Lynx (*Lynx lynx* L.) (Photo: M. Krofel)

Sustainable wildlife management

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Introduction

The ecological and geographical diversity of a country is reflected in the diversity of wildlife species' habitats it includes. In Slovenia three autochthonous large carnivores are present: the brown bear, the wolf and the Eurasian lynx. Among seven wild ungulate species, four are native (roe deer, red deer, wild boar, chamois) and three are allochtonous (Alpine ibex, mouflon, fallow deer). Similar to many other European countries, Slovenia has been characterized by the increasing density and spatial spread of large mammals, especially bears, wolves, red deer and wild boars (Jerina and Adamič, 2008; Stergar et al., 2009); some species have also colonized the country recently, and were not present in the past, such as golden jackals and beavers (Krofel et al., 2017).

Along with the population dynamics of the abovementioned species, the intensity of their environmental impacts has also increased. The main emphasis of wildlife management is usually on the negative impacts on the environment. Through browsing of seedlings and saplings, wild ungulates can affect forest regeneration and tree species composition. When browsing is too intensive, forest regeneration becomes hindered or even completely absent (Klopčič et al. 2010, Simončič et al. 2018). The economic value of young trees is reduced by bark stripping caused by red deer (Vospernik, 2006; Mansson and Jarnemo, 2013). In agricultural landscapes, wildlife causes damage to crops, grasslands, livestock, and so on (Schley et al., 2008). In some areas local inhabitants find themselves in conflict when wildlife species (e.g. bear, wild boar) enter their settlements or even urban centres (Cahil et al., 2012). Traffic safety can also be endangered by the passage of animals (van der Grift et al., 2013), and wildlife species transmit certain diseases to domestic animals, and even to humans (Ruiz-Fons et al., 2008).

Figure 19: Wild boar (*Sus scrofa* L.) (Photo: Stane Draškovič Pelc)

Less is known about the ecological roles of these same species. By spreading the seeds of plant species on their hair or in the gastrointestinal tract, animals play an essential role in the dispersion of many, especially pioneer, tree species. Animals often feed in one type of landscape (e.g. on grasslands), and then defecate in another (e.g. in a forest), providing the horizontal distribution of nutrients between different types of landscape. Wild boars may accelerate the nutrient circle by rooting, which enables the faster growth of tree (and other plant) species. Bear and wild boars remove carrion and thus inhibit the transmission of infectious diseases, while wild ungulates represent key food for large carnivores (Pokorny and Jelenko, 2013; Eisenberg, 2014).

Several direct benefits of wildlife can be seen in the economy and ecosystem services. The hunting of wildlife species represents a source of meat, and its production in Slovenia (around 2,000 tonnes / year) is comparable to the amount of meat obtained from breeding sheep and goats (Jerina et al., 2010). Hunting is also a form of recreation, with around 20,000 hunters registered in the country. Wildlife-related ecotourism (e.g. observing and photographing animals in the wild) is also becoming more popular (Karamanlidis et al., 2016).

The planning and management of wild ungulates and large carnivores, such as bears, wolves and lynxes, which are considered rare and endangered on a European scale, requires special attention (Kaczensky et al. 2013).

The planning approaches used for the management of wild ungulates and large carnivores are different.

i. In Slovenia wild ungulates are considered game, whereas large carnivores are protected species on a European scale. Consequently, the legislative background for the management of both animal groups is different.

ii. Large carnivores are more charismatic than wild ungulates, and people also perceive their negative impacts as more dramatic (e.g. endangering human life, predation of domestic animals). Therefore, large carnivores attract much more attention from the broader public, and greater engagement and pressure from different stakeholders for their management.

iii. Wild ungulates and large carnivores differ significantly in ecological and biological characteristics. Compared to ungulates, large carnivores are represented in lower population densities and larger home ranges.

Wild ungulate management

Since 1993, game management planning in Slovenia has been under the competence of the forestry profession (Slovenia Forest Service). This system significantly facilitates the consolidation of forest and game management, providing an ecosystem approach and holistic forest management. Nevertheless, for decades some parts of Slovenia have faced the problem of over-browsed forest regeneration, which makes achieving forest management objectives much more difficult. In 1996, the Slovenia Forest Service started the systematic inventory of the browsing of forest regeneration across the whole country. The method was revised in 2010 and ever since has provided a useful and effective tool in forest and game management. The inventory of browsing of forest regeneration has been performed every three years since 2010, and the results of the three consequent measures revealed the relatively high browsing impact in some parts of the Dinaric and Alpine mountains (Terglav et al., 2017), which has been an important argument for changing the deer management practices in these areas.

Besides forestry, wild ungulates also have important impacts in other sectors, for example in agriculture, where they can cause considerable local damage. In addition, the environmental impacts of wild ungulates can influence the well-being of other stakeholders or the broader public.

The process of the preparation of management plans, which is primarily the responsibility of the Slovenia Forest Service, is therefore transparent and participatory. All interested stakeholders can participate and influence management decisions in the process of developing the plans.

Wildlife ungulate management is hierarchically organized in spatial and temporal terms. Slovenia is divided into 15 hunting management units, which, in terms of populations of locally dominant game species, present complete ecological units. Game management units are further divided into hunting grounds. There are 423 hunting grounds in Slovenia, of which 12 (13 % of the country) are managed by the state (special purpose hunting grounds) and 411 are managed by hunting clubs (voluntary associations).

The fundamental goals and strategies of game management are defined by the long-term (10-year) plans of hunting management units. The annual plans of these units follow the long-term plans and present their level of implementation (https://www.gov.si/teme/upravljanje-z-divjadjo/), by defining and quantifying measures for achieving long-term objectives (e.g. the degree and structure of the cull of animal species, measures in the environment). The most detailed level of game management planning is seen in the annual plans of hunting grounds. Measures from the annual plans of units are broken down to the level of hunting grounds, with the suggestions and interests of hunting managers also considered within the professionally acceptable limits.

Figure 20: Central European red deer (*Cervus elaphus* L.) (Photo: Petra Draškovič Pelc)

The main emphasis of game management is based on control, and future plans for the next management period are developed based on the analysis of population and environment states, as well as an analysis of the previous management. Unlike other countries, Slovenia does not estimate the density of ungulates, but instead uses indirect indicators to assess population trends, i.e. whether the population grows, decreases or remains unchanged, and indicators are used to show the intensity of the environmental impacts of game species. Particularly important among these indicators is the damage to forest regeneration (due to wild ungulates), which, besides the trends of game populations, also shows the balance between game and forest vegetation, and defines the carrying capacity of the environment for game (Stergar et al., 2013).

Management of large carnivores

The management of large carnivores in Slovenia is the responsibility of the Ministry of the Environment and Spatial Planning. However, under the authority of the Ministry, most of the operational tasks in the area of large carnivore management are performed by the Slovenia Forest Service. Every year, this body prepares a proposal for a central management document, i.e. an act on the yearly cull of brown bears and wolves. The proposal is discussed by a broader group of experts in the Ministry, and is then submitted to a public hearing, in which amendments and improvements can be suggested by anyone, ensuring the necessary public participation in the process.

The management of large carnivores, because of their potentially negative impacts, charismatic and endangered nature, perhaps poses an even greater challenge in terms of management than wild ungulates. The key to the management of large carnivores is searching for the fragile balance between the favourable conservation status of their populations and assuring coexistence with humans on the other. Two management approaches are used to achieve this. The first is influencing population density by culling. This measure is used to maintain the populations of large carnivores under the social carrying capacity of the environment, which is the level that is still sustainable for the local residents. The other group of measures are preventive ones to decrease conflicts – measures to protect property, e.g. livestock, beehives, orchards (electric fences, livestock guarding dogs) and measures to prevent large carnivores (especially bears) from entering settlements (bear-proof garbage containers and compost bins; see also https://dinalpbear.eu). Much effort is given to rising awareness of the importance and proper use of these measures.

Measures to mitigate conflicts with large carnivores once they appear are also used. A system of state compensation for damage to property caused by large carnivores (and other protected animal species) has been established. The pre-condition

for compensation is the use of minimum protection measures. The intervention group for large carnivores also works to mitigate conflicts; trained specialists deal with difficult situations, where large carnivores enter settlements, endanger human lives, are involved in traffic accidents, etc.

Achieving the goals in the management of large carnivores is monitored in different ways. We rely on updated methods to assess the abundance and other population characteristics of large ungulates (Skrbinšek et al., 2019). The systematic use of automatic cameras has been applied to monitor the lynx population (Fležar et al., 2019). Due to the well-organized hunting in Slovenia, additional data on large carnivores is also systematically provided from the hunting ground managers (e.g. annual counts of bears).

An important step towards effective large carnivore management was made by associating and collaboration with neighbouring countries, which share the populations of bears, wolves and lynxes (Croatia, Italy, Austria). Together, we strive towards uniform monitoring and management of the populations of large carnivores on the cross-border scale (see https://dinalpbear.eu).

Future challenges

Wildlife management can be considered as balancing among various human interests. The perceptions of different interest groups (e.g. farmers, rural residents, hunters, urban residents) about the goals and management of animal species are often diametrically opposed. Expressing interest and influencing management decisions is a necessary part of a democratic society, but it can also be a serious impediment to professional wildlife management. For effective governance, management decisions require both the appropriate legislative background and to be made based on sound expert knowledge.

European legislation for large carnivores is outdated and should be adjusted to the current conditions of their density and distribution, as in many parts of Europe they are no longer endangered (Chapron et al., 2014). Such an approach would decrease the possibilities for blocking the procedures for the culling of large carnivores that we have witnessed in Slovenia and other European countries in recent years. However, the cooperation of all European countries facing similar problems is required to achieve this.

Figure 21: Brown bear (*Ursus arctos* L.) (Photo: Petra Draškovič Pelc)

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Figure 22: Grey wolf (*Canis lupus* L.) (Photo: M. Krofel)