls, 170 bears harvested by shooting, and 299 bear-human conflicts.

The annual average of the same elements, registered in (i2) interval, was 1,812 phone calls, 49 harvested bears, and 1,487 human-bear incidents.

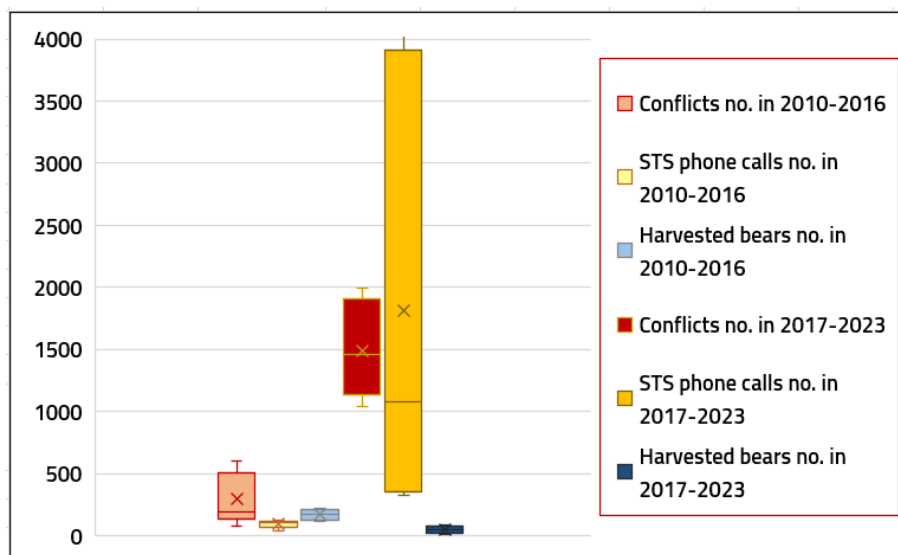


Figure 26. Variation of calls to 112 and human-bear conflicts depending on the number of bears harvested

## 12. Evolution of the forest area in the research area

The surface of the forest area within the radius of the six constitutive counties of the region under study totaled 1,255,600 hectares in 2010 and 1,269,780 hectares in 2022.

The largest number of hectares of forest area was recorded in 2019 when the area included in the forestry circuit was 1,270,262 hectares (Figure 27).

The lowest annual forest area average, 170,958 hectares, was recorded in Covasna County. The highest annual average, n=263,713 hectares, was that of the existing forest area in Harghita County.

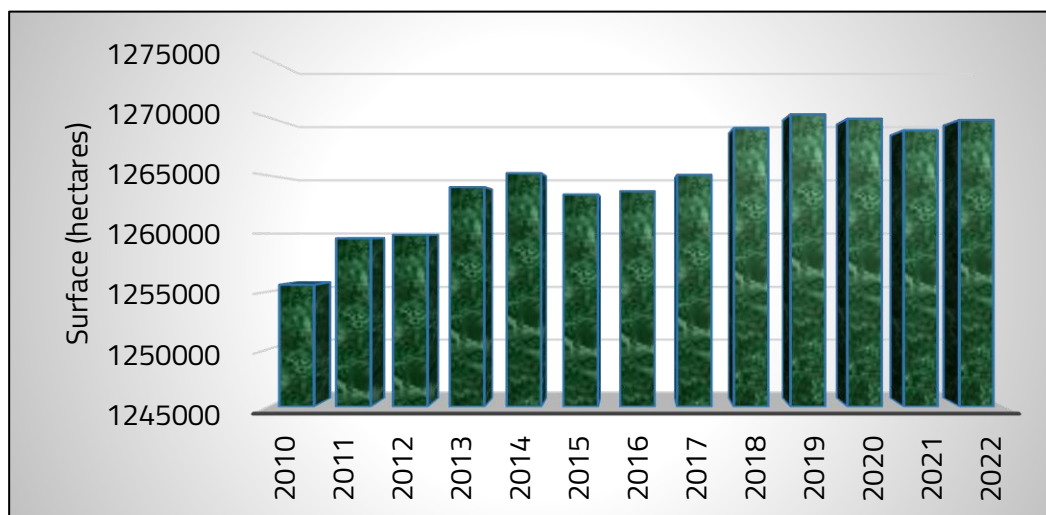


Figure 27. The forest area surface in the period 2010-2022



### 13. Evolution of the harvested wood volumes from the research region

In the period 2010-2022, from the research area, 56,168,000 cubic meters of wood were exploited. Of this total, the smallest quantity (n=3,638,000 cubic meters) was harvested in 2017, and the largest quantity (n=5,055,000 cubic meters) in 2020, according to Figure 28.

The wood from forest vegetation was harvested annually from the counties of the studied region. Sibiu County recorded the lowest annual average of exploited volumes, 474,000 cubic meters.

The largest volume, n=1,279,000 cubic meters, was the one harvested annually from Harghita County.

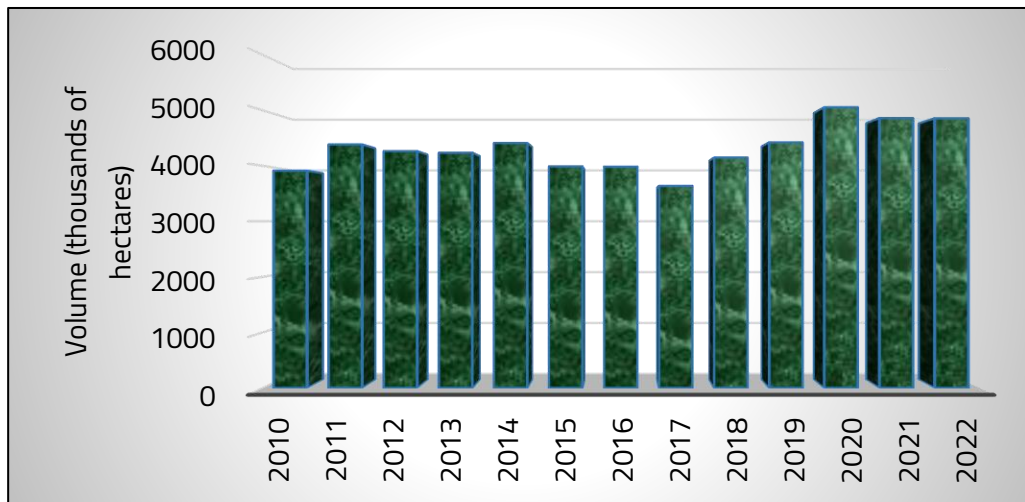


Figure 28. The volume of harvested wood from the Centre Region of Romania

### 14. Evolution of artificially planted surfaces

Within the counties of the Centre Region of Romania, 28,395 hectares were planted artificially. The lowest number (n=1,830 hectares) was planted in 2021, and the highest (n=2,557 hectares) in 2015 (Figure 29).

The lowest annual average of artificially planted areas was 237 hectares, recorded in Covasna County. The highest annual average, n=731 hectares, was that of the forest area existing on the territory of Harghita County.

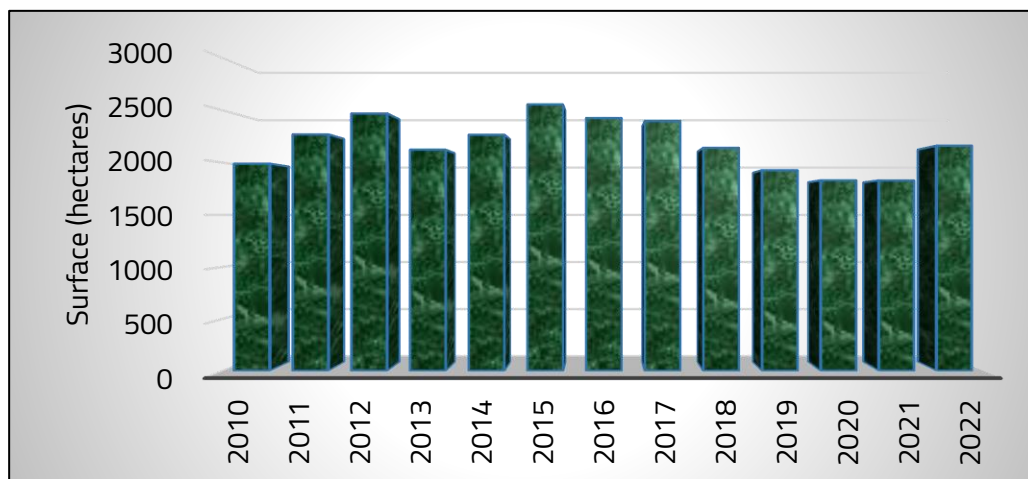


Figure 29. The number of artificially regenerated hectares in the period 2010-2022

### 15. Analysis of the dynamics of human-bear incidents, depending on the evolution of the surface of the forest area and the volumes of harvested wood

Conflicts between humans and bears in the research region totaled 3,919 cases in Harghita County. The annual average of the forest surface area in Harghita County in the period 2010-2022 was 263,713 hectares. Annually, 1,279,000 cubic meters of wood were harvested from this county, and the brown bear density was 34 bears/100 km<sup>2</sup>.

In Alba County, the number of incidents reached the value of 342 cases during the investigated period. The average annual area of the forest area in this county was 206,083 hectares, the average volume of annually harvested timber amounted to 530,000 m<sup>3</sup>, and the bear density was 10 bears/100 km<sup>2</sup>, according to Table 8.

The number of human-bear conflicts reported in Sibiu County was 1,248. The forest surface area in Sibiu County had an average area of 199,513 hectares. During the examined period, 474,000 cubic meters were harvested annually on average from this county, and bear density was 29 bears/100 km<sup>2</sup>.

Table 8. The amount of timber exploited and the number of human-bear conflicts

County	Forest area annual average in 2010-2022 (hectares)	Harvested wood volume annual average in 2010-2022 (thousands of cubic meters)	Conflicts number in 2010-2023	Bears density (100 km <sup>2</sup> )
Covasna	170958	579	2737	46
Sibiu	199513	474	1248	29
Braşov	205047	735	1032	28
Alba	206083	530	342	10
Mureş	219632	724	3227	33
Harghita	263713	1279	3919	34

### 16. The compensation granted by the competent ministry for brown bear damages

After the members of the evaluation commissions ascertained and evaluated the damages, the eligible files of the damaged persons were approved. The total amount approved for the compensation of people from the Centre Region of Romania in the period 2012-2023 was 29,116,210 RON.

The amount of damages approved for payment was 2,939,300 RON from 2012 to 2016, and 26,176,910 RON from 2017 to 2023. The lowest amount of approved compensation (n=88,100 RON) was established in 2012, and the highest amount (n=7,942,396 RON) was established in 2023.

### 17. The compensation granted by the competent ministry to the factors involved in the prevention and combating of bear-human conflicts

The territorial structures of the central public authority approved and submitted for settlement in the period 2021-2023, a number of 1,251 statements justifying the expenses incurred by some

administrative-territorial units within the study area for the services provided by game managers and veterinarians.

The total value approved for settlement was 7,710,490 RON. From this amount, the lowest approved value (n=159,804 RON) represents the value for the services provided by game managers and veterinarians to prevent and combat human-bear incidents in Alba County, and the highest value (n=2,506,026 RON) represents the payments made by the town halls in Mureş County for the previously specified purpose.

### 18. Moral damages approved by the courts for persons attacked by bears in the evaluated region

Court actions brought by persons who suffered bodily injuries or by the descendants of deceased persons, as a result of conflicts with brown bears in the Centre Development Region of Romania, resulted in the compensation of existing damages. The amount of moral damages approved by the courts in the period 2017-2023 was 976,223 RON and 638,060 EURO.

Within Alba County, no actions of people who suffered injuries from bear attacks have been registered in courts.

The lowest amount, in national currency, was 1,038 RON and was awarded to a person from Sibiu County. This amount represented court costs. The lowest amount, in the official currency of the European Union, was 10,000 EURO and was accepted as compensation for moral damages suffered by a child from Covasna County.

The highest amount, in national currency, was 586,000 RON and was awarded to people from Harghita County. In EU currency, the highest amount was 392,000 EURO and represents the amount of moral damages approved for people from Mureş County.

### 19. Habitat, approved intervention/harvest quota in European countries, brown bear density and damage, compared to the Centre Region

The *Ursus arctos* species is not present in Switzerland and Germany, according to McLellan et al. (2017).

According to the Eionet Platform (2024), the number of brown bears in the Czech Republic and Austria was below 10.

Also, from the data reported on the Eionet Platform, it follows that the density of bears in Estonia was 5 individuals/100 km<sup>2</sup> in the period 2013-2018, 7 individuals/100 km<sup>2</sup> in Slovenia, 8 individuals/100 km<sup>2</sup> in Croatia and Slovakia, and 10 individuals/100 km<sup>2</sup> in Romania (Table 9).

Table 9. Bears number and density in Europe

Country	Brown bears number (2000-2021)	Suitable habitat area (km <sup>2</sup> )	Brown bear density (individuals/100 km <sup>2</sup> )
Czech Republic	3	3900	0
Austria	8	2622	0
France	28	6818	0

Table 9. Bears number and density in Europe (continued)

Country	Brown bears number (2000-2021)	Suitable habitat area (km <sup>2</sup> )	Brown bear density (individuals/100 km <sup>2</sup> )
Polonia	112	8274	1
Italy	113	7076	2
Spain	244	21990	1
Slovenia	900	12096	7
Bulgaria	484	12822	4
Slovakia	900	12000	8
Estonia	950	20000	5
Croatia	1072	14090	8
Bosnia&Herzegovina	1260	22100	6
Finland	2400	264800	1
Sweden	2876	150000	2
Romania	6825	71840	10

The size of suitable habitat for the brown bear in the Centre Region of Romania is 8374 km<sup>2</sup> (Almășan 1988).

Based on the level of intervention allocated, bears harvested annually from the Centre Region represent 2% of the number of individuals existing in the studied region in the period 2010-2023. Annually, bears in this area caused material damage to people's property, their average amounting to 877 cases.

According to the European Environment Agency Portal, the area suitable for bears in Slovakia is 12,000 km<sup>2</sup>. The number of bears that Slovakia's habitat can support is 300-500 individuals (Rigg & Adamec 2007).

Brown bears in Slovakia can be harvested as part of bear population regulation and protection hunting. The relevant ministry annually approves a quota of 10% of the total number of brown bears to avoid human-bear conflicts and preserve the species. The average damages recorded as produced annually by the species under study totaled 516 cases, and the Slovak state returned the obligation to pay the value of the damages.

Based on the data available on the European Environment Information and Observation Platform (Eionet), the optimal habitat for bears in Slovenia covers an area of 12,096 km<sup>2</sup>. According to Table 10, although they have been listed as a protected species since 2004, 10%- 15% (Rigg & Adamec 2007) of the brown bears found in this country were shot in Slovenia annually to ensure an optimal level of bears and low damage.

In Slovenia, compensation for such damages is paid by the Slovenian Environment Agency, according to information available on the Slovenian government website (GOVSI 2023). The average damage produced by the species *Ursus arctos* was 464 cases/year.

The management plan, revised in 2019, states that bears in Croatia inhabit an area of 14,090 km<sup>2</sup>. The optimal population established for bear habitat in Croatia is 1,100 individuals, but the level of human acceptance is considered to be 900 individuals (Huber et al. 2008). In this country, to keep the number of bears within tolerable limits for humans and reduce the amount of damage, the percentage allowed for harvesting bears is 16% of the total number of bears.

The average of material damages recorded annually in Croatia was 40 cases, and the compensation of these damages is carried out by the managers of hunting areas, according to Skrbinek et al. (2019).

According to Trbojevic (2018), the area of optimal habitat for bears in the Federation of Bosnia and Herzegovina totals 22,100 km<sup>2</sup>. The number of bears reported in this country was 1,260. Even though it is a species strictly protected by the provisions of the Berne Convention, the authorities of this state approve the harvesting of 11% of the total number of bears.

The annual average of bear damage in Bosnia was 29 cases (Kunovac 2017). Bears are still treated as fauna of hunting interest, and according to the Hunting Law of Bosnia & Herzegovina, their hunting cannot be carried out in the breeding areas of the species. The damages caused by bears in these areas are the only ones paid from the federation budget, the others remaining the responsibility of managers of the hunting areas (Hunting Law 2006).

Eionet Platform (2024) reported that Sweden's ideal brown bear habitat from 2007 to 2012 covered 150,000 km<sup>2</sup>. According to data from the Swedish Environmental Protection Agency (DSEPA), to maintain the favorable conservation status of brown bears, Sweden must maintain a minimum of 1,400 individuals. In Sweden, two types of hunting are practiced, namely, licensed and protected, and the percentage of bears harvested annually was 17%.

The damages reported annually in Sweden totaled 260 cases, and the county administrations compensate the affected persons (SUAS 2010-2023).

Table 10. The quota allocated for harvesting bears based on density

County	Optimal bear no.	Bears average no.	Harvested bears percent out of the total number	Bear density (individuals 100/km <sup>2</sup> )	Bears damage annual average
Slovakia	300-500	900	10%	8	516**
Slovenia	-	900	10-15%	7	464**
Croatia	900	1072	16%	8	40**
Bosnia & Herzegovina	-	1260	11%	6	29**
Suedia	1400	2876	17%	2	260**
România*	1437	6076	2%	5	877***

\*The data used are from the Centre Region of Romania  
 \*\* The number of dead livestock  
 \*\*\* Damage file number

## Discussions

### 1. Discussion of optimal bears number and evolution of brown bear population size

The obtained results indicate a double annual increase in bear population in the i2 interval (2017-2023) compared to the i1 interval (2010-2016). This disparity stemmed from active species management during the initial interval (i1), wherein hunting area managers maintained numerical and structural equilibrium within the bear population. In contrast, in the subsequent interval (i2), excessive bear protection measures were adopted, although *Ursus arctos* was not endangered, leading to a shift in management strategies.

The bear population exceeded the optimal numbers, with Alba County having the lowest population, but still experiencing a 51% increase. Harghita County had the largest population and also saw a notable increase. These trends are attributed to protective measures that have led to decreasing bear harvests and uncontrolled population growth.

### 2. Discussion of the dynamics of bear shootings and recorded mortality

The difference in the percentage of harvested bears between the first analyzed interval (78%) and the second interval (22%) can account for the increased population size in the second interval. This is especially significant because the bear population had exceeded the optimal level for the studied area, and a low harvest level would not have been recommended. Permitting a small intervention quota, or the absence of it, can be beneficial when the optimal population size is much lower than the actual one.

The recorded data indicates a 67% difference in non-shooting bear deaths between the two intervals, with a higher value occurring in the interval (i2). This contrast in values is also noticeable for deaths resulting from collisions with cars or trains, suggesting a stronger correlation to the higher bear population in interval (i2) than interval (i1).

Bear mortality due to car accidents is also closely linked to the expansion and development of land infrastructure in Alba, Sibiu, Mureş, and Braşov counties. This is especially true in the case of highway construction and expansion, which leads to increased road traffic, as Jurj et al. (2021) also noted. The information gathered from the field also suggests that railway accidents may occur due to the absence of bear-crossing corridors.

Deaths of unknown causes may also be linked to illegal human activities, and the increase in these deaths was 76% higher over the time frame (i2).

During the period of 2017-2023, the number of bears that died from other causes than shooting increased, but despite this, the number of shot and found dead bears in this interval was 30% less compared to the 2010-2016 period. This indicates that banning bear hunting may not guarantee an end to poaching but could actually promote it.

The simulation performed for normalizing real bear numbers also suggested that, with a bear population close to the optimal size ( $n=1,437$ ), an annual harvest quota of 150 bears would be sustainable. However, between 2017 and 2023, when the bear population in the research area totaled 7,476 individuals, the annual average of harvested bears was 49 individuals.

### **3. Discussions of carrying out interventions in the interest of preventing and combating incidents between bears and humans**

Efforts to drive away bears from urban areas have involved using signals such as acoustic or light signals. However, this has led to temporary dispersion of bears and sometimes mistakenly led them into areas outside their natural habitat.

Relocating bears has been implemented but often leads to the bears returning to their original habitats, being poached, or pre-emptively killed. The lack of specialized personnel and technical resources, as well as the difficulty in obtaining acceptance for relocation locations, pose challenges to bear relocation actions in Romania.

Accepting problem bears can lead to liability for managers in the event of incidents. Hunting associations, as signatories of relocation agreements, are responsible for managing relocated bears because banning bear hunting doesn't absolve managers of their contractual obligations.

Electric fences, the alternative human-bear incident prevention measure, are relatively effective to prevent bear damage, but they require proper installation, regular inspections, and a significant upfront investment. They may also not prevent bear attacks on people found in various outdoor settings. Additionally, installing these systems in certain areas could negatively impact the bear population, because such recommendations may increase people's aversion to the species under study and encourage poaching.

In contrast to driving away and relocation, harvesting actions are conducted solely by specialized technical personnel in the hunting field. This method poses fewer risks and places less pressure on the targeted bear. These actions were more frequent in Covasna and Harghita counties compared to Sibiu, Alba, and Mureş. This suggests an elevated risk level in these two counties, leaving shooting as the only viable option for bear extraction.

### **4. Discussions about damage development**

The uncontrolled surge in the bear population in regions with unaltered or disrupted natural habitats due to human activities (Roellig et al. 2014) has caused high bear concentrations in specific counties. Consequently, this scenario has given rise to numerous instances of human-bear conflicts in the Centre Region of Romania.

The frequency of material damages during the period of 2010-2016 was considerably lower compared to the subsequent period. This could be attributed to the underreporting of damages at the town hall and a lack of information among affected individuals about the process for seeking compensation. Additionally, the decreased presence of bears during that time may have contributed to the lower incidence of damages, given that bear hunting was permitted within specified harvest quotas. This idea was also found in a study by Micu (2021) in which the correlation between the greater number of conflicts was highlighted when the bear individuals were more numerous than the optimal ones, for example, in the period 1971-1988.

The previous argument is not valid for the period between 2017 and 2023. During this time, the amount of damages in just one year (2021) equaled the total damages over the seven-year period of 2010-2016. This increase can be attributed to improved reporting procedures for declaring

claims, as the procedure for reporting them has started to be brought to the attention of the injured persons.

The high number of damages in the (i2) interval could also be attributed to shooting practices, where only certain bears were targeted. These actions disrupted the balance of the bear population, leading to an increase in their numbers. The absence of supplemental food provision may have further contributed to exacerbating the damages. Abruptly terminating supplementary feeding to bears is not a viable solution, especially given the decades-long practice of this method.

The increasing trend of damage caused by bears was apparent across all counties, not just those with the largest bear populations. In the interval (i1), the number of areas without recorded damage (n=211) was lower than the number (n=66) in the interval (i2) by approximately 220%.

## **5. Discussions about attacks development and the correlation between bear mortality**

The majority of incidents involving injuries to people in forest areas occurred during the first interval, while in the second interval, the attacks mainly targeted individuals on pastures, in agricultural fields, on the outskirts of towns, or in residential yards. This suggests that conservation efforts for bears in the first interval (i1) were carried out in accordance with the provisions of the Habitats Directive within natural habitats, while in the second interval (i2), they occurred near human-inhabited areas.

It is worth noting that the recent bear attacks have, in some instances, occurred due to unexpected encounters with bears. These attacks have often happened when individuals were foraging for mushrooms, hazelnuts, or other forest resources or while engaging in recreational activities such as hiking. These incidents were more frequent during the initial studied period (2010-2016), during which there were also cases of people being injured while trying to protect their livestock in or near the bear habitat, but not as many as in the second studied period (2017-2023).

During the second interval (2017-2023), there has been a noticeable increase in both bear attacks on humans and property damage. The number of attacks and resulting damage has doubled, highlighting a strong correlation between the two. This is further evidenced by a significant number of incidents involving attacks on animal caretakers.

In the assessed area, the mortality patterns of the species under investigation closely paralleled the incidence of bear-human conflicts, suggesting a strong link between the two phenomena. This correlation was also evident in the frequency of phone calls made to the "National Single Emergency Call System" reporting bear presence or attacks, which decreased in tandem with the increasing number of bear harvestings.

## **6. Discussions about the dynamics of the surface of the forest area and harvested wood**

During 2011-2016, the forest area in the Centre Region of Romania increased compared to year 2010 but decreased in the period 2015-2016. The decrease can be attributed to the shifting of destination of some forest area surface to allow the construction of highways, water networks, and the development of tourist resorts or holiday homes.

The increase in forest area surface between 2017 and 2022 was attributed attributed to the inclusion of land covered with forest vegetation, such as wooded pastures with a consistency equal



to or greater than 0.4. According to Law No. 46/2008, these surfaces are part of the national forest area. Additionally, the expansion could be due to the introduction of improvement perimeters.

Timber harvesting in the study region increased between 2020 and 2022 due to abiotic factors (e.g., tree felling) that caused a higher percentage of logging. However, efforts to reforest areas that were cleared or previously harvested for timber have been carried out annually by planting seedlings and promoting natural regeneration, according to the specific requirements of the area. However, field research indicated that clear-cutting positively impacts bear populations by contributing to the development of shrubs (e.g., *Rubus hirtus*, *Rubus idaeus*) which are absent from the forests with the full consistency of trees. Additionally, the forests that grow after clear-cutting provide bears with more quiet and shelter than old and sparse forests, owing to their thickness.

Instead, human activities such as collecting non-timber forest products negatively impact the bear population. These activities not only deprive the species of its natural food sources but also disrupt its habitat and tranquility. These activities are particularly rampant in the bear's habitat and are seen to be increasing in frequency from year to year, potentially posing a greater threat to the well-being of the research species.

In essence, it's not logging that drives bears into human territory in search of food. Instead, the abandonment of their natural habitat and the occurrence of numerous human-bear conflicts are caused by the bear's territorialism, coupled with their density and management, and to some extent, the expansion of urban areas (Hipolito et al. 2018). The results of this research align with the previous observation. Despite higher timber exploitation volumes in Alba and Braşov counties, bear-human incidents were lower than those in Sibiu County, where a smaller volume of wood was harvested. Simultaneously, Harghita, the county with the highest bear density, experienced the most incidents.

## **7. Discussions about the evolution of the expenses incurred by the Romanian State for the compensation of the injured persons or for the compensation of the factors involved in preventing or combating the incidents**

The value of compensation has been on an almost similar rise to that of damages. This is evident from the data presented, showing that the compensation value in the first interval (i1) was lower (n=9%) than the value of 91% in the interval (i2).

If the claim for damage compensation was denied, the affected individuals would be entitled to challenge the decision in court, as occurred in this case. However, the settlement amount covered the damages and included the court costs, resulting in an even greater strain on the state budget.

Even though Law No. 13/2020 regulated compensation for individuals attacked or killed by bears, the only way to obtain this compensation was through the courts. As a result, the injured parties sought to recover damages through legal means from the relevant ministry. The compensation awarded by the courts, which included moral damages, court costs, and penalties, was paid using funds from the Romanian State's budget.

Under normal circumstances, controlling the bear population by shooting would have reduced the occurrence of such incidents and the resulting expenses. In many cases, the compensation awarded

does not fully cover the costs incurred by the injured parties, especially when recovery is still possible.

The state budget also allocated funds for hunting associations and veterinarians, but the approval of bear hunting quotas could have avoided these expenses.

## **8. Discussion about the actions taken for the sustainable management of the brown bear in Europe**

The European countries mentioned in this paper, including Romania, are all part of the legal agreements at the European level. Sweden approves about yearly 14% more intervention quota for bears than Romania. Additionally, protective hunting in Sweden aims to reduce conflicts between predator species and humans. Despite having a double natural habitat area than Romania, Sweden's bear population is significantly lower.

In some member states, like Slovenia, bears have been designated as a protected species since 2004. However, proactive principles guide the management of bear populations, and their conservation involves carefully regulating the annual harvest to maintain an optimal bear population level while minimizing damage. According to a study by Skrbinek et al. (2019), bear impacts in Slovenia include damage to animals and crops as well as sporadic attacks on humans. In contrast, Romania has a significant number of annual bear attacks on humans; the researchers note that 45% of bear attacks in Europe are recorded in Romania (Bombieri et al. 2019).

In Croatia, the brown bear is strictly protected by the Habitats Directive but is also of hunting interest. Annual harvest quotas are approved to manage the bear population and prevent property damage. Croatia is successful in minimizing damage and achieving high harvest percentages, largely due to rigorous prevention measures. This approach ensures balanced bear populations and minimizes human-bear conflicts.

According to research by authors such as Rigg & Adamec (2007), Hipolito et al. (2018), Skrbinek et al. (2019), and Marsden et al. (2022), the brown bear is hunted and rarely relocated in multiple European countries. The proposal to move the bear individuals from Romania to other European habitats has faced resistance from populations in potential host countries, as some countries prioritize human safety over the reintroduction of *Ursus arctos* species.

## **Conclusions**

### **1. Conclusions for Objective 1**

From 2010 to 2016, the administrator of the national hunting area implemented a systematic and rational program of harvesting bears, by approving an intervention level that maintains the optimal size for which there is natural habitat, as well as a balance in the population structure of brown bear in the Centre Region of Romania.

From 2017 to 2023, the level of intervention approved by the authorities for the harvest of brown bears in Romania's Centre Region was much lower than in the period 2010-2016 and allowed the extraction by shooting only certain bear individuals.

The level of intervention allocated to game managers in the study region in the period 2017-2023 was not sufficient to maintain bear population size close to the optimal value and resulted in uncontrolled bear packs growth.

## **2. Conclusions for Objective 2**

The numerical growth of the bear population in the second interval (i2) analyzed created high densities of the species, overpopulating all constituent counties of the study region. In addition, it has created high intraspecific pressure in the natural habitat and contributed to increased bear mortality from causes other than shooting (e.g., railroad and car accidents). At the same time, it has increased human aversion, expressed by a high number of illegal activities against them.

During the period 2017-2023, there was a noticeable misalignment between the economic and social interests of the human population and the conservation of bears in their habitat compared to the period 2010-2016. Consequently, this led to the expansion of bears into human-inhabited areas, resulting in a significant increase in human-bear conflicts, conflicts that also involved children. Thus, in interval i2 (2017-2023), bears caused significantly more damage and attacks in the surveyed area than in the first interval i1 (2010-2016), and this was closely related to the intervention quota agreed.

The correlation between human-bear conflicts and insufficient intervention quotas has led to financial losses for the state budget, particularly high material and moral damages. Allocating appropriate harvest quotas for each hunting area could have prevented these costs.

## **3. Conclusions for Objective 3**

Although it was expected that bear habitat would be reduced due to logging and the permanent shifting of the destination of some surfaces, the forest area surface has not decreased. On the contrary, it has continued to increase due to the larger areas offered as compensation, which were subsequently afforested.

The volume of harvested trees and the artificial regenerated area in the first interval (i1) had a mean value close to that in the second interval (i2), compared to the mean number of human-bear incidents, which was higher in interval (i2). This suggests that there was not a correlation between logging and bear events, as logging does not drive bears into urban and rural areas, but rather bear density.

## **4. Conclusions for Objective 4**

The brown bear is a protected species in Slovenia, Sweden, Bosnia & Herzegovina, Croatia and Slovakia, but the authorities in these countries have different approaches to brown bear conservation than the Romanian authorities, in which harvest quotas are approved for *Ursus arctos*.

Although the bear population in Romania's Centre Region is much larger than in the European countries studied, the level of brown bear intervention in Slovenia, Sweden, Bosnia & Herzegovina, Croatia and Slovakia was 8-15% higher than in Romania's Central Region. In addition, proactive management of *Ursus arctos* in the five European countries studied resulted in a lower number of human-bear conflicts compared to the number of conflicts in the Centre Region of Romania.

### **Original contributions**

- Highlighting human-bear conflicts in Alba, Braşov, Covasna, Harghita, Mureş, and Sibiu counties.
- Determining the size of the bear population in the Centre Region of Romania.
- Highlighting the severity of bear overpopulation on human safety.
- Determining the intensity of human-bear conflicts in the Centre Region of Romania.
- Geolocalization of bear conflicts in the Centre Region of Romania.
- Highlighting the differences in hunting management in Europe for the species *Ursus arctos*.
- Determination of the correlation between bear population density and silvicultural-technical works carried out in the forest area of the Center Region of Romania.