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Large Carnivore Monitoring in the Carpathian Mountains



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Large Carnivore Monitoring in the Carpathian Mountains

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Table of Content

Foreword CIC 4
Foreword Carpathian Convention 6
Introduction and Synopsis 8
Czech Republic 14
Hungary 21
Poland 23
Romania 33
Serbia 44
Slovakia 50
Ukraine 58

Foreword CIC

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The publication you are holding in your hand is the result of an international effort towards the improvement of large carnivore monitoring in the Carpathians. The project was initiated at a workshop on the standardization of monitoring procedures for large carnivore populations in the Carpathians, during the Fifth Forum Carpathicum on the 15th of October 2018 in Eger, Hungary, organized in cooperation between the Secretariat of the Carpathian Convention and the International Council for Game and Wildlife Conservation (CIC).

The CIC, at the initiative of Prof. Dr. Klaus Hackländer (Austria), President of its Applied Science Division, took on the lead in this project, together with Dr. Jacqueline Frair (United States of America), Deputy President of the Applied Science Division of the CIC, and Prof. Ovidiu Ionescu (Romania), Expert of the CIC and of the Large Carnivore Initiative for Europe (LCIE). This report on the population status and monitoring of large carnivores in the Carpathians is based on 7 national reports, comparing the different monitoring methods applied in the countries in order to be able to build transboundary monitoring schemes. The final product is this joint publication by the Carpathian Convention and the CIC.

The CIC is a prominent member of the worldwide community for the conservation of wildlife through sustainable use, and is an Intergovernmental Observer to the Carpathian Convention. In order to strengthen the cooperation, the two organizations signed a Memorandum of Cooperation in 2016. They have a shared interest in the conservation of nature and wildlife, the sustainable management of wildlife resources including tackling human-wildlife conflicts, as well as sustainable development and the improvement of livelihoods and food security. Another common interest is preserving the cultural heritage of the region. The Carpathians are especially important for the CIC as its global Headquarter is located in the hills around Budapest, Hungary.

The CIC, as the global advocate for conservation through sustainable hunting, is delighted to be able to contribute to this project – improving wildlife monitoring methods in cooperation with other friends in conservation and science. This project is very much in line with the CIC's core activity profile, as the organization has been and is working on developing and establishing standards, policies, legislation and best practice guidelines in relation to many issues relating to the conservation of nature and wildlife, and is also supporting applied scientific research, facilitating the dissemination of scientific knowledge. For the CIC it is crucial, that wildlife management and conservation measures are based on sound scientific research and regular monitoring of wildlife populations – in this case that of large carnivores.

An important part of the CIC's mandate is to make sure that monitoring results influence political decision-making, while insisting that the voices and needs of local communities, who live with and around nature, are heard and considered. Hunters in

many countries are formally trained in inter alia wildlife biology and they are out in the field, which enables them to collect and deliver data on the distribution of the different species, their population trends, and even emerging diseases originating from wildlife can be detected with their assistance. Hunters are the sentinels in the forests, pastures, and wetlands, with boots, eyes and ears on the ground. At the end of the day, the majority of all natural and semi-natural areas in the Carpathian region are the hunting grounds of someone.

The hunting community is already contributing substantially to the conservation and restoration of wildlife habitats: this is shown by the wealth of wetlands created, hedges planted, and wildflower strips sown, creating habitat not only for small game like hares, pheasants, and partridges, but for all kinds of species from insects through to small mammals and a variety of birds. In relation to the need to step up and coordinate monitoring of large carnivores in Europe across national borders, one should count on the intensified contributions of the hunting community, whose aim will always be to conserve nature and wildlife species for future generations in cooperation with other friends of conservation, while considering the livelihoods of local communities.

The International Council for Game and Wildlife Conservation (CIC) is a politically independent advisory body which aims to preserve wild game and hunting. To achieve this goal, the CIC is promoting the sustainable use of wildlife resources.

The CIC was born in 1928 in Tótmegyer (today Palárikovo, Slovakia) and the international organization was officially established in Paris in 1930.

The CIC is unique in its diversity uniting Member States, universities, organizations, associations, as well as individuals from more than 80 countries on 5 continents.

CIC's mission

To promote and support the conservation of wildlife and related landscapes, local communities, and traditions through sustainable use including hunting.

CIC's vision

A world where wildlife is valued and conserved as part of nature for the benefit of humanity.

Foreword Carpathian Convention

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The Carpathians are a range of mountains in Central and Eastern Europe, stretching across seven countries in the form of an arch: starting in the north-east of the Czech Republic, continuing through the whole Slovak Republic, southern Poland, eastern Hungary, the west of Ukraine and Romania, and extending southwards to the eastern part of Serbia.

The Carpathian region is one of Europe's last great wilderness areas, with exceptional levels of biodiversity, extensive tracts of old-growth forest, one of the most important and the biggest large carnivore population in Europe.

Large carnivore species (brown bear, wolf, lynx) require extensive, non-fragmented habitats to establish their vast home ranges and to allow long-distance movements to satisfy their biological and ecological needs. However, their habitats' size and connectivity are being challenged by increasing pressures of current and future development of transport and other types of infrastructure in the Carpathian region. Furthermore, despite their functional role as ecosystem keystone species and their long-term protection in some countries, human-carnivore conflicts can occur. The large carnivore species existing in human-dominated landscapes often face multidimensional problems, ranging from human-caused mortality to habitat loss and fragmentation.

The Sixth Meeting of the Conference of the Parties (COP6) to the Carpathian Convention adopted the International Action Plan on Conservation of Large Carnivores and Ensuring Ecological Connectivity in the Carpathians in 2020. This action plan is setting a unique and innovative example of transboundary coordination and a truly population-based approach to the conservation of large carnivores of European and global importance.

The first strategic objective of the action plan is to standardize monitoring procedures of large carnivores in the Carpathians. The Carpathian countries committed themselves to develop and implement standardized monitoring systems for each of the large carnivore species (brown bear, wolf, Eurasian lynx) in the Carpathians, allowing continuous assessment of the population status. For this purpose, data collection shall be improved by using agreed and harmonised monitoring protocols across the Carpathians. This way, transparent information on large carnivore populations' status shall be made available for stakeholders and for the general public.

The present report "Large Carnivore Monitoring in the Carpathian Mountains" constitutes the first milestone to realize the changes intended within the action plan.

This is the moment to thank all the participants of the Conference on Large Carnivores` Protection in the Carpathians, which was hosted by the Czech Republic on 18-21 October 2016, in Rožnov pod Radhoštěm. The participants adopted the Declaration on the Management and Protection of Large Carnivores in the Carpathians, calling for the development of an International Large Carnivores Action Plan for the Carpathians. On 19th October 2016, the Carpathian Convention and the International Council for Game and Wildlife Conservation (CIC) signed their historic Memorandum of Cooperation.

In the framework of the Memorandum of Cooperation, the CIC and the Carpathian Convention organized a Large Carnivores workshop at the 5th Forum Carpaticum in Eger, Hungary, in October 2018. The preparation of the present report was initiated at the workshop with active participation of all workshop participants, to whom we would like to express our gratitude.

I would also like to thank very much the Carpathian Convention Focal Points and Observers and the members of the Working Group on Conservation and Sustainable Use of Biological and Landscape Diversity, which finalized the content of the Action Plan during several consecutive Working Group meetings: the 9th meeting , held on 30 -31 May 2019 in Ostrava, Czech Republic, the 10th meeting, held on 25-28 November 2019 in Coltesti, Romania, and the 11th meeting, held on 10 March 2020 in an online format.

The Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) was adopted and signed by the seven Parties (Czech Republic, Hungary, Poland, Romania, Serbia, Slovak Republic, Ukraine) in May 2003 in Kyiv, Ukraine, and entered into force in January 2006. It is the only multi-level governance mechanism and sub-regional treaty covering the whole of the Carpathian region.

The common vision of the Parties is to pursue a comprehensive policy and cooperate for the protection and sustainable development of the Carpathians with a view to improving quality of life, strengthening local economies and communities, and conservation of natural values and cultural heritage.

Large Carnivore Monitoring in the Carpathian Mountains –

Introduction and Synopsis

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Managing wildlife populations include protection of endangered species, control of conflict species and sustainable use of game. For all management strategies one has to know size, status and distribution of the target species if sustainability is to be considered. Monitoring populations is a prerequisite for a sustainable wildlife management (Wilson and Delahay 2001). According to Gese (2001), basically three major questions are to be answered: how many are there, where are they and what is the population trend? Many vertebrate monitoring programs have substantial shortcomings (Thompson et al. 1998) as they appear to be developed without paying adequate attention to the three fundamental questions of monitoring: (i) why monitor? (ii) what should be monitored? and (iii) how should monitoring be carried out? (Yoccoz et al. 2001).

Proper monitoring is mandatory especially in large carnivores, a group of mammals which are either endangered and thus need conservation measures or are leading to conflicts with humans and thus have to be controlled by indirect or direct management. Therefore, large carnivore management is much about politics (Trouwborst and Hackländer 2018, Hackländer and Trouwborst 2019) as some interest groups aim to have low numbers, others are seeking for (too) many of them (in order to claim for control). Consequently, it is decisive that large carnivore monitoring follows some major principles of science: reproducibility, repeatability, and transparency.

Usually, large carnivore monitoring is conducted to collect numbers and distribution maps. Such maps show permanent presence (territories, reproduction) and sporadic presence (single individuals). But do we know why we produce this information? Is it for scientific purpose or for management? Do we collect the right information and do we draw the correct conclusions? And finally, are we using the most appropriate method to provide convincing reporting?

To answer these questions the Secretariat of the Carpathian Convention and the International Council for Game and Wildlife Conservation initiated this publication. Until now, we were unable to thoroughly discuss a large carnivore monitoring program across the Carpathian arch as we were unaware of the used methodology in an area ranging from the Czech Republic to Ukraine. National reports on large carnivore monitoring were often published in local languages – if published at all. Hence, the main aim of this publication was to compile the monitoring methodology

of all Carpathian countries for the first time in English, the *lingua franca* in science and politics.

Before you read the national reports, we have to define relevant terms of monitoring first (based on Hellowell (1991), Wilson and Delahay (2001) and Vesely et al. (2006)):

Monitoring or inventory?

When collecting data about the abundance and distribution of a species, terms are sometimes used synonymously although they have different meanings. Compiling data just for describing the status quo of a species (size, status, distribution) is called inventory, survey, or census. The term monitoring is an inventory to evaluate a measure and to ascertain whether a specific goal is reached. Thus, monitoring is an inventory for a special purpose (Vesely et al. 2006). Because the aim of large carnivore management is to ensure a favorable conservation status, the census or survey of large carnivores is generally called monitoring (following Hellowell 1991). However, the boundaries between the terms are fluid and it is a matter of debate whether countries should call their inventories monitoring when no measures are in force to reach a goal.

Indication or evidence?

Data on large carnivore presence are ranging from weak to secured signs. Monitoring needs reproducible and reliable data for quality assurance and finally acceptance of monitoring reports. Therefore, quality criteria have to be established in order to provide convincing and comparable monitoring results. In large carnivores, the so-called SCALP criteria are commonly used. SCALP, the abbreviation of "Status and Conservation of the Alpine Lynx Population", distinguishes between the following criteria (following Linnell et al. 2008):

- C1 "hard facts": verified and unchallenged observations such as dead individuals, live captures, genetic proof from faeces, hairs or saliva, telemetry locations or clear photos
- C2 "confirmed observations": observations controlled and confirmed by an expert such as killed prey (wild or livestock), tracks or other field signs, e.g. dens
- C3 "unconfirmed observations": all observations of C2 signs not confirmed by an expert

If quality criteria are used, the source of observation (scientists, hunters, trained volunteers) is irrelevant. The fate of observations depends on the quality of observation and the evaluation of experts only.

Accuracy or precision?

When it is about large carnivore numbers, some countries give exact figures, others rounded numbers. This depends both on accuracy of monitoring methods and population size. Here, accuracy means the closeness of estimates to the exact or true value. Note that the synonymously used term precision is referring to the closeness of each other of repeated measurements of the same quantity (Vesely et al. 2006). The larger the population the less accurate are the figures. In contrast,

when populations are small, some countries know the identity of every single large carnivore individual. In addition, countries with hundreds or even thousands of large carnivore individuals usually invest less in accuracy of monitoring. Thus, the accuracy is negatively correlated with population size.

Opportunistic or systematic monitoring?

Monitoring could be categorized into opportunistic and systematic programs. Opportunistic means that indications and evidence reported by chance are collected, evaluated and analysed. These observations might include direct and indirect signs of various quality. Opportunistic monitoring is also called passive monitoring. In contrast, systematic monitoring is a standardized way of collecting indications and signs and helps to cover an entire distribution range of a species and a valid minimum number of individuals. Usually, the systematic approach is also called active monitoring.

Stratified or rotative approach?

In case of large carnivore monitoring there are some challenges to overcome, as bear, wolf, and lynx are rather rare and cryptic. In addition, they have huge home range sizes. In order to be efficient when estimating population size over huge areas, Breitenmoser et al. (2006) recommended a stratified approach. Here, different levels of monitoring intensity in time and space are combined, ranging from opportunistic monitoring in a multi-year rhythm to systematic monitoring on a yearly basis. Alternatively, Reinhardt et al. (2015) recommended a rotative approach where the total distribution range of the species is monitored by opportunistic observations, but on a regular basis and in a portion of the range a systematic monitoring is conducted. The systematic monitoring is rotating within the distribution range from one area to the other. The results of these intensively observed areas can then be extrapolated to the whole distribution range.

Recommendations for large carnivore monitoring in the Carpathians

The country reports in this publication reveal that monitoring of large carnivores differ in methodology. This is due to the fact that population sizes of bear, wolf, and lynx are at different levels and monitoring methods started independently from each other. Much about monitoring methods is about traditions, available funds and organizational structures. When deciding on monitoring methods countries have to consider both major principles of science as well as practicability. Reports on monitoring should define which quality of evidence has been used to provide numbers and maps, otherwise comparability in time and space is impossible.

Proper monitoring needs proper data management. The process from data collection to reporting should be organized professionally. This can be done by national authorities or NGOs. Either way, the steps are observation > validation > data storage > interpretation > communication. It is not necessary that all steps are in one hand or place, but every country would need a focal point coordinating the whole process. Finally, the conference of focal points compiles the data once a year to produce Carpathian-wide maps and figures.

It is obvious that a cross-border report would need minimum standards on how data are collected, evaluated, and presented. The quality of the standards has to be oriented to the main questions of every reporting of large carnivore monitoring: how many are there, where are they and what is the population trend (Gese 2001). The basis for all monitoring reports are the observations. It is decisive to have active observers across each country, otherwise observations are clumped at the sites where a limited number of observers is active. It is recommended to involve as many observers as possible, including experts like hunters and volunteers like citizen scientist. This involvement would definitely increase the acceptance of report results, especially in those groups which are potentially affected by negative effects of large carnivores. Thereafter, the high quantity of observer data has to be evaluated in a proper way. I suggest the SCALP criteria mentioned above as well as in some national reports. The larger the country and the larger the carnivore populations are, the more evaluators are necessary to ensure a high quality of data used for interpretation and communication.

Where are they?

Providing maps seems to be the simpler task than providing numbers. Using the 10x10 km² grid already used in most countries would provide an appropriate accuracy, of course within a common projection across all countries. The cells can then be attributed to permanent presence (with and without reproduction) and sporadic presence. Permanent presence is given, if there is at least one C1 observation or two (for bear and lynx) or three (for wolf) independent C2 observations (see Reinhardt et al. 2015). Cells with only C2 observations below those thresholds represent sporadic presence. Reproduction is valid if there is at least C2 proof for offspring. The final distribution maps shall be produced at least every six years (in line with the EU Habitats Directive reporting), however, yearly maps are recommended in order to have a permanent monitoring of management measures (e.g. in countries with hunting quota) and to keep the motivation of observers high.

How many are there and what is the population trend?

More difficult would be to conclude to Carpathian-wide numbers of bear, wolf, and lynx. As the populations are not evenly distributed over the Carpathian arch, methods of estimating numbers will differ. In addition, monitoring methods depend on species. The following strategy might be appropriate for a Carpathian-wide large carnivore monitoring:

In small populations (i.e. below 100 individuals) a systematic genetic monitoring on a yearly basis would be most suitable. The genetic information from faeces, hairs, or saliva can also be used to follow the fate of each individual, e.g. survival, dispersal, reproduction, space use. In case of the lynx, an opportunistic camera trap monitoring could be used in addition as individuals can be identified by their coat colour pattern. In areas with permanent lynx presence camera-traps can be used in a systematic way, too.

In large populations (i.e. above 100 individuals) an opportunistic monitoring is recommended, accomplished by a stratified strategy following Breitenmoser et al.

(2006) or by a rotative approach (Reinhardt et al. 2015). For large populations of wolves, an estimation of pack number is more pragmatic than estimating individual numbers. Either way, one has to know that every method produces just minimum numbers of each species. Especially in areas with latent conflicts, the minimum number should be realistic and as close as possible to the true number.

The way forward

Of course, every country has still to provide national reports, at least the EU member states. However, large carnivore management should be based on biogeographical regions rather than political units (see Linnell et al. (2008)). Managing large carnivore populations will definitely be more effective and will reach more acceptance by the EU or international legal entities when the Carpathian countries are willing to harmonize their large carnivore monitoring strategies.

When comparing the recommended methods with those mentioned in the national reports, a Carpathian-wide large carnivore monitoring is within reach. Irrespective of monitoring methods used or figures and maps produced in the past the next steps for the group of large carnivore experts in the seven countries would be to

- discuss the “why”, “what” and “how” of monitoring,
- reach an agreement of the projection and grid system for providing maps,
- assigning the different observation categories (e.g., livestock carcasses, snow tracks, DNA) used in each country to Carpathian-wide SCALP criteria,
- agree on common genetic methods for C1-observations, and finally
- establish a database for a sustainable data management.

The Secretariat of the Carpathian Convention as well as the International Council of Game and Wildlife Conservation are looking forward to support the countries to proceed on their way to a large carnivore monitoring scheme in the Carpathian Mountains.

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Large Carnivore Monitoring in the Carpathian Mountains – Czech Republic

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1. Background

1.1 Legal status of large carnivores in the Czech Republic

1.1.1 Bear

The bear is protected under the EU Habitats Directive, listed in Annexes II and IV. There is one Site of Community Importance designated for the bear in the Czech Republic: CZ0724089 Beskydy. It is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Further protection applies under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), where the species is listed in Appendix II (Strictly Protected Fauna Species), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

The Red List of Vertebrates in the Czech Republic lists the bear as a critically endangered species (Chobot and Němec [eds] 2017). Pursuant to Act No. 114/1992 Coll., on the conservation of nature and the landscape, and related Decree No. 395/1992 Coll., the bear is defined as a specially protected species and classified as critically threatened. Under Act No. 449/2001 Coll., on game management, the species is understood as game that may not be hunted.

1.1.2 Wolf

The wolf is protected under the EU Habitats Directive, listed in Annexes II and IV. There is one Site of Community Importance designated for the wolf in the Czech Republic: CZ0724089 Beskydy. It is listed in Appendix II of the CITES. Further protection applies under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), where the species is listed in Appendix II (Strictly Protected Fauna Species), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

The Red List of Vertebrates in the Czech Republic lists the wolf as a critically endangered species (Chobot and Němec [eds] 2017). Pursuant to Act No. 114/1992 Coll., on the conservation of nature and the landscape, and related Decree No. 395/1992 Coll., the wolf is defined as a specially protected species and classified as critically threatened. Under Act No. 449/2001 Coll., on game management, the species is understood as game that may not be hunted.

1.1.3 Lynx

The lynx is protected under the EU Habitats Directive, being listed in Annexes II and IV. There are four Sites of Community Importance designated for the lynx in the Czech Republic: CZ0314024 Šumava, CZ0314123 Boletice, CZ0314124 Blanský les and CZ0724089 Beskydy (the only site in country which falls within in the Carpathian Mountains). It is listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Further protection applies under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), where the species is listed in Appendix III (Protected Fauna Species), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention).

The Red List of Vertebrates in the Czech Republic lists the lynx as an endangered species (Chobot and Němec [eds] 2017). Pursuant to Act No. 114/1992 Coll., on the conservation of nature and the landscape, and related Decree No. 395/1992 Coll., the lynx is defined as a specially protected species and classified as strongly threatened. Under Act No. 449/2001 Coll., on game management, the species is understood as game that may not be hunted.

1.2 Development of large carnivore populations in the Czech Republic

1.2.1 Bear

The brown bear is the rarest large carnivore in the Czech Republic. Its presence is restricted solely to the Carpathian area, at the easternmost edge of the country.

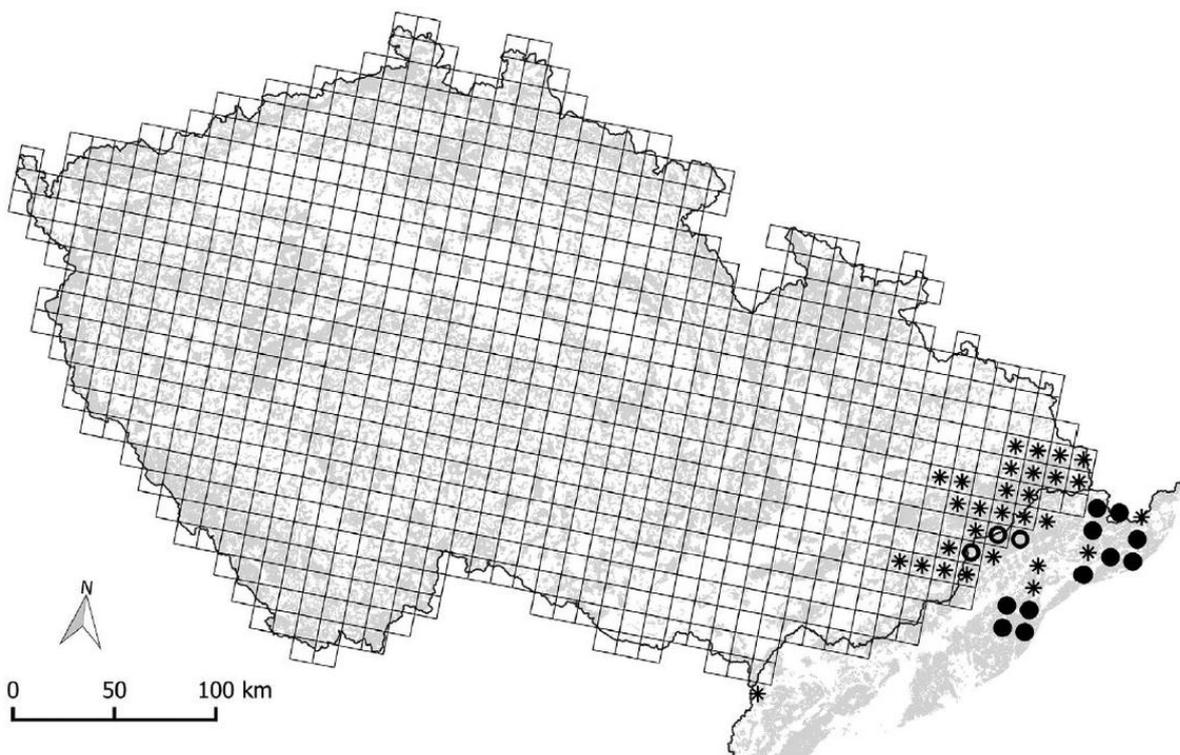


Figure 1. Bear occurrence in the Czech Republic and Western Slovakia between years 2012-2016. Legend: EEA grid 10x10km, distribution: ● Permanent with reproduction ○ Permanent without reproduction * Sporadic (Kutal et al. 2017).

Reproduction within the territory of the Czech Republic and in the adjacent mountains on the Slovak side has not been documented recently. Most likely, the sporadic appearance of bear in the Czech Republic is the result of wandering individuals from the Slovak or Polish areas where they occur permanently. These are individuals that venture into the Czech territory before returning or being poached. In 2012 and 2014, there was a significant increase in observations; while in 2013 and 2015 the confirmed observations were lower (Kutal et al. 2017). These fluctuations indicate that the occurrence of bears on the Czech-Slovak border can be dependent on the situation in the core areas of the bear population in Slovakia and Poland. A detailed study using non-invasive genetic approaches demonstrated travel by the same male bear across the mountain range of the Moravskoslezské Beskydy Mountains in 2012 (Bojda et al. 2014), suggesting that fluctuations observed can be caused by a few individuals in the Czech-Slovak border region (Kutal et al. 2017). Some 2 or 3 bears were estimated to be present in the Moravskoslezské Beskydy and the Javorníky mountain ranges during the winter of 2018/2019. One of them caused several damages to beehives and sheep.

1.2.2 Wolf

The wolf is the second most numerous species of large carnivore in the Czech Republic. The wolf population is increasing at country level. It can be assumed that the wolf's range expansion especially into Bohemia is related to the growth of the Central European lowland population.

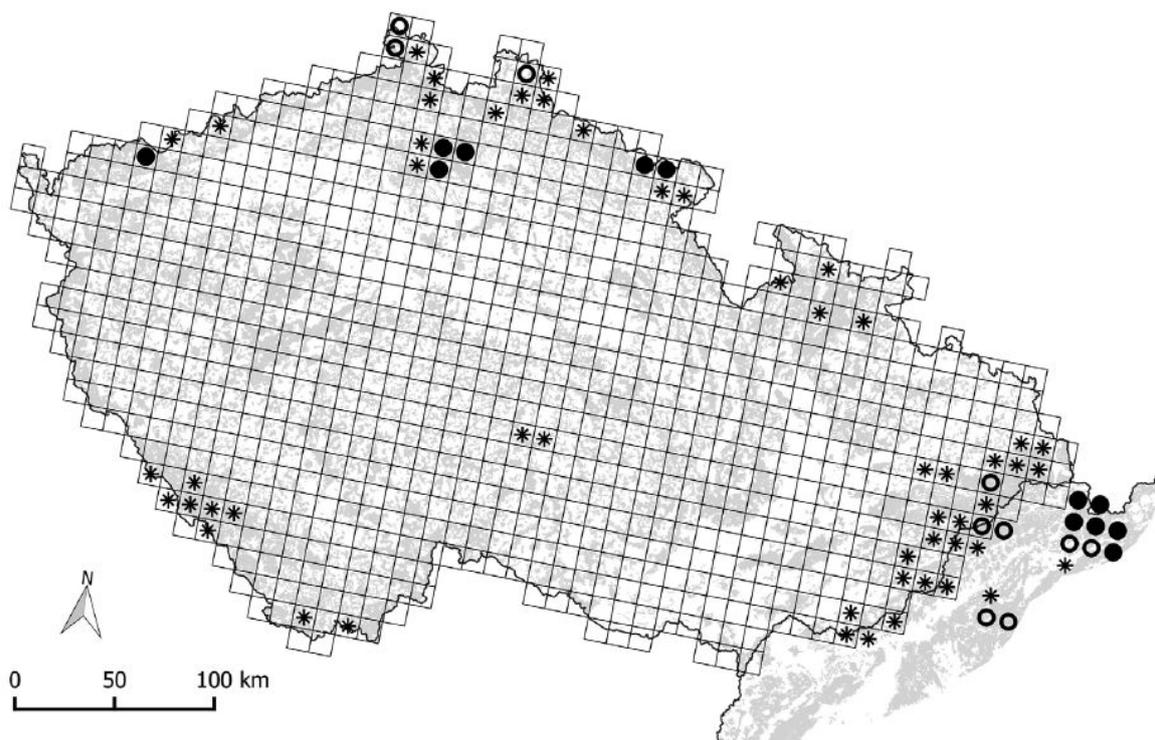


Figure 2. Wolf occurrence in the Czech Republic and Western Slovakia between years 2012-2016. Legend: EEA grid 10x10km, distribution: ● Permanent with reproduction ○ Permanent without reproduction * Sporadic (Kutal et al. 2017).

On the other hand, the situation in the Carpathian area, at the easternmost edge of the country, has not changed significantly, despite the proximity of confirmed breeding packs in Kysucké Beskydy (Slovakia). The reason could be a relatively low number of grids with confirmed reproduction in the adjacent Carpathian territory in Slovakia. Reproduction, for example, was not confirmed in Javorníky or Strážovské vrchy. The occurrence of the wolf on the Czech-Slovak border is influenced by the population dynamics of its prey and the hunting quota for wolves in the regions of Kysuce and Orava (Kutal et al. 2016). The legal hunting of wolves in Slovakia probably also affects the lower occupancy of the Czech and Slovak Carpathians. Two packs and one territorial individual which have a transboundary home range (CZ-SK) belong to the population in the Carpathian part of the country.

1.2.3 Lynx

Lynx is the most widespread species of large carnivores in the Czech Republic. It is found on more than 10% of the territory of the country. Reproduction by lynx was confirmed in almost half of the grid cells (see figure 1, Kutal et al. 2017). There are two main breeding populations: 1) Bohemian-Bavarian-Austrian; and 2) Carpathian. Both populations are transboundary and their status is rather stable.

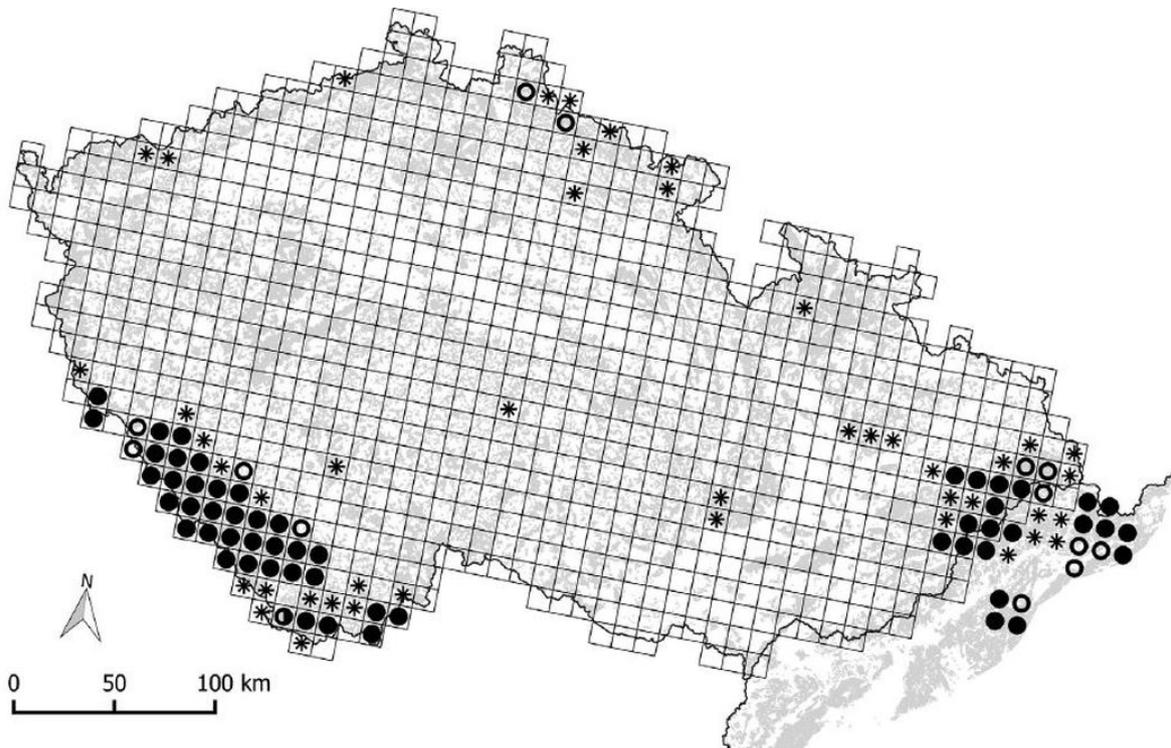


Figure 3. Lynx occurrence in the Czech Republic and Western Slovakia between years 2012-2016. Legend: EEA grid 10x10km, distribution: ● Permanent with reproduction ○ Permanent without reproduction * Sporadic (Kutal et al. 2017).

The lynx population in the Czech Republic has grown gradually since the 1980s, mainly thanks to the successful reintroduction program in the 70s and 80s in the Šumava and Bavarian Forest (DE) national parks (Červený et al. 1996). The peak expansion was reached in the second half of the 1990s when the population was estimated to be 100-150 individuals based on monitoring of the signs and the questionnaires that were sent to hunters (Anděra and Červený 2009). Subsequently, a decline of the lynx population was recorded between the years 1999-2003 at the

level of the whole country. Nevertheless, the situation in the Carpathian part of the country remained relatively stable during the same time period.

This was also true for the period that followed, between the years 2003-2012 (Kutal et al. 2013). The number of lynxes in the Carpathian part of the country at the end of this period was estimated at 11 individuals (Kutal et al. 2015).

2. Monitoring of large carnivores in the Czech Republic

Systematic monitoring of large carnivores is conducted mainly by the NGO Friends of the Earth (FoE) Czech Republic in a close cooperation with academic institutions (Mendel University in Brno, Institute of Vertebrate Biology in Brno) and governmental organizations (Nature Conservation Agency of the Czech Republic (NCA CR) – Administration of protected landscape area (PLA) Beskydy and PLA Bílé Karpaty). NCA CR also prepares and submits report about the status of large carnivores according to the EU Habitats Directive requirements. The majority of the data is stored in a species occurrence database (ndop.nature.cz) managed by NCA CR at country level. It is accessible on request (based on an agreement), and only for responsible nature conservation authorities (e.g. district/town administrations), as well as the above-mentioned institutions, public bodies, museums, researchers etc. who would like to know about the distribution of specially protected species. The species occurrence data entered into this database are evaluated according to their credibility: 1 – credible, 3 – less credible, 6 – implausible. These values mainly correspond (not completely, and should be improved) to data evaluation standards using SCALP criteria: C1 (hard facts – pictures, dead animals, DNA analysis), C2 (confirmed observations) and C3 (unconfirmed observations).

The monitoring in the Carpathian part of the country has both forms of monitoring: 1) extensive (opportunistic); and 2) intensive.

Extensive monitoring is being done year-round by all relevant institutions mentioned above. Monitoring is essentially based on all possible methods including snow/mud tracking, collection of hair/scat/dead animals for DNA analyses, and opportunistic use of camera traps. Lynx DNA analyses are done by the Institute of Vertebrate Biology in Brno. Wolf DNA analyses are done by the Zoological Department of Charles University in Prague, which cooperate with Conservation Genetics Group of Senckenberg Research Institute, which is the reference centre for wolf genetics in Germany.

Intensive monitoring of large carnivores is organized by FoE who have been conducting so-called Wolf patrols since 1999 – systematic field monitoring (tracking) of all large carnivores is conducted by skilled volunteers and professionals during the whole winter. Since the 1970's, the Administration of PLA Beskydy organises a 2-4 days long intensive tracking event which takes place in the middle of February each year during the lynx mating season. The Protected Landscape Area Kysuce (in Slovakia) and FoE also participate in this monitoring.

Since the 2011/2012 winter season, systematic use of camera traps for the robust estimation of lynx abundance, population density and reproduction (deterministic camera trapping) has been conducted by FoE. The methodology involves the use of camera traps with a white flash. These are useful for the identification of individual lynx as they allow the identification of specific coat patterns. The area is divided into 5x5 km grid cells where 1-2 camera traps are installed in each. This method of monitoring is suitable for accurate estimation of abundance and population density of

the lynx using Capture-Mark-Recapture and Spatially Explicit Capture-Recapture models.

Monitoring of wolf packs is done intensively by FoE. It consists of snow tracking during the winter, bioacoustics monitoring (howling simulation) and pack localization during the summer, as well as camera trapping along wolf paths. During the monitoring, the search for scats is also done in order to confirm wolf territories based on genetic analyses.

Analysis of the occurrence of wolf and lynx over the course of the year (from 1st of May – 30th of April) was done on the basis of SCALP criteria in 10x10km EEA grid during last 5 years (Kutal et al. 2017). Only verifiable data were included (C1 and C2 according to the SCALP methodology).

3. Future perspectives of large carnivore monitoring in the Czech Republic

Management plans for the wolf, lynx and bear in the Czech Republic are still in the development since 2004. The management plan for the wolf was prepared by the NCA CR in collaboration with all relevant above-mentioned institutions. The plan was finally approved by the Ministry of the Environment on 16.3.2020.

Law 115/2000 Coll. - Shortcomings: costs for veterinarian protocol and cost for removal of dead animals is not covered. Process of money reimbursement is too long (from Ministry of finance to the District Administration and then to the farmer).

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Large Carnivore Monitoring in the Carpathian Mountains – Hungary

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1. Background

1.1 Legal status of large carnivores in Hungary

In Hungary, the Eurasian lynx has been nationally protected since 1988, and strictly protected since 1993 with a conservation value of HUF 500,000. The conservation value is a monetary value laid down in legislation. In practice, it is mostly used as the amount of the penalty to be paid in case of illegal possession, taking, killing etc. of one individual of the species¹. The Wolf has been nationally protected since 1993, and strictly protected since 2001 with a conservation value of HUF 250,000. The Brown bear has been nationally protected since 1993, and strictly protected since 2012 with a conservation value of HUF 250,000. All three species are listed on Annexes II and IV of the EU Habitats Directive, on Annex II of the Bern Convention, and on Annex II of CITES, classified as an EU CITES “A” species. The bear is not considered a year-round resident of Hungary, occurring only occasionally along the Slovakian border region. These three species are strictly protected by Hungarian law, so their individuals are owned by the Hungarian state. The organisations responsible for conservation management of large carnivore species are the ten national park directorates².

Hunting of these large carnivores is prohibited. In 2004, species conservation plans for wolf and lynx were adopted, approved by the Ministry of Environment and Water. The plan for wolf is under review as of 2020. In 2018 a coordination body (Large Carnivore Coordination Group) was established for emergency events (where human lives are at risk), with the participation of government decision-makers, national park directors, experts and NGOs. No such event occurred in 2018 and the coordination group has been inactive since.

1.2 Development of large carnivore populations in Hungary

In accordance with the requirements of the Habitats Directive, the main conservation objective for large carnivores in Hungary is to ensure suitable habitats and living conditions for individuals either temporarily entering the country along the border or

¹ Source of law:

<https://net.jogtar.hu/jogszabaly?docid=A0100013.KOM&searchUrl=/gyorskereso%3Fkeyword%3D13/2001%2520korm%25C3%25A1nyrendelet>

² See the jurisdiction of each national park directorate at <http://web.okir.hu/map/?config=TIR&lang=hu> by ticking „Nemzeti park igazgatóságok működési területe”

establishing themselves permanently. Nowadays, 10-25 individual lynx and 6-7 wolf families (about 70-75 individuals) live in Hungary, while brown bear (about 2-5 individuals per year) only migrate from Slovakia occasionally, and do not reproduce here³.

2. Monitoring of large carnivores in Hungary

Trail cams (50-60 Reconyx) are used at the rendezvous sites and along roads. The use of hair traps and acoustic monitoring is under evaluation. Genetic examinations are carried out by separate research institutes, professors and PhD students, as in the case of the diet analysis and determination of hairs. Moreover, other sources of information are used occasionally e.g., snow tracking, direct observations, and killings. The monitoring of large carnivore populations is coordinated by the national park directorates. Data are collected by the national park directorates and must be entered into the Nature Conservation Information System - NCIS (TIR in Hungarian). By law, the Minister responsible for nature conservation (presently the Minister for Agriculture) ensures the availability of data. Records of species presence are available for the public on the 10 X 10 km ETRS grid mapping surface of the NCIS information system. Hungary uses SCALP criteria in the collection and use of data. Hungary only uses SCALP 1 and 2 classified data in the country report and in monitoring. References for monitoring reports can be found in the 2019 Habitats Directive Article 17 report³.

3. Future perspectives of large carnivore monitoring in Hungary

In recent years, the establishment of large carnivores in Hungary, arriving from the Carpathian Mountains, has become more common. The distribution of large carnivore populations in Slovakia and Hungary appear to complement one another, with large carnivore species appearing now in habitats where there was no data indicating their before e.g., appearance of the wolf in the Börzsöny Mountains and brown bear in the border region near Salgótarján city and the Medves plateau.

The Hungarian state conservation managers are committed to supporting the prevention of the potential economic damage caused by large carnivores. For example, farmers living in the habitats inhabited by large carnivores can apply for and receive electric fences. In recent years, about 20-25 farmers received fencing systems. Electric fences, which constitute a basic technical protection tool, can be supplemented with registered, special breed ("kuvasz") shepherd dogs from the Hungarian Kuvasz Association. The co-operation between farmers and nature conservation managers and dog-breeders is coordinated by the director of the "Kuvasz-Őr" Large Carnivore Program and the coordinators of the national park directorates. The basic aim of the program is for the farmers to breed the dogs, thereby allowing a number of other farmers to use shepherd dogs for protecting their flocks. WWF Hungary participates as a partner in an ongoing LIFE project on large carnivore species (LIFE EUROLARGE CARNIVORES, 2017-2022). The application was submitted by the German WWF, and is based on communication activities related to large carnivores, and cooperation between various sectors.

³ http://www.termeszetvedelem.hu/_user/browser/File/Natura2000/HD_17_adatlap_es_terkep_fajok_2019/Lynx_lynx_2019.pdf
National reports about status and development of Hungarian wolf population
http://www.termeszetvedelem.hu/_user/browser/File/Natura2000/HD_17_adatlap_es_terkep_fajok_2019/Canis_lupus_2019.pdf

Large Carnivore Monitoring in the Carpathian Mountains –

Poland

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1. Background

This overview is based on the information received from the General Directorate for Environmental Protection and the Chief Inspectorate of Environmental Protection.

1.1 Legal status of large carnivores in Poland

1.1.1 Bear

The bear (listed in Annexes II and IV of the EU Habitats Directive) is under strict protection in Poland (according to the Act of 16 April 2004 on Nature Conservation and Regulation of the Minister of the Environment of 16 December 2016 on the Protection of Animal Species). Therefore, without an adequate permit, bears cannot be e.g., caught, killed, kept, transported, intentionally disturbed, bothered, and their habitats cannot be destroyed. A so-called protection zone is also established for this species covering the den site area and the area within a radius of up to 500 m from this place during the period between 1 November and 30 April. Active protection is required for this species. In 2018, no permits were issued for derogations for the killing of bears.

1.1.2 Wolf

The wolf (listed in Annexes II and V of the EU Habitats Directive) is under strict protection in Poland (according to the Act of 16 April 2004 on Nature Conservation and Regulation of the Minister of the Environment of 16 December 2016 on the Protection of Animal Species). Therefore, without an adequate permit, wolves cannot be e.g., caught, killed, kept, transported, intentionally disturbed, bothered, and their habitats cannot be destroyed. A so-called protection zone is also established for this species, covering the breeding site and an area within a radius of up to 500 m from this site during the period between 1 April and 31 August. Active protection is required for this species. In 2018, 12 permits were issued for derogations for the killing of 32 animals. Of these permits, three of them related to the elimination of wolf/domestic dog hybrids (17 animals in total). The remaining permits were issued mainly in response to, and in order to limit serious damages to property and to ensure public safety.

1.1.3 Lynx

The lynx (listed in Annexes II and IV of the EU Habitats Directive) is under strict protection in Poland (according to the Act of 16 April 2004 on Nature Conservation and Regulation of the Minister of the Environment of 16 December 2016 on the Protection of Animal Species). Therefore, without an adequate permit, lynxes cannot be e.g. caught, killed, kept, transported, intentionally disturbed, bothered, and their habitats cannot be destroyed. A so-called protection zone is also established for this species, covering the breeding site area and the area within a radius of up to 500 m from this place during the period between 1 April and 31 August. Active protection is required for this species. In 2018, no permits were issued for derogations for the killing of lynxes.

1.2 Development of large carnivore populations in Poland

1.2.1 Bear

The brown bear population in Poland is increasing. The range covers only the alpine region. Over 80% of the individuals live in the Podkarpackie Voivodship, and a total population of approximately 369 individuals live in the Carpathian voivodships (Central Statistical Office).

Table 1. Estimates of the number of brown bears in Poland between 2014 and 2019. Voivodships in the Carpathian Mountains are given in italics (Source: Central Statistical Office).

Voivodships	2014	2015	2016	2017	2018	2019
P O L A N D	163	224	262	304	292	369
Dolnośląskie	4	–	–	–	–	–
<i>Małopolskie</i>	32	54	22	50	60	60
<i>Podkarpackie</i>	125	165	233	249	229	304
<i>Śląskie</i>	2	5	7	3	3	5

1.2.2 Wolf

The wolf population has been increasing since 1998, when the species was placed under strict protection. It is estimated that at the end of 2019 more than 3,200 individual wolves live in Poland (in 2012, there were only about 1,000). It is estimated that currently almost 40 % of the Polish wolf population lives in the Carpathians.

1.2.3 Lynx

It is estimated that at the end of 2019 there were approximately 545 lynxes living in Poland, the vast majority of which (75%) were present in the Carpathian voivodships. In the Polish part of the alpine region, both the range and distribution of the lynx population seem to be stable.

Table 2. Estimates of the wolf population in Poland between 2014 and 2019. Voivodships in the Carpathian Mountains are given in italics (Source: Central Statistical Office).

Voivodships						
	2014	2015	2016	2017	2018	2019
P O L A N D	1276	1484	2139	2390	2868	3222
Dolnośląskie	31	32	42	52	58	75
Kujawsko-pomorskie	17	18	20	25	128	128
Lubelskie	150	150	160	200	230	280
Lubuskie	55	88	263	335	369	348
Łódzkie	–	–	–	–	–	–
<i>Małopolskie</i>	72	63	72	77	80	80
Mazowieckie	5	26	33	33	46	29
Opolskie	–	–	–	–	–	–
<i>Podkarpackie</i>	370	482	732	785	818	1080
Podlaskie	167	167	167	167	167	167
Pomorskie	82	91	122	142	148	150
<i>Śląskie</i>	23	38	35	30	30	25
Świętokrzyskie	15	15	15	45	40	40
Warmińsko-mazurskie	135	140	120	130	140	150
Wielkopolskie	92	89	96	108	344	390
Zachodniopomorskie	62	85	262	268	270	280

Table 3. Estimates of lynx numbers in Poland between 2014 and 2019. Voivodships in the Carpathian Mountains are given in italics (Source: Central Statistical Office).

Voivodships						
	2014	2015	2016	2017	2018	2019
P O L A N D	309	390	434	432	427	545
Dolnośląskie	4	3	2	2	2	–
Lubelskie	35	35	34	34	40	45
Lubuskie	–	–	–	–	–	6
<i>Małopolskie</i>	42	38	38	35	45	45
Mazowieckie	8	4	3	4	4	4
<i>Podkarpackie</i>	155	238	287	279	255	342
Podlaskie	30	30	30	30	30	30
<i>Śląskie</i>	18	24	25	25	25	24
Warmińsko-mazurskie	17	18	15	15	15	15
Zachodniopomorskie	–	–	–	–	11	34

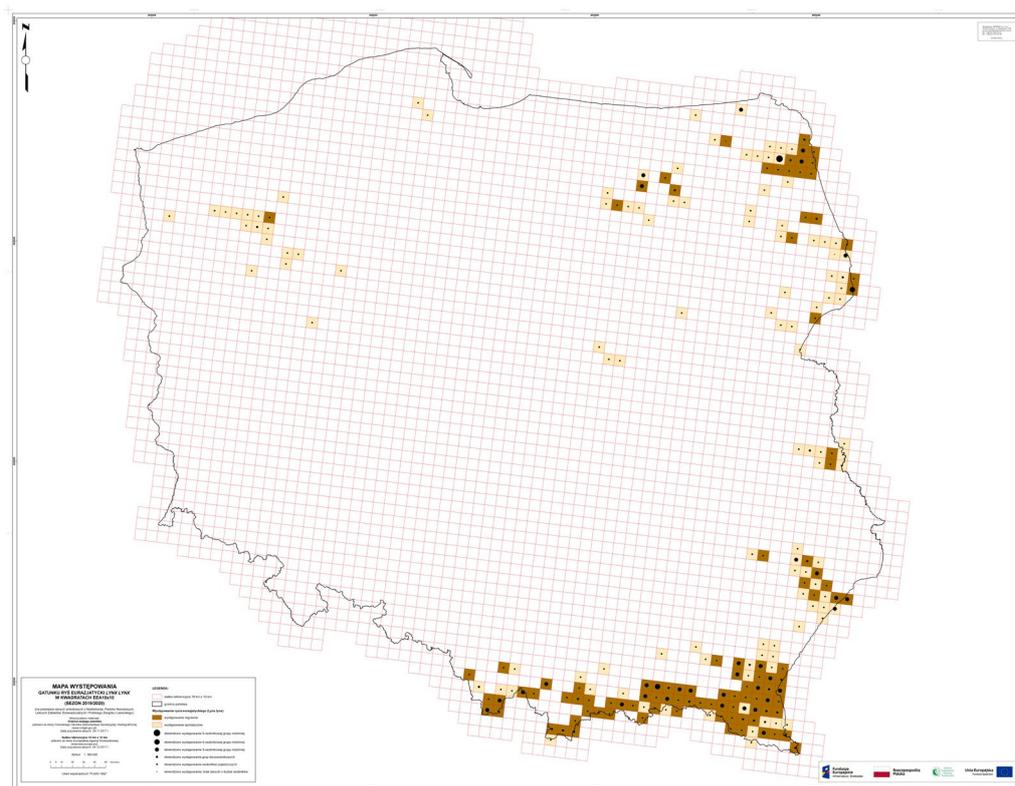


Figure 2. Distribution of European lynx in 10x10 km EEA reference grid (2019/2020 season) based on information obtained from the State Forests, National Parks and Polish Hunting Association. Permanent occurrence (dark brown) means the confirmed presence of lynx at least once a month, while occasional occurrence (yellow) concerns areas where lynxes were observed less than once a month. The size of the point in the grid means the maximum observed size of a family group, in categories, starting with the lowest: no data on the number of individuals / only single individuals / groups of two individuals / groups of 3 individuals / groups of 4 individuals / groups of 5 individuals (Pilot monitoring of wolf and lynx in Poland carried out in the frame of the State Environmental Monitoring, Chief Inspectorate of Environmental Monitoring).

2. Monitoring of large carnivores in Poland

The above data on wolf, brown bear and lynx population sizes that are published by Central Statistical Office, are estimates that come from the hunting district managers and are then collected by the organizational units of State Forests and Regional Directorates for Environmental Protection. These data are not based on the results of a large-scale nature inventory. Therefore, the reported total numbers of animals may differ to a greater or lesser extent from the actual numbers. More detailed data is available from the results of the national scale monitoring of large carnivores in Poland, currently carried out as part of the State Environmental Monitoring, commissioned by the Chief Inspectorate of Environmental Protection and performed by contractors selected through an open tender process.

In Poland Large Carnivores monitoring is carried out at two organizational levels: at the local level, e.g. by National Parks or by Regional Directorates for Environmental Protection (under the General Directorate for Environmental Protection; <https://www.gdos.gov.pl/>), as well as at the national level – by the Chief Inspectorate of Environmental Protection (<https://www.gios.gov.pl>) as part of the State Environmental Monitoring Programme. In addition, local studies of brown bear, wolf and lynx populations are carried out independently by universities, research institutes

or NGOs, such as the Institute of Nature Conservation of the Polish Academy of Sciences in Krakow (<https://www.iop.krakow.pl>), the Mammal Research Institute of the Polish Academy of Sciences in Białowieża (<https://ibs.bialowieza.pl>) and the "Wolf" Association for Nature (<https://www.polskiwilk.org.pl>).

Large Carnivores monitoring has been conducted as part of State Environmental Monitoring since 2006, when the Monitoring of species and habitats programme (www.siedliska.gios.gov.pl) was started by Chief Inspectorate of Environmental Protection (CIEP). The first assessment of the conservation status of Large Carnivores was conducted in 2008, and the next in 2014. In 2019, the conservation status of wolf and lynx was assessed by CIEP in the frame of a project co-financed by the European Union under the Infrastructure and Environment Program (POIS.02.04.00-00-0040/16; <https://www.gios.gov.pl/pl/poiis-monitoring-wilka-i-ryisia>).

In the frame of the Monitoring of species and habitats programme, the conservation status of species, including large carnivores, is assessed on selected, representative research areas, located throughout the entire area of species occurrence in the country. Assessment of the conservation status of each species, similar to the report under Art. 17 of the Habitats Directive submitted to the European Commission, is made on the basis of assessments of three parameters: 1) population, 2) habitat for the species and 3) future prospects. The parameters: population and habitat for species are assessed on the basis of species-specific indicators, the value of which is determined based on field studies or analysis of available data. Both the assessment of indicators and the assessment of parameters, as well as the overall assessment of the conservation status of the species on the research area are determined, similar to the report under Art. 17, as favourable (FV), unfavourable inadequate (U1), unfavourable bad (U2). In addition, pressures and threats for the species are identified on each research area.

During the development of large carnivores monitoring under the State Environmental Monitoring, the approach to research and research methods have evolved and improved. Over the years, the method of determining the values of some indicators have changed. Therefore, the results of the various stages of monitoring are not fully comparable. However, the data obtained from the monitoring constituted the basis for the preparation of reports under Art. 17 of the Habitats Directive, submitted to the European Commission every six years.

In the first stage, in 2008, the methods and indicators were tested and as a result, in 2010, the first methodologies for monitoring the brown bear, wolf and lynx in Poland were published (Makomaska-Juchiewicz 2010). In accordance with the methodologies, monitoring of brown bear was carried out on 5 research areas (Special Areas of Conservation located in the most important brown bear refuges in Poland, additionally enlarged by adjacent areas in 2014) located in the Alpine biogeographic region, wolf – on 10 areas (forest complexes with area from 769 km² to 1793 km²), including 3 in the Alpine region, and lynx – on 8 areas (forest complexes with area from 769 km² to 1793 km²), including 3 in the Alpine region. The Alpine biogeographical region in Poland approximately covers the Polish part of the Carpathians. 8 of the above-mentioned monitoring areas, including all located in the Carpathians, are common for wolf and lynx.

In general, in 2007 and 2014, the condition of the bear population was assessed on the basis of indicators referring to the number of individuals, reproduction (number of females with cubs) and average number of young/female on each of the research areas (Jakubiec 2010). So far, the assessment of the bear population has been

based mainly on survey data, obtained from the State Forests and National Parks, data on cases of bear aggression and habituation to humans, den sites, feeding sites, damages caused by bears and bear's deaths cases, collected by the Regional Directorates for Environmental Protection and the Institute of Nature Conservation of the Polish Academy of Sciences, as well as the available data from genetic analyses. The assessment of the habitat condition was based on the analysis of available data on forest cover, habitat fragmentation, people population density, road network density and tourism pressure in GIS-type software.

In 2008, the conservation status of lynx and wolf was assessed on 3 monitoring areas in the Continental region in north-eastern Poland, based on the established population indicators. In the case of lynx, these indicators are: population density, number of females with young, number of young/female (Jędrzejewski et al. 2010a), and for wolf: population density and number of wolf packs/100 km² (Jędrzejewski et al. 2010b). For both species, the condition of the habitat was assessed on the basis of indicators concerning: availability of prey, forest cover, habitat fragmentation, road density and isolation of monitoring areas. In 2014, further research areas were included, according with monitoring methodologies. However, apart from the area in the Piska Forest (northern Poland) established for lynx, the population status was not assessed on new areas due to the lack of available data. In 2008 and 2014, the assessment of wolf and lynx populations was based on available data collected during year-round observations and winter tracking, incl. data collected during research coordinated by the Mammal Research Institute in Białowieża and WWF Poland. The assessment of the habitat condition, like in the case of brown bear, was based mainly on the analysis of spatial data in the GIS system.

In 2016-2020, in the frame of State Environmental Monitoring, a project co-financed by the EU funds was implemented, under which the methodologies of wolf and lynx monitoring were once again modified and the monitoring of these species was carried out on all established monitoring areas. As part of the project, a method of estimating wolf density using non-invasive genetic sampling to identify individual animals for capture – recapture studies was developed. The state of wolf population on research areas was assessed on the basis of one indicator – population density, and the state of lynx population – on the basis of two indicators: the number of females with young/100 km² and the number of young/female. Lynx population indicators were determined based on the results of one-day winter tracking. In addition, the method of determining two indicators of habitat status (habitat fragmentation and road density) was changed. The final methodologies are available on the project website: <https://www.gios.gov.pl/pl/poiis-monitoring-wilka-i-ryisia>.

In 2019, on 4 out of 10 areas, the wolf density was above the favourable (FV) assessment threshold i.e., more than 2.5 individual/100 km². The conservation status of wolf was assessed as favourable (FV) at 3 sites, as inadequate (U1) at 4 and as bad (U2) at 3. The inadequate and bad assessments of the conservation status of the species on research areas was mainly due to too low population density and the following habitat condition indicators: 1) habitat fragmentation, defined as the share of the area covered with buildings, and 2) road density. In the case of lynx, the population status, and therefore also the conservation status of the species, was assessed as bad (U2) in all the sites studied, mainly due to the insufficient number of females with kittens recorded at the sites (<0.3 individual/100 km²). The habitat status at the sites was assessed as unfavourable (U1 or U2), mainly due to too low roe deer density ($\leq 100\text{kg}/\text{km}^2$). In addition, as part of the project, distribution maps of both species were developed based on the results of a survey conducted in the

organizational units of the State Forests and National Parks. The distribution maps and other project results are available on the project website.

Results of Large Carnivores monitoring, conducted in the frame of the State Environmental Monitoring, were used to estimate the population size in the Alpine and Continental biogeographic regions for the purposes of the reports under Art. 17 of the Habitats Directive submitted in 2007, 2013 and 2019. Data on wolf, brown bear and lynx populations in the reports differ from those coming from the Central Statistical Office, which are included in the tables 1-3, due to the different methodologies used (see Figures 1 and 2).

According to the report submitted to the European Commission in 2019 under Art. 17 of the Habitats Directive (<https://nature-art17.eionet.europa.eu/article17/>), in the Continental region, the wolf population was estimated at 1,592 individuals (range of values for the 95% confidence interval: 896-2,288; density extrapolation from 7 monitoring sites). In the Alpine region, the wolf population was estimated at 294 individuals (extrapolation of results from 3 monitoring areas located in the Carpathians). Currently, there is an increase in the population size and a colonization of new areas by wolves in the areas west of the Vistula river (in the Continental region), while the trend of the Carpathian population (in the Alpine region) in recent years has been assessed as stable.

Data from the 2019 report under Art. 17 of the Habitats Directive on the lynx population (<https://nature-art17.eionet.europa.eu/article17/>) estimated that there was a minimum of 67 individuals in the Continental region (extrapolation of results from 5 monitoring areas). In the Alpine region it was estimated that there was a minimum of 56 individuals (extrapolation of results from 3 monitoring areas). In both regions the population trend was assessed as stable.

Data from the 2019 report under Art. 17 of the Habitats Directive on the brown bear population (<https://nature-art17.eionet.europa.eu/article17/>) estimated that there were 122 individuals (between 99-166; based on research from 2014-2017, with the use of molecular methods). The trend in population size changes is uncertain. Telemetry studies using a GPS collar indicate that 82% bears caught and stocked in Poland are transboundary, and their habitats extend to other countries within the range of the Carpathian population. The population status and range of occurrence of the species in the Alpine region in Poland are defined as appropriate i.e., close to the reference population numbers.

3. Future aspects of large carnivore monitoring in Poland

In the future, it is planned to continue the monitoring of large carnivores by the Chief Inspectorate of Environmental Protection in accordance with the adopted scheme.

In the case of wolf, it is planned to include another 3 monitoring areas, located in central and northern Poland.

In the case of lynx, due to climate change resulting in a lack of snow cover in winter, it is planned to use camera traps to assess population indicators. Additionally, a new monitoring site for lynx is being added in north-western Poland, where the species reintroduction program is being carried out.

In the case of brown bear, it is planned to implement a new monitoring methodology, assuming the collection of non-invasive samples for genetic capture-recapture studies in the entire area of the bear's occurrence in Poland (i.e. in the Carpathians).

According to the draft methodology available on the website (http://siedliska.gios.gov.pl/images/pliki_pdf/publikacje/pojedyncze_metodyki_dla_gat_zwierzat/niedzwiedz_brunatny_modyfikacja_metodyki.pdf), the conservation status of bear will be assessed on the basis of the estimated population size, changes in the distribution range and changes in the breeding range. The condition of habitat will be assessed on the basis of indicators concerning forest cover and fragmentation of relevant habitats.

Field studies for each species, i.e. genetic testing and winter tracking, will be repeated approximately every 6 years, in accordance with the reporting period under Article 17 of the Habitats Directive

In addition to the State Environmental Monitoring run by the Chief Inspectorate of Environmental Protection, there is also monitoring of large carnivores in all Carpathian National Parks in Poland. They use direct (visual confirmation, including car and foot patrols, camera traps) and indirect methods of monitoring of large carnivores (winter tracking, presence of excrements, traces and kills). National park employees collaborate with scientists from universities and research institutes and other stakeholders in that regard.

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Large Carnivore Monitoring in the Carpathian Mountains –

Romania

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1. Background

1.1 Legal status of large carnivores in Romania

1.1.1 Bear

The first thoughts on the need to protect bears came from hunters, who were aware of the importance of wildlife conservation following World War II. At the time, the protection of the species was not stipulated in a law. This was primarily due to political reasons, with most of the livestock herders not being interested in protecting the species. This meant that all of the relevant laws, including the Law no. 231/1947 on the organization of the economy of hunting, classified bear as a dangerous species, with its hunting being unrestricted throughout the year.

Motivated by an alarming decrease in bear populations through to the late 1940s, the hunting of the species was subsequently restricted by Decree no. 76/7.02.1953 on the hunting economy. The Decree established a legal shooting season from 1 March until 15 January, prohibited the hunting of female bears with cubs throughout the year, as well as the shooting of bears in their dens. In addition, it established harvest quotas, and made it compulsory to obtain individual licenses in order to hunt bears.

The year 1976 marked the beginning of a new period in the management of bear populations in Romania, with the introduction of the Law 26/5 November 1976 regarding the economy of hunting and the individual hunts themselves. The law included further restrictions on bear hunting, and included special management measures aimed at increasing the density of the population. Among the restrictions, the law reduced to 6-months. This was divided into two periods: March 15 – May 15 and September 1 – December 31.

It is worth noting that up until the late 1970s, foreign hunters were still allowed to hunt in Romania. During the 1980s foreign hunters were no longer allowed to hunt in Romania. Many hunting licenses were also revoked because political leaders wanted to limit the number of people carrying weapons. The use of poison and traps was also forbidden.

A special paragraph of the Law 26/5 November 1976 provided the possibility to shoot bears that attacked domestic livestock, as well as those that became dangerous for

people. This was possible through the year, but only with special and anticipated approval of the specialized central public authority.

As well as the protection afforded by the restriction of the legal period for hunting, and the regulation of the hunt; the forestry department initiated special units for game management. These units were administered and regulated through special forestry and hunting planning which led to an increase in bear populations, attributable also to higher amounts of supplementary feeding and the increasing of feeding periods in spring and autumn (Micu 1998, Servheen 1996).

1.1.2 Wolf

Wolves were persecuted in modern times in Romania (Nedici 1928, 1940). However, in ancient times they were admired for their social life and skills in hunting – especially their capacity to hunt much bigger animals through cooperation. During the feudal period, there were already bounties for dead wolves. (Nedici 1928, 1940). This situation persisted up until to the last days of the communism.

In 1993, the use of poison was forbidden and wolves were only allowed to be harvested through hunting. In 1996, wolves became recognized as a game species for the first time, and were afforded a period of protection during the time where they raised their cubs.

Today lynx, bear and wolf are protected under Directive No. 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora, and are listed in Annexes II and IV. Wolf is listed in Appendix II of CITES. Further protection applies under the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention), where the species is recorded in Appendix III (Protected Fauna Species). All these directives and conventions were adopted in the Romanian legislation. Under hunting and conservation law 407/2006 on game management, the large carnivore species are understood as game that may not be hunted without derogations. Derogations are issued in accordance with Habitat Directive, art. 16.

Compensation schemes for damages caused by all large carnivores to humans, livestock, bee-hives, orchards or crops in the case of the bears are in place and administered by the Ministry of Environment.

All protected areas in the Romanian Carpathians are home to large carnivores. Their management plans include special measures and management actions aimed at securing the conservation of large carnivores.

1.1.3 Lynx

In 1934, as a result of intense hunting and the reduction of the population to an alarming level, lynx were declared a "monument of nature", subject to total protection. Until 1950 there were no lynxes in the Apuseni Mountains in Romania. Since 1962, following an increase in the lynx population, hunting was permitted throughout the year with a special individual license. According to the 1976 and 1996 Hunting Acts (Law No. 26/1976 and 103/1996), lynx is classified as a game species which can be hunted, with an individual license, within the limits of annual quotas, between September 15 and March 31.

1.2 Development of large carnivore populations in Romania

1.2.1 Bear

Little is known about the historical situation of bear numbers in Romania. During World War II this species was heavily hunted and after the war less than 1000 individuals remained. In the early 1950s, the Romanian bear population reached its lowest size, with an estimated 860 individual animals. The bear, which until 1953 was hunted with no restrictions at all, with guns, all kinds of traps and even poisoned with strychnine used to kill other carnivorous animals, became less negatively influenced by human activities after this year. The environmental conditions in the natural forests of the Carpathian Mountains meant that bears were, for a long period of time, under almost constant pressure from hunters (Cotta and Bodea 1969).

In the 1960s the management of this species changed. The former President Nicolae Ceausescu was a passionate bear hunter. During his regime, bears were strictly protected. Due to the decree 76/1953, the bear population in Romania saw a constant increase up until 1969, when they reached a climax of about 4700 bears. Starting from 1969, and because of the hunting pressure, the bear population began to decrease, reaching about 3,700 bears in 1974 (Ionescu 2002).

As a result of the protection measures, bears increased in numbers thereafter. In sum, the density (individuals/10 km²) increased constantly: 0.6 in the 1950s, 0.7 in the 1960s, 0.8 in the 1970s and more than 1.0 in the 1980s.



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Figure 1. Bear feeding site

Bears were artificially fed in President Ceausescu's favorite hunting areas. In addition, in one area in Argeş (Țarcul Râușor) an intensive captive breeding and introduction program was carried out. Over seven years, some 216 two-year-old bear cubs were released from this enclosure into the hunting grounds of Argeş. Due to these measures the Romanian bear population grew extremely fast, reaching a peak of almost 8000 individuals in 1988, with some areas inhabited by a considerable number of partly human-habituated bears.

Starting from 1978 and until the end of the 20th century, the population exceeded the number considered to be economically and ecologically optimal. Simultaneously, the distribution range of the species increased to 64,000 km², which represents about 30% of the surface of Romania. The highest densities can be found in the northeastern and central part of the Carpathians, in the counties of Harghita, Covasna, Bistrița, Braşov, Buzău, Mureş and Neamţ.

The number of bears decreased substantially from 1989 to 1996 due to poaching/illegal killing. The conflicts that arose were the result of a hostile attitude by the local human population towards bears, which resulted in the illegal use of poison, snares, traps and illegal shooting. Poisoning has decreased substantially since then and it was officially forbidden by the Law 13/1993. The sale of poisons is now banned.

Currently, the Romanian bear population occupies an area of around 69,000 km² and consists of more than 7,000 bears, which represents about 35% - 40% of the European population west of Russia. This number exceeds the estimated optimal number of bears, which the natural habitat would sustain under natural conditions, and where socio-economic impacts could be considered relatively acceptable. This number is estimated to be around 4,000. The current high density of bears is the result of abundant food sources, included those provided by humans. In some areas, bears congregate to feed on garbage. Also, agriculture fields, livestock, bee-hives and fruit plantations are still intensively used as food sources by these animals (Mertens and Ionescu 2000).

The Romanian bear population is distributed across the whole of the forested range of the Romanian Carpathians. Some 93% are located mainly in the mountains, and the remaining 7% live in the hills (Isuf and Ionescu 1997). A smaller population of 250-300 bears is present in the Apuseni Mountains. Although the data reported from the hunting areas suggests a gap between the population in the Apuseni Mountains and the main Carpathian population, we suggest that the two populations are still connected. The recent studies done in the area have shown that there are connectivity corridors between the southern part of Apuseni Mountains and the rest of the Carpathians (Popa 2019).

Particularly high densities of bears can be found in concentrated areas during the autumn, where bears gather in large numbers to feed on fruit plantations. The two most outstanding cases are: Dealul Negru – Bistrița, where each year, around 70-75 bears can gather to feed on a fruit plantation of 650 ha, and Domneşti – Argeş, where up to 80 bears have been counted entering the fruit plantation of about 300 ha.

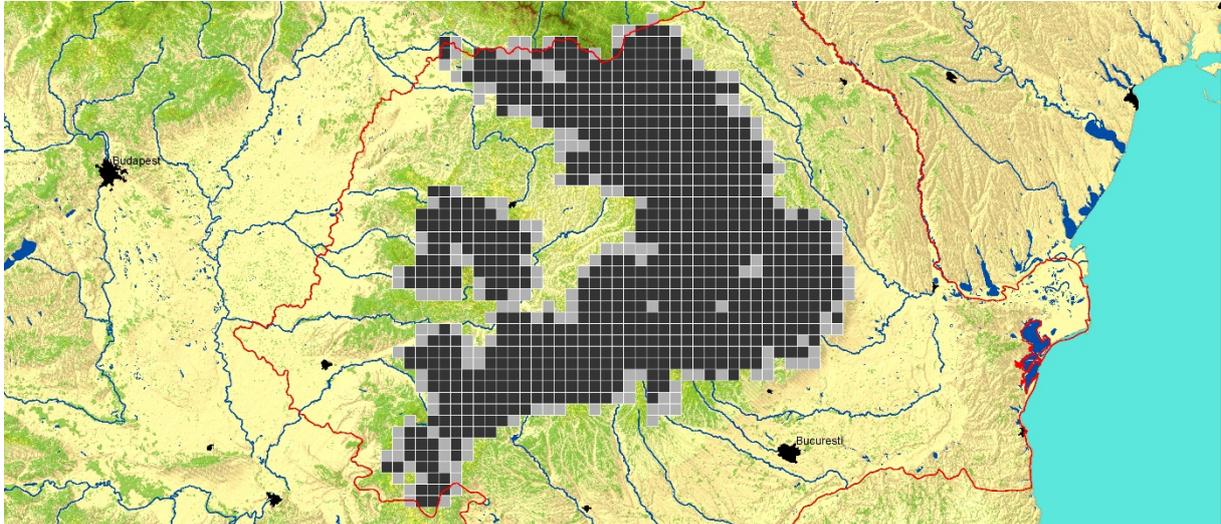


Figure 2. Results of bear monitoring in Romania between years 2013-2019. EEA grid 10x10km; distribution: ● Permanent with reproduction ○ Permanent without reproduction (Popa et al. 2019)

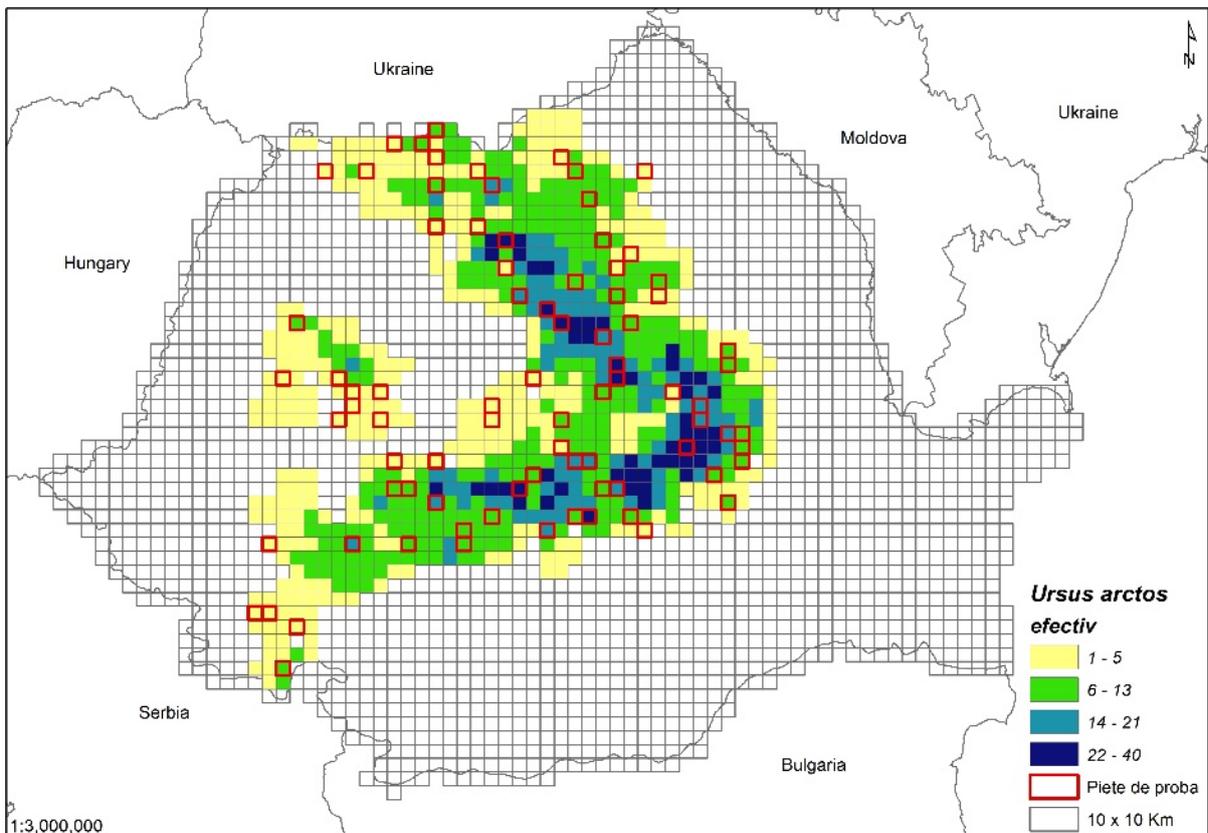


Figure 3. Bear densities per 1000ha in Romania. Yellow: 1-5 individuals, green: 6-13 individuals, light blue: 14-21 individuals, dark blue: 22-40 individuals. Grid cells with red frame represents sampling plots (Popa et al. 2019)

1.2.2 Wolf

The wolf in Romania is a protected species, which deserves the utmost care and attention. Wolf is a valuable element of biodiversity, and plays an important role in maintaining healthy ecosystems. When compared to other animal species, the wolf is at the top of the food chain and is directly threatened only by humans and their activities. Since wolves and humans inhabit the same areas, there is a need to ensure their coexistence, which is the final goal that the various measures defined in this plan aim to accomplish. Considered in the past as one of most important enemies for domestic and wild animals, the wolf was systematically and intensively persecuted in the 1950s and 1960s. The main methods of persecution were rifles, traps, poison, and cub killing. Between 1954 and 1964 about 28,000 wolves were killed in Romania (Cotta 1982). As a consequence, the wolf disappeared from plain woods in the early 1960s. In 1967 the wolf population of Romania reached the lowest level described: 1,550 individuals were left, distributed mainly in the mountains. After 1970 the population starts to increase thanks to increasing prey availability. The increase can also be attributed to socio-economic changes which led to lower hunting pressures. In 1990, the estimated population was around 2500 individuals, the highest value observed since the 1960s. This led to 455 individual wolves being harvested in 1990, of which 250 were adults.

From 1991 onwards, the wolf was intensively hunted. Whereas the wolf population in 1991 was estimated at 2400 individuals, the number of wolves harvested reached 874 individuals. From 1991 onwards, the number of wolves continued to increase, in parallel to relatively low hunting pressure.

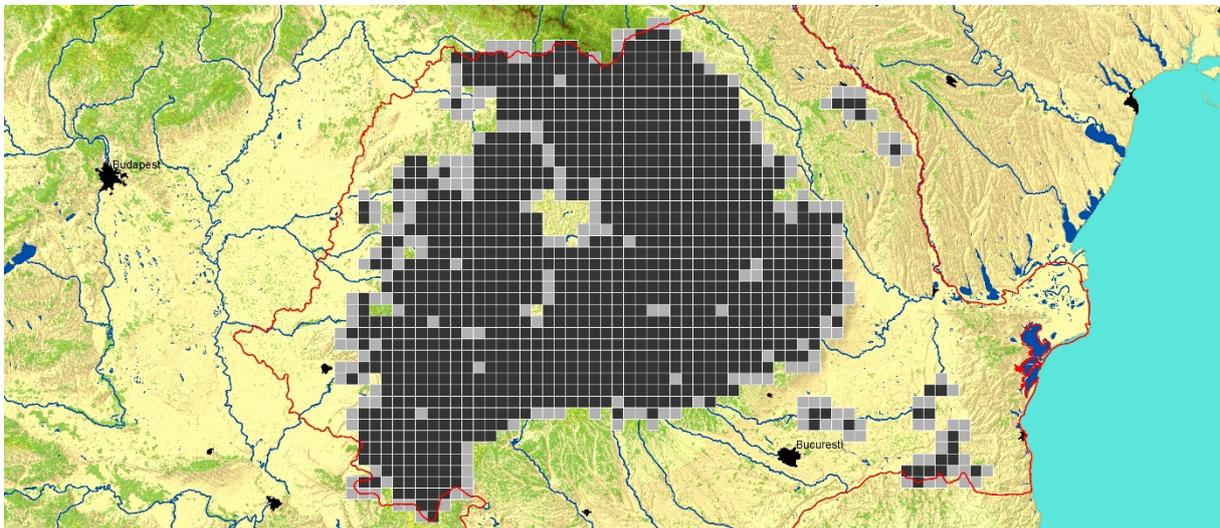


Figure 4. Results of wolf monitoring in Romania between years 2013-2019. EEA grid 10x10km; distribution: ● Permanent with reproduction ○ Permanent without reproduction (Popa et al. 2019)

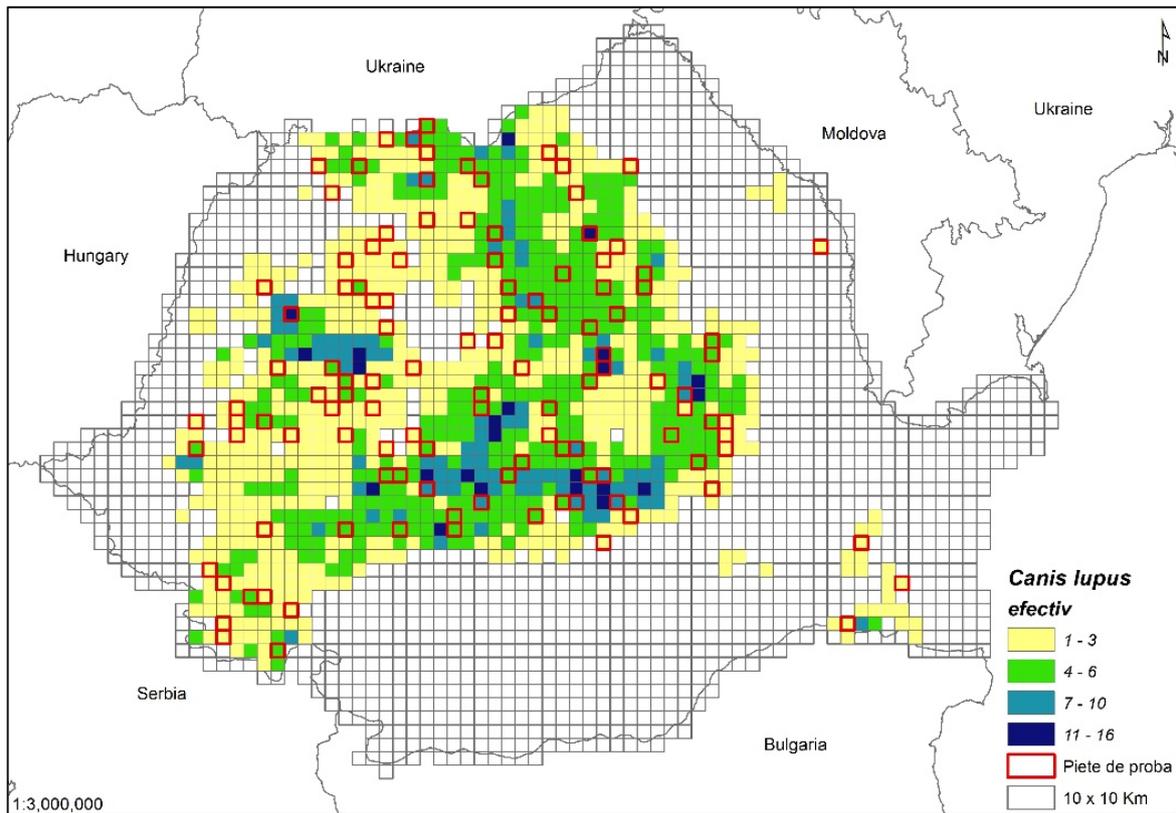


Figure 5. Wolf densities per 1000ha in Romania. Yellow: 1-3 individuals, green: 4-6 individuals, light blue: 8-10 individuals, dark blue: 11-16 individuals. Grid cells with red frame represents sampling plots (Popa et al. 2019)

1.2.3 Lynx

The lynx population of Romania is the only population in Europe, excluding the Nordic countries, which is spread evenly over an area of about 70,000 km² across the Carpathians.

The lynx population in Romania was estimated at around 500 individuals in 1950, about 1000 in 1960, some 750 in 1965 (Cotta and Bodea 1969), and returning to about 1000 again in 1970.

Between 1970 and 1980, the lynx population increased sharply. In 1980, the population was estimated at over 2500 individuals. In 1990, estimates showed a decrease to around 1500 individuals. In 2000, the lynx population was estimated at 2000 individuals. Starting from 2007, and due to the changes in the monitoring system, the size of the lynx population was estimated at between 1500 and 1800 individuals, with an optimum estimate of 1200 individuals based on further recalculations in 2002.

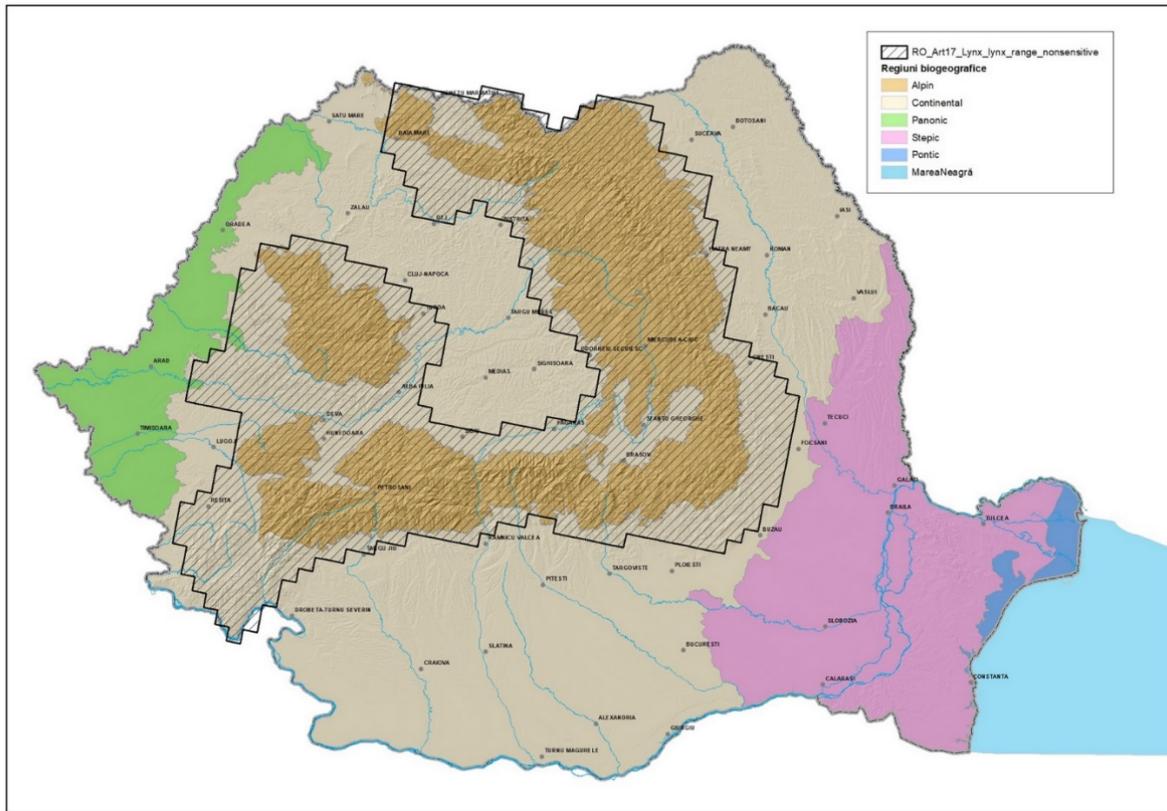


Figure 6. Lynx distribution range and biogeographic areas in Romania (INCDS – Popa et al. 2019)

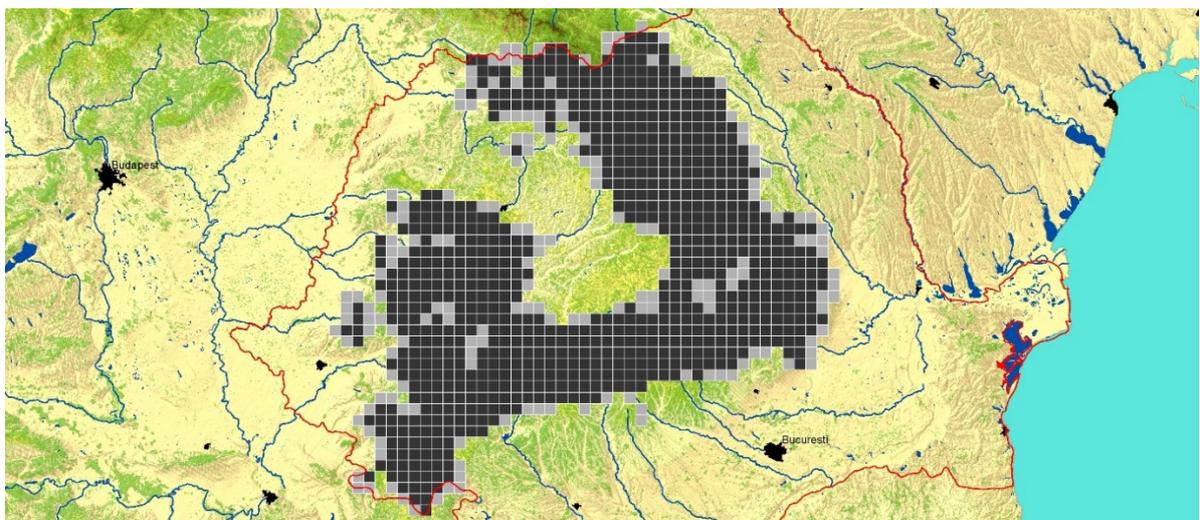


Figure 7. Result of lynx monitoring in Romania between years 2013-2019. EEA grid 10x10km; distribution: ● Permanent with reproduction ○ Permanent without reproduction (Popa et al. 2019)

2. Monitoring of large carnivores in Romania

Monitoring is essential in the active management of large carnivore and is one of the obligations for EU Member States under the EU Habitat Directive – Art. 17.

Systematic monitoring of large carnivores is conducted each year by the Ministry of Environment, Waters and Forests and governmental organizations (INCDS Marin Dracea, Transylvania University) – County Environmental Agency, Forest Administration, Administration of Protected Areas, and NGOs (mainly hunting organisations which are obliged, as a result of wildlife management contracts, to participate in the monitoring).

Lynx monitoring is based on the size of the occupied area and the size of the resident female territory, measured using radio telemetry. In practice, the number of resident females is doubled in order to obtain the minimum size of the lynx population. This method was calibrated with several other methods, including genetic studies, camera trap data, and snow tracking.

Wolf monitoring is based on an identification of the number of packs, the average number of wolves in the pack in winter, and the average size of the territory measured using telemetry. The method was calibrated with several other methods including genetic studies, camera trap data, and snow tracking.

Bear monitoring is based on females with cubs born during the year. The number of females with cubs is then multiplied by 10 to determine the size of the population. The method was calibrated with radio telemetry, genetical studies, camera trap observations, and identification of snow tracks. For bears, there is also a monitoring system used during the autumn in the areas where bears are traditionally concentrated. This method provides supplementary information.

The wildlife report about the status of large carnivores, based on the requirements of the EU Habitat Directive, is done by a research institute and universities at the country level. Only C1 (hard facts – photos, dead animals, DNA analysis) and C2 (confirmed observations) are taken into consideration. Calibration of the monitoring results is done by alternative estimation methods like genetic identification of individuals, camera trap photographs, radio telemetry, etc. Collection of the genetic sampling is carried out by the National Forest Research Institute – Marin Dracea. Radio-telemetry is carried out mainly by the forest institute, but also by the Transylvania University, Forest Faculty, National Park Administration and NGOs. The results of the studies (number of individuals identified through genetics, size of the territories, dispersal, etc.) are used to evaluate the classical estimation methods.

All the data have to be reported to the Ministry of Environment, Waters and Forest by 30 May each year. There is standard information which has to be reported by the managers of the hunting areas, together with environmental agencies. Monitoring activities mobilize a lot of other people from universities, a research institute, the national environmental guard, protected areas personal, and NGOs. Activities are conducted in mixed teams. The objectives of the large carnivore monitoring in Romania are: estimation of the size and the density of large carnivore populations; permanent, seasonal and accidental distribution; monitoring of ecological corridors/critical points of crossing; and identification of areas where there are high levels of human-caused mortalities and high levels of large carnivore–human conflict.

3. Future perspectives of large carnivore monitoring in Romania

Management and action plans for wolf and bear in Romania were revised and adopted by the Ministry of Environment in 2018 in accordance with the action plans for bears and wolves which form part of the Large carnivore initiative for Europe (LCIE 2011). For lynx, the revisions are still under development. In 2006, the first management plan for bears was elaborated by INCDS Marin Dracea, followed in 2007 by the management plan for wolves, and in 2008 the management and action plan for lynx. The management and action plans were prepared in collaboration with all relevant partners.

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Large Carnivore Monitoring in the Carpathian Mountains –

Serbia

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1. Background

The Republic of Serbia is located in the central part of the Balkan Peninsula and has an area of 88,407 km². The country consists of three distinct geographical regions: lowlands of Pannonia Basin in the north, mainly hilly landscapes in central Serbia and mountainous regions in the south. Land cover consists of 45% agricultural fields and arable land, 35% forest and woodlands, and 14% pasture and meadows (Lavadinović 2016). Three mountain ranges meet within Serbia: Dinarides, Rhodope and the Carpathians. The southern portion of the Carpathians, represents less than 10% of the Carpathian range, and extends into eastern Serbia. These mountains are 800-1,300 meters high (Marković 1980). While these mountains cover approximately 7,500 km², the term “Carpathians” is used in reference to the whole north-eastern part of the country.

Over 95% of Serbia’s landmass is open to hunting, with 354 individual hunting grounds. An average size of a hunting ground is 22,107 ha and usually managed by one wildlife manager and two gamekeepers, which is not sufficient manpower for effective management, especially in hilly and mountainous areas (Lavadinović 2016). Therefore, the hunting sector is in charge of all wildlife and game management in the country. This falls under the Ministry for Agriculture, Forestry and Water Management. Serbia has a regal hunting system, meaning that the game species belong to the State and that most of the hunting grounds’ users are the State’s representatives, such as public forest enterprises, national parks, army and the University of Belgrade. However, the most important and the biggest stakeholders are hunting associations which consist of local hunting fellowships, altogether with a total of approximately 76,000 hunters. Hunting associations have NGO status.

Serbian hunting legislation recognizes 62 wild mammal and bird game species of which 16 are from the order Carnivora (Lavadinović 2016). Except for the raccoon dog (*Nyctereutes procyonoides*) which occurs in low numbers, all other carnivores are autochthonous, including large carnivores such as brown bear, wolf, and Eurasian lynx. Serbian citizens’ attitudes toward these large carnivores vary, from those of conflict to admiration. For example, many Serbian masculine given names as well as family surnames are derived from wolf, but at the same time people have low tolerance for coexistence with this species.

1.1 Legal status of large carnivores in the Republic of Serbia

The Serbian hunting sector has been regulated by the Law on Game and Hunting since 2010. The Law regulates conservation, management, hunting, use and improvement of game populations on hunting grounds, as well protection, conservation, and improvement of game habitats. The Law is supported by several ordinances, including an Ordinance on the Regulation of Hunting Seasons for Protected Game Species. According to the Law and the previously mentioned ordinance, all game species have some level of protection. If a species is abundant such that it may be hunted, it is classified as “protected with a closed season”. This means that there is a period of the year, defined by the ordinance, when hunting activities are prohibited and populations can recover without stress and hunting pressure. In contrast, if their numbers are low and hunting affects their survival then game species are “permanently protected”, which means that no hunting is allowed. The Serbian hunting regulation identifies a hunting year extending from 1 April of the current year to 31 March of the following year. The hunting year consists of a hunting season (when hunting is allowed) and a closed season (when hunting is prohibited) for each game species recognized by the hunting regulation. If a certain game species becomes endangered, then the Ministry has power to ban hunting of that species until the population recovers.

The Ordinance on Regulation of Hunting Seasons for Protected Game Species recognises, among large carnivores, lynx and brown bear as endangered game species in Serbia, and thus they are “strictly protected” with hunting prohibited. Wolves are strictly protected in the Vojvodina region (lowlands in the northern part of the country, which are part of the Pannonian Basin), because they are only present in the Special Nature Reserve “Deliblatska peščara” and Vršачke Planine Mountains and its surrounding area (end of the Carpathian Mountains), though they are abundant in the rest of Serbia and hold “protected with a closed season” status.

In addition to current hunting regulations, nationally endangered large carnivores such as the wolf (in Vojvodina), lynx and brown bear are listed in Regulation on Proclamation and Protection of Strictly Protected and Protected Species of Wild Plants, Animals and Fungi from 2010, as a part of the Law of Nature Protection issued by the ministry responsible for environmental protection. Although all three species are classified as least concern (LC) at global and European level (IUCN Red Data List 2018), at the national level they are categorized as vulnerable (VU) (Savić et al. 1995). Moreover, the Balkan lynx sub-species found in southwestern Serbia, corresponding areas of neighbouring countries, and Greece, is classified as a critically endangered taxon at the global level (Melovski et al. 2015).

1.2 Development of large carnivore populations in the Republic of Serbia

According to the official data from the Serbian Statistical Yearbook, the number of large carnivores in Serbia is increasing (Table 1).

Table. 1: Estimated population size of Large Carnivores (Statistical Office of the Republic of Serbia, 2018)

Year	Wolf	Bear	Lynx
2011	1,362	48	8
2013	1,441	103	13
2015	1,978	147	23
2017	1,665	149	43

The same source indicates that the proportion of harvested wolves is around 10% of the estimated population size (Table 2).

Table 2: Hunting bag for wolf (Statistical Office of the Republic of Serbia, 2018)

Year	Harvest size
2011	145
2013	194
2015	276
2017	176

In addition to estimates from the Statistical Yearbook, population sizes for large carnivores at the national level were calculated from data from the Annual Management Plans for hunting areas. According to the hunting legislation, all hunting grounds are obligated to have 10- or 20-year Hunting Ground Management Plans, depending on their status and hunting ground users. These management plans must provide all information about hunting grounds, hunting activities in it, and game management practices. In addition, management plans contain estimates of population size for each managed game species, as well as a model of their population dynamics for the upcoming period (10 or 20 years). These 10- or 20-year long-term management plans consist of a corresponding number of Annual Management Plans. Although hunting legislation recognizes the importance of establishing a national database, it has yet to be realized.

Lavadinović (2016) suggested that the wolf population in Serbia is increasing, although below optimal abundance. The abundance of canids in Serbia was calculated using the ratio of the number of individuals in each hunting area in the sample. According to these estimates, the optimal wolf abundance in Serbia was 1,344 individuals, but at the end of the 2012/13 hunting year the wolf abundance was estimated at 1,520 individuals. The high wolf abundance can be explained by low harvest rates, as only 188 of the allotted 432 individuals were harvested. The number of wolves per analysed hunting ground was variable, as their numbers ranged from 1 to 70 individuals.

Estimates for fully protected large carnivores such as brown bear and lynx are presented in Table 3. Data from Table 3 shows that the number of brown bears and lynxes were almost identical at the beginning and end of the hunting season 2012/2013. This finding could be considered satisfactory because protection measures are maintaining population size and reducing population threats. However, it is odd that bear and lynx populations are not increasing in size as a result of their annual offspring, which raises concerns regarding the reliability of the monitoring.

Table 3. Population size of bear and lynx at the beginning and the end of hunting year 2012/2013 (Lavadinović 2016)

Species	Abundance in hunting year 2012/13	
	Beginning	End
Bear	54	53
Lynx	15	15

In addition to official numbers from the Statistical Yearbook and estimates of hunting ground management plan data (Lavadinović 2016), wildlife biologists have attempted to measure population sizes of large carnivores. During the last 12 to 15 years, all three species have been the subject of a variety of national scientific and specialist

research projects (Paunović and Milenković 2013). Consequently, the first management plans for each of the three species were issued in 2018 (Ćirović et al. 2018, Paunović and Ćirović 2018a, b). Currently, they are in the process of being authenticated by the Ministry of Agriculture, Forestry and Water Management. According to data obtained and management plans, the current abundance of the three large carnivore species in Serbia are: 800-900 wolves, 115 brown bears, and 115 lynxes. The distribution of each species is not uniform.

Brown bears occur in three separate populations: Dinaric-Pindos, Carpathian and Balkan. The Carpathian population is the smallest and consists of only 5-10 individuals, though all bear populations have seen a slight increase in numbers. There are Balkan and Carpathian populations of lynx. The Balkan population inhabits the south-eastern parts of Serbia and has been decreasing. In contrast, the Carpathian population has experienced a significant increase in numbers (about 90) and distribution, with individuals spreading to the southern and eastern parts of the country. Wolves are divided into Dinaric-Balkan and Carpathian populations. The Carpathian population occupies the area of Southern Banat in Vojvodina province (lowlands), as well as the northern half of the Serbian Carpathians. Large carnivores are absent from the central part of Serbia due to high human population density in the valleys of the Morava River Basin as well as a lack of suitable ecological conditions.

2. Monitoring of large carnivore populations in the Republic of Serbia

The hunting sector in Serbia has defined and standardized methods to estimate population size of managed game species. However, censusing large carnivores is far more challenging than estimating population size for wild ungulates or small game. Therefore, and in contrast to what has been stated above, methods for monitoring large carnivores in Serbian hunting grounds are diverse and unfortunately not synchronized. They vary across hunting grounds and their reliability and precision usually depend on the individual motivation of wildlife managers or gamekeepers. Another challenge is the current way of game species census at the level of hunting grounds, which do not consider the territory size of a species or migration events. Thus, a wolf pack occupying the border area of two hunting grounds easily doubles the population size in the region.

Hunters' estimates are usually based on the size of hunting bags, scope of damage to livestock or frequency of occurrences. Nevertheless, these data are often not reliable enough to provide accurate estimates on population size. Other methods employed by wildlife managers or scientists include: occurrences at feeding stations, interviewing local communities, monitoring tracks, droppings/scats or other signs of large carnivore presence, use of camera-traps to identify individuals or reproductive groups, genetic analyses of different sample types, marking individuals with telemetry collars, sampling and projecting, geo-referencing and mapping data, and the creation of databases. SCALP criteria have also been used as part of such scientific projects.

Beyond differences in spatial variation, monitoring is not equal for all large carnivore species. Hunters and wildlife managers have focused mostly on wolves, while wildlife biologists have done the majority of bear monitoring. The reason for such differences is the conservation status of those species. In the future, the focus will be on scientific studies carried out in the context of national projects, with some

international projects. Thus far, most monitoring activities focused on bears, followed by lynx, and in very recent years on wolves. Studies have been mainly conducted by a group of experts from several biologically-oriented national institutions, but a significant amount of data, especially in early stages of research, came from hunters and forest enterprises. All previously mentioned data have been published in several publications and have been integrated in the strategic documents and management plans related to large carnivore populations in Serbia.

3. Future perspectives of large carnivore monitoring in the Republic of Serbia

It is likely that large carnivore populations will increase in upcoming years. Nevertheless, there are certain threats which could severely negatively affect their abundance, especially conflict with humans. Therefore, in accordance with species-specific management plans, with a focus on intensification of monitoring with the above-mentioned methods, it is necessary to continue with scientific population monitoring for the next five years. Additionally, the management plans stress the importance of establishing more extensive transboundary cooperation in accordance with different international conventions and agreements such as the Carpathian Convention. Human dimensions are important aspects of management, as they can indicate the direction of human-carnivore relations, and therefore should be further developed and comprehensively implemented. Use of these game species should be conducted in a sustainable manner, based on data collected with scientific and long-term monitoring methods. Such an approach will promote stable population trends and optimal numbers of large carnivores in Serbia.

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Large Carnivore Monitoring in the Carpathian Mountains –

Slovakia

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1. Background

1.1 Legal status of large carnivores in the Slovak Republic

Large carnivores are protected by the Ministry of Environment of the Slovak Republic under Act No. 543/2002 (Collection of Laws on Nature and Landscape Protection, as amended by later regulations) and Order No. 24/2003 (Collection of laws upon which the Act No. 543/2002 Collection of laws on nature and landscape protection is executed). Under this legislation, it is prohibited to knowingly capture or kill a protected species in its natural environment; disturb the species, especially during breeding, rearing, hibernation or migration periods; or disturb or damage the species' habitat. As the large carnivores are also game species, they are further subject to Act No. 274/2009 (Collection of laws on hunting as amended by later regulations). Protection is extended to bear and lynx year-round, with hunting allowances requiring a derogation from Act No. 543/2002. Whereas lynx have not been hunted since 1999, derogations allowing bear hunting are issued every year. In contrast, the wolf is not protected year-round and has a specific hunting season from 1 November through to 15 January. Illegal killing of large carnivores and other wildlife is regulated under Criminal Code 300/2005 (Collection of Laws, Chapter VI Crimes of public danger and crimes against environment, Section 305/4/b – Breach of Plant and Animal Protection). Trade in wildlife, including large carnivores, is further regulated by Act No. 15/2005 (Collection of Laws on protection of species of wild animals and plants by regulating trade therein, as amended by later regulations).

Management of large carnivores is a responsibility of the Ministry of Environment of the Slovak Republic, the State Nature Conservancy of the Slovak Republic (SNC SR), and the 79 District Offices – Departments of Environment, the latter especially with regard to damage caused by protected species. Hunting is managed by the Ministry of Agriculture and Rural Development of the Slovak Republic, which also participates in decision-making related to the three large carnivore species.

With respect to habitat protection, the State Nature Conservancy of the Slovak Republic has been involved in the process of designating Natura 2000 sites (Sites of Community Importance (SCI)) in line with the EU Habitats Directive. New protected areas were designated in 2017 to protect wolves, bringing the total area protected for large carnivores to 12.6% of the Slovak Republic (from 11.9% prior), and bringing the total number of SCIs to 642 (with 235 SCIs designated specifically for the protection

of large carnivores). Action or Management Plans for all three species have recently been adopted (2015-2017).

1.1.1 Bear

The brown bear is a species of European Conservation Concern and a Priority species (Annexes IV(b), VI(a)) whose social value has been set at 3,690 Euro. In Slovakia, bears are protected year-round in accordance with Act No. 543/2002 and Order No. 24/2003, and there are 66 SCIs (4,216 km²) in which the bear is the subject of protection. As mentioned previously, bear is also managed as a protected game species (in accordance with Act No. 274/2009 and Order No. 344/2009) and can be hunted through derogations from Act No. 543/2000.

A derogation is given for the elimination of a problem bear for any individual that attacked people, repeatedly caused damage to agricultural crops or beehives, depredated on livestock or became a raider of bins in residential areas such as villages, suburbs and recreational centres. In the Slovak Republic, people and brown bears live in close proximity. In search of their seasonally-variable food sources, bears often pass through developed areas and encounter human sources of food, especially where homeowners do not take the necessary precautions. The leading complaint is bears getting into residential garbage. Although not every bear that passes through a developed area is a 'problem bear', access to human food sources can quickly turn them into one.

By the decision of the General Director of Nature and Landscape Protection Directorate of the Ministry of Environment of the Slovak Republic (Methodological Instruction 4970/2014-2.3 from 27 August, 2014), an Emergency Team was established within the SNC SR to resolve conflicts between bears and humans. The Emergency Team is responsible for operational intervention in cases of bear damage to human property or after an attack on a human being. The Emergency Team is also responsible for deterring, removal or translocation of bears occurring in residential areas.

1.1.2 Wolf

According to Order No. 24/2003, the wolf is a species of European Conservation Concern as well as a priority species (Annexes IV(b), VI(a)). There have been 84 SCIs (4,404 km²) designated for wolf protection. In these areas, the wolf can be lethally removed only through the issuance of derogations, for example in response to high livestock depredation (e.g., on sheep).

The Slovak Republic is a signatory to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention). Annex II thereof lists the wolf as a strictly protected species. However, the Slovak Republic has made a derogation for the wolf (and brown bear), based on the reasoning that "*the present level of their population in the Slovak Republic permits the regulation of their numbers without detriment to their survival and to the functions of these species in the natural ecosystems*".

For wolves, the hunting quota is set by the Ministry of Agriculture and Rural Development of the Slovak Republic by the end of October each year, with the wolf hunting season open from 1 November through to 15 January. The advisory body for setting the hunting quota is composed of representatives from the Ministry of Agriculture and Rural Development of the Slovak Republic, the Ministry of

Environment of the Slovak Republic, the State Nature Conservancy of the Slovak Republic, the Slovak Hunting Chamber and District Offices in regions where wolves occur. The annual hunting quota is determined based on the estimated number of breeding packs that summer (compared to previous years) as well as damages caused to livestock and predation on ungulate game species within the specific district (as proposed by relevant District Offices).

The final decision for the hunting quota and specific hunting conditions is made by the Ministry of Agriculture and Rural Development of the Slovak Republic. In Slovakia, the wolf can be hunted only with a rifle (driven hunts prohibited).

Wolf hunting is not permitted in SCIs which are designated for wolf protection (including national parks), national nature reserves (strictly protected areas), the Slovak-Polish border area, or in putative movement corridors between Slovakia and the Czech Republic and Slovakia and Hungary. By the end of the hunting season, the actual number of wolves taken is reported to the Ministry of Agriculture and Rural Development of the Slovak Republic from representatives of each District Office (Land and Forest Department) on a bi-weekly basis. Every hunted wolf is checked *in situ* by the leader of a hunting club, representative of the SNC SR, and representative from the relevant District Office.

The social value of a wolf is considered to be 2,000 Euro (Order of the Ministry of Agriculture and Rural Development of the Slovak Republic No. 421/2013 Coll., determining the social value of game).

Damage caused by wolves to livestock and ungulate game species (such as red deer, roe deer and wild boar) is compensated by the state. According to Act No. 543/2002 and Order No. 24/2003, the Government has a duty to compensate damage caused to: a) life and health of a human being; b) selected domestic animals; c) livestock guarding dogs; d) beehives and beekeeping equipment and facilities; e) agricultural crops not harvested according to agro-technical schedule; f) fruit trees or forest stands; and g) game species of ungulates (red deer, roe deer, wild boar, fallow deer and mouflon) in areas where large carnivores are protected all year-round. An unusual provision related to compensation for ungulates killed by large carnivores (Act No. 274/2009) has been introduced although there is an attempt to discard this provision. Government compensation for livestock damage is limited to between 15 January and 31 October, whereas during the hunting season (1 November to 15 January) livestock damage is compensated by the hunting club responsible for the area in which the damage occurred.

1.1.3 Lynx

The lynx is a species of European Conservation Concern (Annexes IV(b) and VI(a)) having a social value set at 3,690 Euro. In Slovakia, lynxes are protected year-round under Act No. 543/2002 and Order No. 24/2003, and they cause negligible damage to human property and livestock annually. There are 85 SCIs (4,604 km²) where lynxes are the subject of protection.

1.2 Development of large carnivore populations in the Slovak Republic

There are no reliable annual data on the abundance of large carnivores in the Slovak Republic. Annual population sizes “estimates” are derived from data submitted by hunters to a central hunting database. However, these data typically overestimate population size compared to formal population estimates, because numbers are derived independently for each hunting ground (irrespective of animal movement between neighbouring hunting grounds). Thereby, the same animals are repeatedly counted on different hunting grounds. For this reason, we do not report hunter-derived population estimates in this document.

Wolf numbers estimated based on large-scale snow tracking surveys and experts' estimates indicate that between 300-600 wolves are present in the country, with a significant proportion of wolves shared between the Slovak Republic, Poland and Ukraine.

Likewise, in 2013-14 DNA-based capture-mark-recapture methods (CMR) indicated that 1,256 bears (1,023-1,489, 95% CI) are present in the Slovak Republic (Paule 2015). The sex ratio was in favour of females (59.9% females, 40.1% males). This was the first (and to-date the last) scientifically-sound estimate of bear numbers in Slovakia.

Based on photo monitoring and capture-mark-recapture estimates, there are currently 187 ± 56 SE lynx in the Slovak Republic (Kubala et al. 2017).

In the course of recent history, hunting of large carnivores has undergone major changes. Before 1975, neither wolf nor lynx were protected, with bear hunted based on exemptions. In 1975, Order No. 172/1975 Coll. extended protection to wolf and lynx during the period of offspring rearing. In addition, at that time some hunting practices (e.g., poisoning, leg hold trapping and removal of young from dens) were banned. Since then, wolf and bear numbers appear to have increased steadily. Although hunting of lynx has been banned since 1999, the recent population estimate by Kubala et al. (2017) indicates continued population decline, probably due to illegal killing and traffic collisions (road and railway). Hunting conditions for bear tightened in 1996, and since then illegal killing of bears has increased dramatically. Illegal killing of bear, wolf and lynx represent a major challenge to their conservation in Slovakia. Although poaching is a criminal offense, too rarely are cases of illegal killing litigated and therefore litigation is not an effective deterrent.

Table 1. Bears hunted in the Slovak Republic from 2008 to 2018

2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
31	25	46	27	78	20	20	26	17	22	17	3

Comments: Registered bear-vehicle collisions in 2017: 16 individuals; in 2018: 10 individuals; and in 2019: 19 individuals.

Table 2. Wolves hunted in the Slovak Republic since introduction of hunting quotas in 2010

	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020
Quotas	140	150	120	130	80	80	90	70	76	70	35
Bag	138	159	138	151	26	56	43	48	40	31	34

2. Monitoring of large carnivores in the Slovak Republic

European Union member states are obligated to monitor species of Community Interest and their habitats, and report their conservation status every six years to the European Commission (Art. 17 of the Council Directive No. 92/43/EEC of 22 May 1992 on the conservation of natural habitats, and of wild fauna and flora). The SNC SR is responsible for reporting for the Slovak Republic, and has released publicly the report covering the period 2013-2019 (see www.biomonitoring.sk).

In support of collecting, processing, evaluating and publishing occurrence data, the SNC SR manages a “*Comprehensive Information and Monitoring system*” (CIMS). SNC SR zoologists and rangers together with external collaborators randomly collect signs and sightings data continuously throughout the year. Occurrence data include tracks, scats, trail camera photos, natural and human caused mortalities, such as hunted individuals and collisions with vehicles. These data are suitable for monitoring the distribution of individual species.

In the past, the size of populations was determined on the basis of expert estimation. More recently, DNA-based estimates have been introduced. Population size information is not collected at regular intervals, but is timed in order to be available for reporting to the European Commission every six years. Non-invasive collection of scat and hair samples is carried out within the entire range of a species. The first ever genetic MR was used for the estimation of the brown bear population size in 2013-2014 (Paule 2015). At present, the first estimations of the wolf and lynx population size are being performed using genetic methods.

Projects aimed at estimating the number of large carnivores were also implemented within smaller regions or study sites. A combination of snow tracking and genetic identification of individual bears was used in the Poľana Landscape Protected Area and the Poloniny National Park (Straka et al. 2013). Genetic non-invasive sampling was used for the individual identification of wolves and the estimation of population size in the Liptov region (Rigg et al. 2014). Camera trapping aimed at the estimation of lynx abundance and population density was performed in several mountain ranges including Veľká Fatra, Štiavnické vrchy, Strážovské vrchy and Muránska planina (e.g. Kubala et al. 2017). Annual summer counting of bears is conducted in the Malá Fatra National Park. Bears are tallied during two consecutive days from the observation spots in open landscape, usually in June. At this time, bears like to feed on herbs and grass even during the daytime; therefore, there is a high probability to record most of the local population. Multiple sightings are eliminated. Besides the numbers, this method provides quite reasonable information about sex and age composition of the population (Kalaš 2017). In some protected areas, snow tracking is still used for

counting large carnivores. This method is unsuitable for bears and provides only coarse information on lynx and wolf numbers.

In Slovakia, there has been a legal duty to record and compensate damage caused by the large predators since 2002. The Government compensates damage by the bear and lynx, and in the case of the wolf only during its protection from mid-January till the end of October. The lynx has negligible impact on farm animals. The SNC SR keeps records on damages caused by large predators. Annual damage data are suitable for assessing the development of the impact of large carnivores on human property.

Hunters collect information on all game species, including large carnivores within their hunting grounds. Data are collected by the leader of a hunting club throughout the year and sent to relevant District Offices (79 offices in SR) by the end of the hunting season. The District Office sends this information for further processing to the Ministry of Agriculture and Rural Development SR and to the National Forester Centre (NFC). The NFC is responsible for keeping records in a database called Hunting Statistics, and for the preparation of Hunting Statistical Yearbook. The numbers of large carnivores are obtained using an inappropriate methodology, so the use of Hunting Statistics for monitoring is limited. However, it is possible to use these statistics for determining the approximate distribution and for long-term assessments of the population trends. Continuous monitoring of large carnivores is planned for the future.

3. Future perspectives of large carnivore monitoring in the Slovak Republic

The goals for the future are to:

- 1) maintain the favourable status of bear and wolf in Alpine bioregion,
- 2) reach a favourable status of wolf in Pannonic bioregion,
- 3) strengthen the legal and institutional protection and management of large carnivores in Slovakia,
- 4) improve processes related to damages caused by large carnivores (e.g., establish system of prevention measures to restrict damages, decrease impact on large carnivores, and strengthen international cooperation; establish regular monitoring and improve public cooperation).

These goals will contribute to the improvement of large carnivores' protection as well as to the sustainability of wolf and bear management.

Other goals are to minimise the negative impacts of transport infrastructure and other human activities on the life of large carnivores (using telemetry monitoring to identify large carnivore migration corridors which are cut through by transport infrastructure). Safeguarding the continuity of carnivore habitats and permeability of the landscape (by constructing green bridges and implementing mitigation measures where necessary) is needed to ensure continued gene flow. To be effective this must be undertaken in cooperation with and in relation to surrounding countries (Skuban et al. 2017, Findo et al. 2019).

An active, nationally-organized approach is needed to mitigate conflict and confront and eliminate illegal hunting aiming to decrease poaching of protected animals, investigate damages caused by large carnivores, carry out field visits, administration and compensation of these damages as well as protection of habitats from negative anthropic influence, is a must. What is also important is international cooperation related to the preparation and implementation of common management plans.

Measures related to elaboration and testing of mathematical-statistical models for determining optimal management (wolf hunting quota) and setting the yearly growth rate of wolf populations, and determining optimal wolf hunting quotas with specification of sites where wolves will not be managed, are all planned for near future. Elimination of baits and feeding places for ungulates, management of the Bear Emergency Team and the Bear Protection and Management Committee are among activities prioritized for these years as well.

Currently, the measures and activities set out in the endorsed management programmes related to the three large carnivores are carried out within an ongoing project financed by the EU.

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Large Carnivore Monitoring in the Carpathian Mountains –

Ukraine

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1. Background

1.1 Legal status of large carnivores in Ukraine

Among the species of large carnivores occurring on the territory of the Ukrainian Carpathians, the brown bear and lynx are completely protected. In the red Data Book of Ukraine (2009) the brown bear is listed as “disappearing” (equivalent to Endangered according to IUCN Red List Criteria) and the lynx is “rare” (equivalent to Vulnerable). The wolf is considered a game species with limited terms for hunting them. According to the Law on the Red Data Book, the protection of listed species should involve the following:

- establishment of a special legal regime for their protection;
- prohibition of their use for economic and military purposes;
- considering requirements for their protection during the development of regulatory acts;
- systematic work on the identification of their habitats, and regular monitoring of the state of their populations;
- creation of nature protected areas, as well as an ecological network in the territories where they are located and on the migration routes;
- creation of centres for maintaining the gene pool of these animals;
- considering special requirements for their protection during decisions relating to land issues, development of project documentation, etc.

In addition, these animals are protected in Ukraine in accordance with the "Law about the Animal World" (No. 2894-III of 13.12.2001) where, in addition to the above requirements, the deterioration of the habitats should not be allowed, migration routes and conditions for the propagation of wild animals ensured, the integrity of natural communities of wildlife and other species preserved. In order to preserve these species, Ukraine has imposed quite high fines for any harm caused to them. For the killing of bear the penalty is 130,000 UAH (about 4200 EUR), and for the killing of lynx, the penalty is 20,000 UAH (about 650 EUR).

1.1.1 Bear

As early as the 17th century, the brown bear had almost disappeared throughout the flat part of the country (with the exception of a small number of individuals in the territory of Polissya). Its core area was restricted to the Carpathians. Based on the

increase in population numbers in the Carpathian region from the middle of the 20th century, bear was classified as a game species. From the 1960s through to the beginning of the 21st century, it was allowed to hunt bear with special permits.

However, given the considerable negative trends in bear populations and the decrease in their range, according to the order of the Ministry of Ecology and Natural Resources of Ukraine on May 28, 2005, the brown bear was listed in the Red Data Book of Ukraine with the status of "vulnerable". Unfortunately, the inclusion of this species had no significant effect on the preservation of its population and, therefore, the bear was assigned the status of "disappearing" in the Red Data Book of Ukraine, published in 2009.

1.1.2 Wolf

The attitudes towards wolves in Ukraine are very ambiguous among the population. There is a significant polarity in relation to this species: from extreme rejection to total tolerance. In the past, the wolf belonged to so-called "harmful" species and its hunting was allowed year-round with no quotas for hunting. A considerable reward (about 15 Euro) had been paid for the hunted wolves. However, in 2010 (Law of Ukraine No. 1827-VI) the terms for hunting a wolf became more limited. According to this document, in Ukraine, a wolf can be hunted from October to February, without a hunting license. Generally, nowadays there are no criteria defining the term "harmful species" for fauna or flora in the Ukrainian legislation.

However, in the public debate, the issue of species status has consistently been influenced by a growing number of animal protection initiatives. A law relating to animal protection caused a violent reaction among hunters and foresters. In their view, the attitude towards and laws regarding this mammal are taken directly from the legislation of countries with low wolf populations. Therefore, they do not consider the situation with the wolf in Ukraine, where its numbers are much higher. However, supporters for the protection of wolves believe that the population size indicators are significantly overestimated. Thus, one of the important issues in solving this discussion is to ascertain the real number of wolves. In addition, the lack of a compensation system for damages caused by these animals in Ukraine does not promote the conservation of wolves and other large carnivorous mammals.

1.1.3 Lynx

Lynx was widespread in the forest and forest-steppe parts of the territory of Ukraine up until the 19th century. As a result of human activity, in particular the transformation of habitats and destruction of this species, its range began to decline rapidly. Already at the beginning of the 19th century, its presence was confined to the Carpathians and the Polissya.

In the middle of the 20th century, lynx was a very rare species in the territory of Ukraine. This led to the inclusion of this species in the Red Data Book of Ukraine (1994) with the classification of "vulnerable". In the next edition of the Red Data Book of Ukraine (2009), this species was assigned as a "rare" species, although no increase in the population size and range of distribution was registered.

1.2 Development of large carnivore populations in Ukraine

1.2.1 Bear

In the past, brown bear was present across a large part of the territory of Ukraine. This was evidenced by fossils from the Paleolithic era in Chernihiv, Poltava, Cherkassy, Dnipropetrovsk, Volyn, Rivne, Lviv, Ivano-Frankivsk and Chernivtsi regions. The remains of bears were also found during the excavation of Tripolian cultural remains in Zhytomyr, Kyiv, Kharkiv, Sumy and Mykolaiv regions (Tatarynov 1956). Studies have shown that the current area of the brown bear distribution in Ukraine has significantly decreased since the end of the twentieth century. Today, the species is only present in the Ukrainian Carpathian area. Individuals also appear sporadically in Polissya, in particular, in the Chernobyl exclusion zone.

The distribution of brown bears in the Carpathians is uneven. In addition to migrations within the Ukrainian Carpathians, active transboundary movements are constantly taking place. These occur between neighbouring areas of Slovakia, Poland, and Romania. In general, in the Ukrainian Carpathians there are two regions where brown bear numbers are concentrated:

- - "North-western" (near the border with Poland, NNP "Skolivski Beskydy"). In particular, in Uzhanskyi National Park the bear movements were noted between Ukraine, Slovakia, and Poland. From here the species extends along the Polonynskyi Range, as well as to the valley of the Latorytsia River.
- - "South-eastern" (near the border with Romania). Visits of bears were noted from Romania to the territory of the Chornohora and Marmarosh mountain massifs, which are located close to the border with Romania.
- - The highlands of the Skolivski Beskids, the Borzhavskyi massif, Gorgany, Svydovets, and Chornohora are inhabited by an Ukrainian sub-population of this species.

Estimating the size of the brown bear population in Ukraine remains a difficult task. Until the middle of the 20th century, the number of the bears within the Ukrainian Carpathians was relatively low. However, there are doubts surrounding the reliability of data on the fluctuations in population numbers of this mammal. These doubts are reinforced further when looking at how many individual bears were observed during the second half of the century. In 1947, 74 individuals were registered; in 1950, there were some 484 individuals; in 1960, 800 individuals, and in 1964, 1000 individuals (Turyanyn 1975). Already, in the 1970s, there were about 1200 bears in the Carpathians, of which about 400 were adult males, as well as many adult females. The rest were young animals under the age of three (Slobodyan 1988). The population density was 0.5-0.7 individuals per 1000 hectares of forest lands. From a rare mammal, its status changed to common one. From the 1960s through to the beginning of the 21st century, the hunting of bears was allowed with special permits.

It is believed that the main factor that contributed to the increase in the population of bears between the 1960s and 1970s was the significant levels of deforestation. Logs with overgrown vegetation on them, and young forests, combined with a decreasing area of spruce forests had created a large mosaic of forest cover. The number of berries increased, thus providing a staple for foraging, while young coniferous trees provided bears with materials to prepare their dens. In addition, the absence of natural enemies, with the exception of humans also contributed to the growth in bear numbers. However, the growth of the bear population subsequently slowed due to

the reduced crop of beechnuts, the transitioning of young animals to closed stands, the decrease in the area of plants bearing berries and, as a result of an insufficient accumulation of fat during the summer-autumn period and unsuitable conditions during the winter. This led to a high mortality among young bears. Towards the end of the 1970s, and the beginning of the 1980s, the bear population stopped growing in the Carpathians, and a decrease was even observed (in 1978 – 970 individuals). This was due to the small number of mature bears and their overall low fecundity, coupled with significant poaching levels.

It should be noted that literary data on the dynamics of the brown bear population in the Ukrainian Carpathians are not considered to be reliable. This is evidenced by rather sharp changes in the number (30-50% and even 1090%) over the course of a few years (Delegan et al. 2011). Over the last decades, a negative trend in bear population numbers has typically been observed on the territory of the Transcarpathian region. However, some authors believe that, since 1995, the number has stabilized and consists of some 110-130 individuals. One of the possible factors leading to this stabilisation is the greater possibility for bear migrations at the Ukrainian-Romanian border (Bashta and Potish 2007). Their concentrations increased markedly after the collapse of the USSR, which is explained by the lack of signalling devices and a partial removal of physical barriers at the border. As a result, the number of bears increased in the areas adjacent to the border. Some 311 individuals, with an average population density of 0.59 individuals/1000 hectares (0.26-2.19 individuals/1000 hectares), were counted on the territory of the mountainous part of the Ivano-Frankivsk region in 1986. By the end of the 20th century, the density had decreased to 0.2 individuals per 1000 hectares (Hoetsky 2000).

In the early 1990s, some 594 bears were recorded in the Carpathian region. Analysis of data from the state statistical service shows that between the 1970s and 2001, the bear population declined by a multiple of 3.3 in the Carpathians. During the period from 1978 to 2000 alone, the number of bears in this territory decreased almost threefold: from 970 to 350 individuals (Dovhanych et al. 2002). The discrepancies between accounting methods often resulted in uncertainties surrounding the dynamics of the brown bear population in the Carpathians. At the beginning of the 21st century, according to official statistics, the total number of bears in the Ukrainian Carpathians was about 300 individuals, and after 2000 there was an increase in the number within the range of between 3.4 - 5.6%. However, the methods used for the inventory do not allow the assessment, in sufficient detail, of the number of the most important prey species: artiodactyls. When analysing the data, the results of the inventory of this species do not appear to be reliable, and seem to be overestimated. A subsequent inventory of the forestry and hunting areas, conducted more recently, show that today there are no more than 200-220 brown bears in the Ukrainian Carpathians.

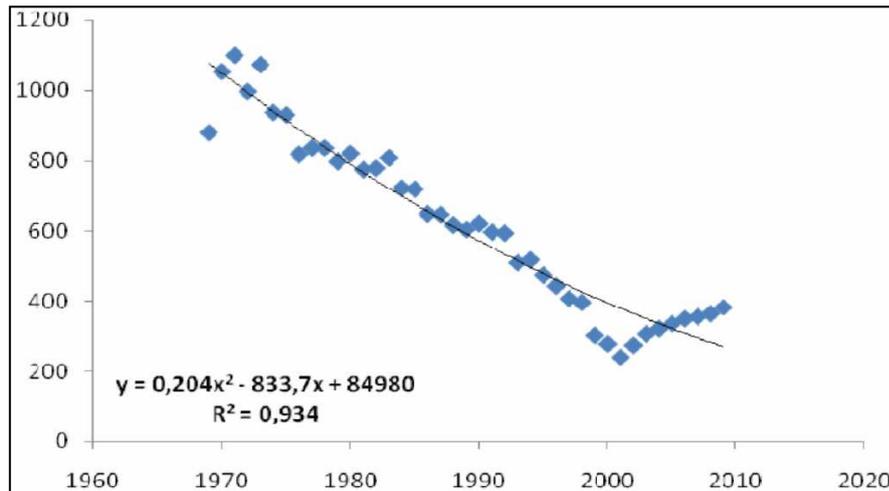


Figure 1. Brown bear numbers in the regions of the Ukrainian Carpathians in the period between 1970-2010 (Delegan et al. 2011)

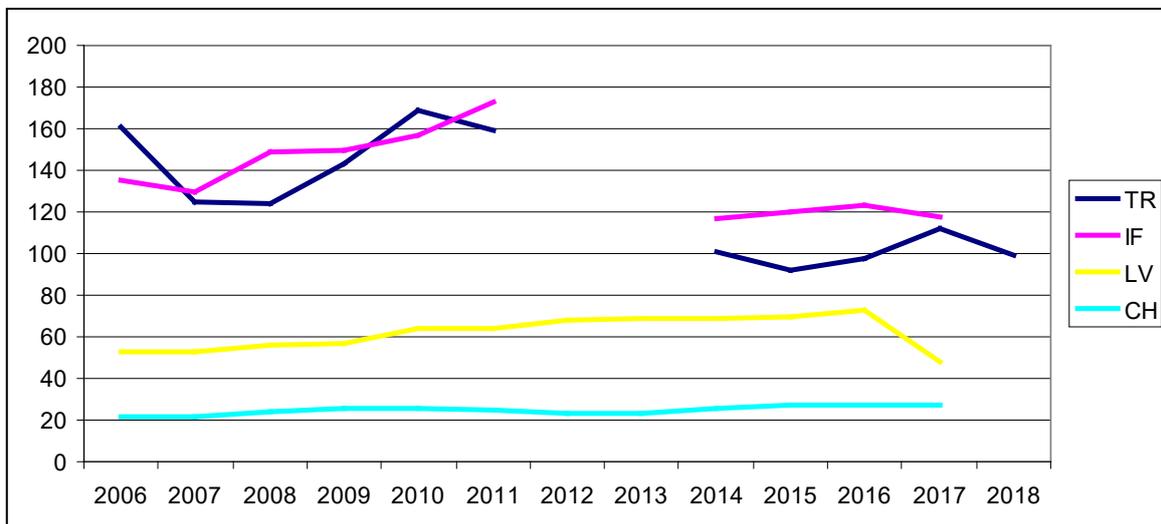


Figure 2. Brown bear numbers in the regions (TR – Transcarpathian region, IF – Ivano-Frankivsk region, LV – Lviv region, CH- Chernivtsi region) within the Ukrainian Carpathians between 2006-2018 (unpublished data of the State Agency of Forest Resources of Ukraine)

1.2.2 Wolf

Wolves are present throughout the territory of Ukraine, and have been since at least the beginning of the 19th century (Korneyev 1953). There are no exact data concerning the quantitative dynamics and area of distribution of wolf populations in the Carpathian region of Ukraine. However, the data from across the whole country may be representative of the situation in this region.

The density of wolves was influenced by human behaviours during the 20th century, being the result of varying economic and social conditions. A powerful campaign to reduce the number of wolves during the 1850s, as a result of pressures from livestock herders, resulted in a significant decrease in wolf numbers. Up until the beginning of the 20th century, the species was considered to be relatively rare. However, military operations between 1914-1920 favoured an increase in wolf

numbers again. This resulted in the next wave in the fight against wolves. It led to an unevenness in their distribution by 1938 (Korneyev 1953). The highest wolf numbers on record date back to after World War II, consisting of about 7000 individuals between 1947-1949 (Kryzhanivskyi 1999).

Since 1950 the wolf had been included on the list of “harmful species”. Up until 1970, a large-scale campaign against wolves led to decrease in their population, down to a minimum of 450 individuals. From 1970 onwards, a gradual increase in wolf population numbers has been recorded in Ukraine. In 1980, according to statistical data, the number of wolves had grown to more than 1,000 individuals. Since 1994, the number of wolves has been growing by approximately 20-25% each year. During the 20th century, their number therefore varied greatly, from around 450-500 at a minimum, to 7,000 individuals at most (Kryzhanivskyi 1999), influenced by hunting pressure and the socio-economic transformations of the territory. A decrease in hunting pressure led to an increase in wolf numbers at the beginning of the 21st century. According to official statistics, between 2006-2017 the population of wolves fluctuated between 1907 and 2737 individuals in Ukraine.

The main factors driving hostility towards the wolves in Ukraine have been their competition with hunters for game species, livestock depredation, and a fear of wolf attacks on humans. To analyse the distribution of wolves in the Carpathians, official statistics from the State Forestry Agency have been used. According to these records, wolf numbers varied between 290-350 individuals at the beginning of the 21st century in the Carpathian region. In comparison to the 1970s, the number of wolves increased between 5 to 6-fold in this area.

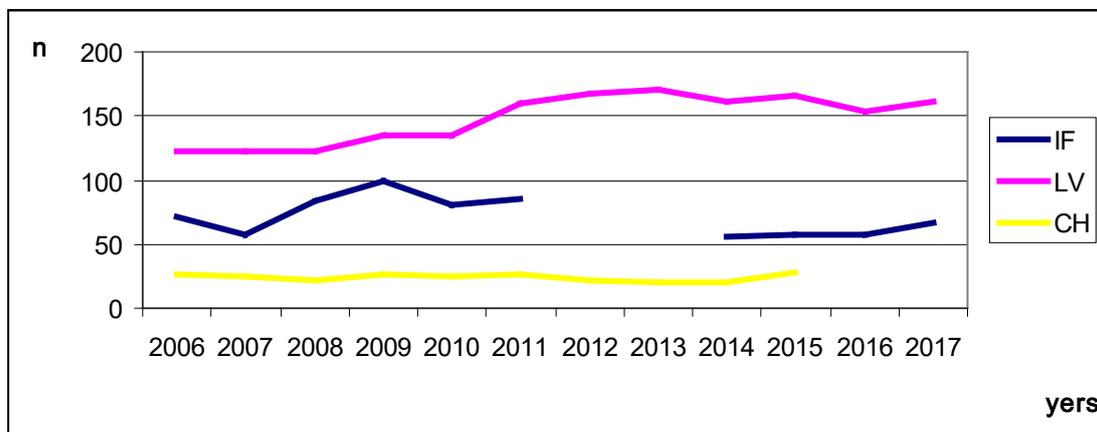


Figure 3. Wolf numbers in the regions (IF – Ivano-Frankivsk region, LV – Lviv region, CH- Chernivtsi region) of the Ukrainian Carpathians between 2006-2018 (unpublished data of the State Agency of Forest Resources of Ukraine)

Opinions concerning wolf numbers in the Carpathians vary among stakeholders. There are no published data on the subject. Some researchers believe that the number of wolves in the Carpathians is half of what the official data claim, and that hunting had removed more than 70% of the total population. According to other researchers, the number of wolves in the Carpathians is more than 400 individuals, and hunting had removed about 30% of the total population as of the beginning of the 21st century.

The increased intensity in wolf killings occurred after the Second World War. Over the 25-year period (1946-1970), more than 2000 individuals were harvested in the Carpathians. Between 1946-1951, some 14-34 individuals were hunted annually. This number increased to between 29-66 individuals per year during the period from 1952-1963. Anthropogenic pressures led to the persecution of wolves during the mid-1960s. This resulted in a decrease in the population size, which affected the hunting levels: during the 5 year-period between 1964-1968 only 36 individuals (average of 7 individuals per year) were harvested.

The current size of the wolf population is characterised by fluctuations, and varies from between 80 and 100 individuals in the Transcarpathian region. Among the four Carpathian regions, the lowest number of wolves was registered in the Chernivtsi region. An increase in the number of wolves in the hunting grounds in the Ivano-Frankivsk region has been observed since the late 1970s. After a slight decrease and stabilization of the number with some 40-50 individuals in the 1980s, the population grew 2 to 3-fold through to the 1990s. Today, the number stands at about 80 individuals. The main population of the species in the hunting grounds of the Lviv region occurs in mountainous areas and is characterized by unstable numbers and significant fluctuations (Figure 4).

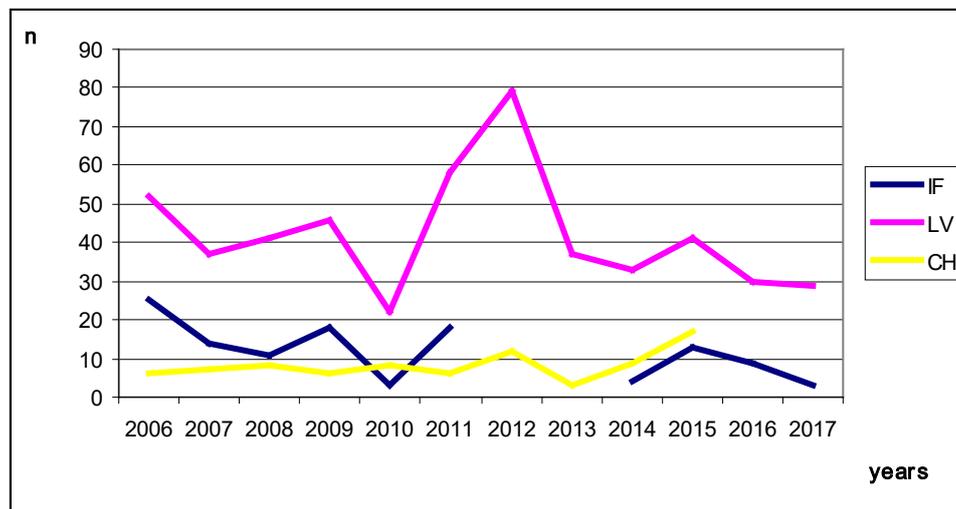


Figure 4. Number of hunted wolves in some areas (IF – Ivano-Frankivsk region, LV – Lviv region, CH- Chernivtsi region) of the Ukrainian Carpathians between 2006-2018

1.2.3 Lynx

In general, lynx occurs on the territory of Ukraine in two regions: the Carpathians and Polissya. In the Carpathians, the largest population of lynx has survived in Ukraine, characterized by the largest continuous distribution area. In the Carpathians, the lynx situation is poorly understood. There is likely be a significant degree of error in the population number estimates for the species in this region. It is often understood that, as in the case for other predatory mammals, hunting data does not fully allow the extrapolation of accurate population numbers for a species, since adequate methods for counting and estimation of the population size are not used. Often, an individual animal occurs on the territory of several hunting grounds. Population figures derived from hunting data involve simply adding these individual animal data together. In addition, all statistics on lynx numbers are restricted to within the administrative

boundaries and therefore do not consider the individual territories of the individual animals.

In the Carpathians, lynx have now been found in all of the large forests. Based on the inventory of lynx, and comparing the figures with those from historical data, it should be noted that from the middle of the 20th century the habitat of the species, as well as the number of individuals, decreased significantly. The number, and density per unit area, of the lynx varies significantly in different parts of the Ukrainian Carpathians. As of 2017, in the Lviv region, 65 individuals were registered; in the Transcarpathian region, 178 lynxes were registered in 2018. However, based on data from a survey conducted through a questionnaire as well as individual expeditionary surveys, it appears that official figures on the size of the species represent over-estimates.

Studies conducted in the Chernivtsi region estimated the number of lynxes at between 38-66 individuals. Data from the Ivano-Frankivsk region indicated some 77-87 individuals. In Transcarpathia, the lynx numbers are low, with a clear preference for coniferous forests. Their distribution is mainly limited to the mountains of Gorgany, Svydovets, and Chornogora, with a visible concentration in the Rakhiv district. The total number of individuals, according to the data collected, ranges from 110 to 167 individuals (Bashta and Potish 2007). Summarizing the collected data on the number of lynx in the Carpathians, the overall figure appears to be between 200-350 individuals.

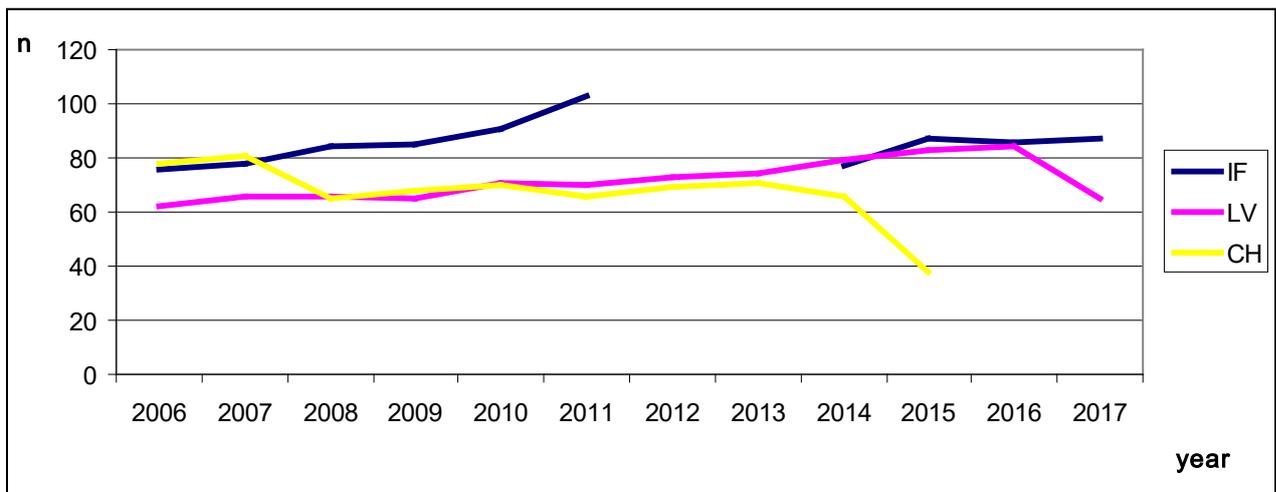


Figure 5. Lynx numbers in the regions (IF – Ivano-Frankivsk region, LV – Lviv region, CH- Chernivtsi region) of the Ukrainian Carpathians in 2006-2017 (unpublished data of the State Agency of Forest Resources of Ukraine)

2. Monitoring of large carnivores in Ukraine

The management of large carnivore populations should be based on accurate knowledge surrounding their actual status and trends.

Information on the distribution and number of large carnivores should be based on the collection of field data, and supplemented by additional scientific research, including genetic analysis. Field data should be reliable and verifiable. This means that people with expert knowledge in detecting signs of the presence of carnivores should be involved in the collection process. If provided by third parties (such as volunteers), the data must be properly documented and geographically referenced so

that they can be verified by an expert (for example, during field visits or on the basis of photographs).

However, regardless of the region, to estimate the distribution area and the size of carnivore populations, field data should be provided to a group of experts. Estimates on the number of carnivores produced at the level of regional forestry and hunting departments in Ukraine are not always reliable and verifiable. For example, all wolves, bears and lynxes found during winter snow tracking in certain forest areas were simply aggregated, without adjusting the data with findings from neighbouring forest areas. This can lead to double-counting and thus a significant overestimation in their numbers. Calculated based on these inventories, the data on carnivore densities are irrelevant, and can be significantly higher than data obtained through sound scientific research.

The conservation status of the brown bear and lynx (Red Data Book of Ukraine 2009) means that they are considered of low commercial value. Therefore, in general, for the hunting area, information on the exact number of bears is not important for each territory. Given the complexities associated with keeping records, users generally do not conduct effective monitoring because their methods are either too labour-intensive or expensive. However, as users of the land, hunters are legally required to maintain the stable existence of rare species on their territories. Therefore, the numbers of predatory animals provided by them are, most of the time, characterized by significant errors. Even when it is required to keep records land users do not, for the most part, identify individuals, nor do they map their whereabouts.

Over-estimating the number of carnivores is also the result of a lack of coordination regarding the accounting of these species among adjacent areas. Therefore, if the individual territory of a single bear, a lynx or a wolf pack is located on the territory of two hunting areas, the total result will indicate double the actual number of individuals. The inventory is also influenced, to some extent, by transient individuals, namely animals which only appear for a short period of time in a given area, before moving on to the next. As a result of their movements, they can be accounted for multiple times across different areas. To ascertain the real situation surrounding the state of large carnivore populations, it is necessary to organize continuous monitoring with the use of standardized methods.

Data on carnivores is obtained *inter alia* through a comprehensive inventory of game species after the first snow. This involves recording the number of crossings traversed by a given species along a given route, the length of which is 10 km. From this, one can calculate the estimated number of animals per unit length. For wolf and lynx, comparisons are relatively reliable no matter what the season or time of year. However, for bears, due to their winter hibernation, results from this method do not always provide an accurate representation of the real situation. It is well known that during winter hibernation the mobility of bears is significantly reduced, and some are already in their dens. Therefore, the accuracy of quantitative data calculated from tracks in the first snow, in particular, is very low for bears. In addition, some of the individual bears or wolf packs that are active during this period are quite mobile during the day, so the same individual can be registered on the territory of several forestry enterprises which, in turn, leads to overestimates in terms of population numbers.

Data on carnivore populations is also obtained through the comprehensive recording of game species, together with other accounting methods. Existing accounting methods do not always allow the reliable determination of a species' population size.

The territories of significant individuals, and the presence of non-territorial animals creates difficulties during the counts. The counts only take place in December, and not at the end of the hunting season, thereby reducing the reliability of the results. Some hunting area managers have corrected the results of their observations by tracking large carnivores, especially bears, throughout the year. This, to a certain extent, raises the accuracy of the results, but it is very difficult to estimate the level of accuracy associated with this method. Therefore, it can be reasonably assumed that the official data on the number of large carnivores in the Ukrainian Carpathians are not an accurately reflection of the real numbers for each species.

For accurate and reliable large carnivore population number estimates, special monitoring methods are required for these species. Researchers, as well as those working in nature protection areas, use a multitude of methods in order to obtain the most accurate population number estimates for large carnivores in their study areas. Estimating the number of individual bears is also done based on paw print sizes. It is very difficult to find two bears with exactly the same size paw print. Registering the size of the tracks allows you to determine not only the number of bears in a certain area (one-time registration) but also the movement of individual animals during the active period (permanent recording).

A one-time registration of prints gives the most reliable results if the recording is done during the first 10 days of June, and is carried out during a period of between 2-6 days. The start date of the monitoring coincides with the moment when the distribution of individual bears across their territories is the highest, meaning that distinct bears are more likely to keep to distinct areas. When processing the information, data from questionnaires is mapped against the area in question, in order to create a common picture. Data is then grouped and extrapolated to the wider area.

The population number estimates for the wider area, and any changes, as well as movements of bears, serve as a permanent census. The monitoring is conducted during the snowless period of the year. As well as recording the size of paw prints, their frequency and locations also help determine the movement of bears. The monitoring (distribution and numbers) of rare species, such as bear, lynx, and wolf, as well as others, is also often done via a questionnaire. When used, this method involves the collection of information through oral or written polls among those residing in a given area or among a certain group of people (foresters, forest guards, loggers, etc.). This method allows the detection of fluctuations in the population numbers of a given species and, in some cases, to calculate their actual numbers.

A further research method, which has become more popular in recent years, is the recording of animals with the help of automatic photographic or video equipment. However, the high cost associated with this technology prevents it from being applied more widely. The technology is particularly expensive because, in order to adequately determine the situation, a network of such devices is needed. Nevertheless, the use of such technology increases the quality of information received and facilitates the collection of data. Observations received through different methods are recorded in an electronic database, which allows the analysis of information, and can draw relevant conclusions.

Locally, with the support of various funds and international grants, it is possible to estimate in sufficient detail the number of large predators in a certain area. One example of this is the project "Open borders for bears between Romanian and Ukrainian Carpathians", implemented a few years ago by WWF-Ukraine and WWF-

Romania. It looked at the distribution of brown bears in the historic region of Marmaros (Maramuresh) on the border area between Ukraine and Romania. The project sought to determine their transboundary movements. Information available at the time about the population status and migration routes was complemented by telemetry studies, carried out within the framework of the project.

The data obtained through such monitoring efforts will form the scientific basis for developing measures for the long-term preservation of a viable population of large carnivores in the region, providing opportunities for free movement and exchange of genetic material between individuals from other subpopulations in the Carpathians. When carrying out monitoring activities, having a high level of accuracy associated with data is important. The data can come from several sources. To achieve this, it is necessary to encourage the administration of forestry areas to involve representatives from the security services. Ultimately, successful monitoring requires some knowledge of the biology of large carnivores. In reality, knowledge levels tend to be quite low. As a result, it is necessary to provide training in surveillance methods for carnivore mammals for relevant forest protection service staff.

The monitoring system for populations of large carnivores should be based on the following principles:

- objectivity and reliability;
- systematic observation of the state of populations and factors influencing them;
- consistency of methodologies;
- if possible, the coherence of technical support, etc.

To achieve this, requires:

- setting up of a unified monitoring system;
- setting up a system for collecting, processing, summarising and storing information;
- an inventory of underlying factors, and ascertaining the degree to which anthropogenic factors impact a mammals' habitat;
- development of managerial decisions aimed at ensuring the conservation and reproduction of large carnivore populations.

Long-term monitoring should be based on the following structure:

- Defining goals and objectives:
 - - Determination of the purpose of monitoring;
 - - Definition of scales, periods and monitoring points;
 - - Detection of partners and stakeholders who may assist in obtaining information,
 - - Choice of adequate monitoring methods.
- Gathering information
 - - Determination of specific monitoring sites;
 - - Ecosystems and habitats to be monitored (maps of territories, past and present state, etc., to identify trends and potential threats);
 - - Species - monitoring objects:
 - - Quantitative data: population size, number;
 - - Qualitative data: dynamics of numbers, reproduction success etc.;
 - - Distribution: spatial distribution, relations with other species;
 - - Relationship with humans;
 - - Value for humans, in particular the economic value associated with the preservation of the species;
 - - Threats that may affect the species and its habitats.

3. Future perspectives of large carnivore monitoring in Ukraine

Member States of the European Union (EU), in accordance with Art. 11 of the EU Habitats Directive are required to monitor the conservation status of priority species, a list of which is included in Annex II of the Directive. Such monitoring should be carried out throughout the distribution area of these species. In addition, Art. 17 of the Directive obliges Member States to submit relevant reports every six years to the European Commission. The reports contain information on changes in the area of distribution and the population numbers for these species. Ukraine, when the country to become a EU Member State, and thus sign the Association Agreement, would need to first adapt its legislation and make efforts to implement the European norms and legislation.

The loss and fragmentation of habitats, poaching, and other forms of anthropogenic pressures represent real threats to the survival of the populations of large carnivores on the territory of the Ukrainian Carpathians. However, a lack of relevant information on these pressures in particular, as well as the limited accuracy and reliability of monitoring data, make it difficult to develop appropriate management measures. There is also a lack of funding necessary for adequate conservation and management measures for large carnivore species in the region.

However, regardless of the region, it is important that the monitoring data that is collected is available to groups of relevant specialists with knowledge on the ecology of large carnivore species. This will allow them to estimate the area of distribution and the size of populations of large carnivores in the region. Currently, large carnivore population estimates, conducted at the level of forestry or hunting communities, are often inaccurate. One example where these inaccuracies are visible is in the results of a so-called “inventory of large carnivores”, which is performed annually by the state forestry and hunting management departments in the Carpathian region. The inventory results include erroneous data which stems from inconsistencies in the monitoring methods. This includes instances where all of the individual wolves that were detected during the winter tracking period, in each of the different forest areas – regardless of which home territory they actually occupy – are recorded as individuals. With certain individuals potentially being recorded multiple times, population numbers can be significantly over-estimated.

Qualitative training of hunters is also an important task. Unfortunately, a significant number of the hunters in Ukraine lack the necessary professional and technical knowledge that would be required as a minimum for monitoring large carnivores. This can be explained by the legislation that is in place, and which does not have well-defined requirements for such specialists and forest users, especially civic organizations acting in this field. While this reduces the expenses associated with the education of hunters, it also allows persons without the necessary knowledge and skills to remain in their positions. In general, in Ukraine, there is an insufficient number of hunting schools and training curricula for hunters, something which on the contrary the majority of EU Member States attribute a lot of attention to. Based on an analysis of the available data, it is therefore necessary to strengthen measures for the protection of large carnivores in Ukraine by creating a system of wildlife nature protected areas along the borders with Poland and Romania. At the same time, it is necessary to continue permanent monitoring, and to develop scientific principles for the conservation of the populations of these species.

The current state of the populations of large carnivores in Ukraine shows that simply providing them with the status of protected species is not sufficient. Instead, one should look at the question: what is stopping their populations from increasing? The reasons behind the unsatisfactory state of large carnivore populations in Ukraine are debatable and certainly down to a multitude of factors. However, the most important factors that are known to limit large carnivore populations are:

- - habitat reductions;
- - poaching;
- - insufficient foraging base; and
- - infrastructure development.

To prevent and reverse the negative trends in the status of large carnivore populations, it is necessary to strengthen relevant international cooperation and enhance concerted conservation measures in the framework of international treaties such as the Bern or Carpathian Conventions. The efforts undertaken by WWF in the last years to protect large carnivores are also encouraging. Further development of International or National Action Plans and projects to protect large carnivores is needed.

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