

1. INTRODUCTION: THE CONTRIBUTION OF CARNIVORES TO THE CONSERVATION OF BIODIVERSITY

1.1 Introduction

The present project aims at identifying areas that are suitable for the conservation of bears, lynx and wolves in the Carpathian Mountains. It was funded by WWF International and represents an example of pro-active conservation in a region covered by some EU accession countries.

The Carpathian Mountains are shared by seven different countries in Central Europe and they host an impressive extent of natural temperate forests. Their geographical location and the environmental conditions have allowed the development of a high degree of biodiversity. Particularly, the presence of key species makes the area of paramount importance when considered at pan-European scale. The populations of such species need to be conserved throughout the process of EU accession and economic development, thus it is important to identify key areas to be preserved from human disturbance.

The approach adopted here was to assume that large carnivores as bears, lynx and wolves are could be proxies for the conservation of biodiversity in the Carpathian Mountains. These species stimulate controversial feelings. Thus, in the different stages of the present work, it was needed to tackle technical as well as social issues.

In order to introduce the reader to the complex world of biodiversity conservation, an overview of the main concepts and the role that carnivores may play in it is given in chapter 1. One of the aspects that emerges as fundamental for any action to be put in place is certainly the spatial distribution of targets, their location in space and their position relative to other relevant features. All these concepts will be the subject of chapter 2, where a description on how to focus on the spatial dimension of biodiversity, and particularly wildlife conservation will be given. This will help the reader to understand the different technical tools available and their applications. Upon this background, a series of punctual objectives were set, and they are listed at the end of the chapter. The three species targeted – bear, lynx and wolf – will be briefly introduced in chapter 3, together with the description of the region considered. The information given will be necessary to understand (a) some of the technical artefacts needed for representing the species-specific needs, and (b) the complexity of dealing with a

multinational issue. Chapter 4 represents the technical report of data collection and pre-processing, which needed to go through a challenging phase of social equilibria, negotiations, agreements and resource management. The results showing the suitable areas for conservation of bears, lynx and wolves in the Carpathians are reported in chapter 5, which also includes their validation.

The chapters 6 and 7 build upon the results achieved and test the adequacy of using data at different spatial resolutions (ch. 6) and the potentials for using environmental data of different nature (ch. 7). Finally, chapter 8 will put the results obtained into the real context, considering the potential efficacy of existing protected areas for the conservation of the three carnivores and the conflicts their presence cause with human activities, thus showing the utility of the study for management purposes.

The present chapter represents an introduction to some of the basics that need to be considered in order to understand why carnivores are good for the conservation of biodiversity and how this may be done, issues that will be investigated throughout the course of the thesis.

1.2 What is Biological Diversity?

Biodiversity is a term with a broad meaning that can be seen at many levels. In his book *The Diversity of Life* (1992), Edward O. Wilson defines biodiversity as “The variety of organisms considered at all levels, from genetic variants belonging to the same species to arrays of genera, families, and still higher taxonomic levels; including the variety of ecosystems, which comprise both communities of organisms within particular habitats and the physical conditions under which they live”. The definition could be even broader, including biomes, species interactions, and ecosystem processes (Spellerberg 1996). The World Wide Fund for Nature (1989) defines biodiversity as “the millions of plants, animals and micro-organisms, the genes they contain, and the intricate ecosystems they help build into the living environment”. All these definitions suggest that biodiversity can be identified at least at three levels: (i) genetics, (ii) species and (iii) community.

1.2.1 Genetic diversity

The variety of genetic material within a species is of vital importance and is the basis of evolutionary processes. The two main sources of genetic variation are

mutations and sexual reproduction. Mutations can develop naturally by chance, or be induced by external factors (e.g., radioactivity).

Individuals belonging to the same species are usually geographically separated into groups called populations. Within a population, individuals differ in their genetic makeup, which is mixed at every sexual reproduction event.

The gene pool of a population is represented by all the different forms in which a gene expresses itself in every individual belonging to the same population. When a population is isolated for a number of generations, the genetic pool tends to lose part of its variability, allowing the expression of weak or rare genes. In certain cases the isolation can be so effective that a new species may arise, but more commonly the individuals of the isolated population become infection-prone or lack resilience for surviving environmental changes, showing an increase in infant mortality because deleterious traits are inherited in the progeny (Caughley and Gunn 1996). In such situation the term *inbreeding depression* may be used to describe the depletion of genetic variation (Gilpin and Soulé 1986). In order to maintain levels of genetic diversity that ensure the population remains healthy and viable, reproduction should take place between individuals coming from different populations, producing a gene flow among populations. The process of habitat loss and fragmentation produced by human activities has a strong potential in preventing the gene flow among populations. The spatial structure of the environment determines the potential for movement of individuals among populations, thus contributing to the diversity of the genetic set of the species. This is the reason why habitat connectivity and biocorridors are extremely important.

This aspect will be investigated in this study, where a spatial analysis of habitat fragmentation will be undertaken, thus discussing the potentials of bears, lynx and wolves to move among patches of suitable areas.

1.2.2 Species diversity

The number of different species in an area may be called species diversity. Considering the spatial extent of species, the population can be considered the species' unit, so that although different populations may show morphological differences, they belong to the same species if they are potentially able to interbreed. The diversity of species is usually measured at geographically limited units as the number of species present within a given area (Hengeveld *et al.* 1995).

It is important to note that the presence of one species inevitably

depends on the presence of other species, creating a complex web of interactions sometimes very difficult to identify. The consideration of several species at once is challenging in this respect, and it is becoming the prominent view of conservation biology of the last 10 years (Meffe and Carroll 1997). This study will focus on the European population of large carnivores, particularly dealing with the subpopulation present in the Carpathian Mountains. The degree of isolation of the Carpathian Mountains from the other European areas where the carnivores are present will not be assessed here, because this falls out of the scope of the project. An attempt at using the synergies that may be present when multiple species, with their different associated needs, have to be conserved in the same area will be made.

1.2.3 Community diversity

Scaling up across spatial resolution, the species interact among each other in order to form communities. A biological community is the set of species - and the relationships among them - that occupy a given area (Putman 1994). The association of a community and the physical environment it develops in is called an ecosystem. The characteristics of the physical environment, its climate, its soil properties, location and aspect determine the type of community that may develop. The community, in turn, can alter some of the physical characteristics by, for example, acidifying the soil or retaining humidity. This suggests that very rarely two ecosystems in different geographical places can be identical, although regulated by similar relationships and parameters. This makes the Carpathian population of carnivores a unique community within Europe, although the same species do live in other areas, such the Alps, the Scandinavian Peninsula, and the Balkans.

In theory, each species occupies a physical and biological space, contributing in its unique way to the structure of the biological community of which it is a part. In practice, there is an array of spaces that are used by a species, depending on the environmental conditions. This space is called the *ecological niche*, and the variability attached to it is termed the niche breadth (Morrison *et al.* 1998). A species with a broad ecological niche is also said to have a broad ecological valence.

The interactions among species and the roles they play in the ecosystems are organised into trophic levels between which energy is transferred (Putman 1994). The trophic levels are part of the food chain that exists in all ecosystems and which constitutes the transformation of energy into different

forms. In a trophic chain primary production, which is the lowest level of production, is usually represented by plants that transform sunlight firstly into chemical energy and then into organic matter via the process of photosynthesis. Successively higher levels are represented firstly by animals that feed on plants, and subsequently by animals that prey on other animals. At a theoretical equilibrium, predators control the prey population by keeping it at levels that the ecosystem can sustain. Large carnivores are at the top of the trophic chain, and they depend on a series of other species.

The presence of carnivores thus can be thought as an index for the presence of their prey species. For this reason they are called *umbrella species*. They are species with broad requirements that include those of a number of other species (Simberloff 1998). Identifying umbrella species would allow conservationists to stay on the safe side: they may act towards the conservation of ecosystems through the conservation of species that require large areas of relatively natural or unaltered habitat for the maintenance of viable population (Meffe and Carroll 1997). Their conservation will indirectly secure the conservation of the others. This study focuses on three large carnivores that can be considered umbrella species as they occupy large areas that may include ranges and habitats suitable for other species.

Finally, as an answer to the question set as title of this section, biodiversity can be thought of as the potentiality for an ecosystem to return to its previous natural equilibrium; or as the ability to find a new point of equilibrium after being disturbed by external causes (most commonly human activity). Thus, measuring biodiversity changes through time is a measure of the resilience of an ecosystem. In an anthropocentric view, it could be considered as a measure of its potential to continue the production of primary goods (Perrings 1995). Conservation of the original level of biodiversity leads, therefore, to the preservation of variety and interactions between species, and processes in ecosystems. It can be considered an investment either through a refrain on current consumption of land or species by humans, or the allocation of space and management techniques to enhance the survival of species (Bulte and van Kooten 2000). The present project represents a contribution to the conservation of European biodiversity in that it offers a baseline picture of the Carpathian biodiversity that is threatened by the economic changes the Carpathian countries will face through the process of joining the EEC.

1.3 Ways of conserving biodiversity

The discipline of Conservation Biology has developed in response to the crisis of biodiversity loss and has two main objectives: (i) to investigate human impact on species, communities and ecosystems; and (ii) to develop new strategies and techniques to prevent the extinction of species and eventually reintegrate those in danger of extinction into their properly-functioning natural habitat (Primack 1998). The interest of humans for wild species and ecosystems has ancient roots, and the innovative approaches to conservation that characterise Conservation Biology, and include the economic and opportunistic values of biodiversity can be considered as different means to obtain the same result: lower the rate of species extinction.

One of the causes of species extinction is their over-consumption by humans. Prehistoric people were mainly hunters and their population density never reached densities that would threaten their prey, although some theories have been advanced making them responsible for local extinctions. The cultural and behavioural changes in human society, especially the shift to agricultural practices and husbandry, have made the hunting of wild species less important for human sustenance. Some cultures attribute special properties (usually medicinal) to specific parts of animal bodies and hunt them to only extract that part, or hunt wild species for trading their furs (Johnson *et al.* 2001). Hunting is nowadays a cultural activity in Western society and its regulation and the management of game populations has become necessary in order to prevent species extinction (Cox and Moore 1993). This is very real in the Eastern European countries, where hunting is practiced by most of the population in rural areas. In some areas of the Carpathians, the hunting tourism industry has developed well, and western hunters pay significant amount of money for a hunting trip to Poland or Romania. Species to be hunted include bears and wolf as well as big herbivores and birds. This calls for an active management of hunting activities, linked with International legislation that also require the designation of areas where hunting may be practiced as well as quotas of animals to be cropped.

Conservation biology is currently focused much more on preserving the processes that generate wilderness *in situ*, and accepting whatever states of biodiversity result from those processes. In this sense, conservation biology must be a multidisciplinary subject that aims at conserving the environment while considering the human population as part of it, as well as trying to reach

compromises between interests coming from different parties (Blockstein 1999). It has an intrinsic dynamic that includes scientific, socio-economic, educational, engineering and legislative aspects and that should aim at managing dynamic ecosystems that maintain natural processes (Grumbine 1994, Samson and Knopf 1993). Such aspects will be considered in this study, where biophysical characteristics of the environment will be considered together with legislation and anthropogenic activities in the development of guidelines for the conservation of carnivores in Central Europe.

Conservation biologists are *crisis managers* who consider each single organism as a masterpiece worth the effort and care needed to avoid its extinction (Wilson 2000). They can plan ahead and act to avoid the loss of biodiversity, if the degree of understanding of natural ecosystems is enough for them to be satisfactorily pro-active. The tools available to conservation biologists are diverse and are sometimes borrowed from different disciplines. Nevertheless, their integration can sometimes be challenging and the present study represents an effort in this direction.

In order to conserve biodiversity, basic knowledge of the natural history of target species is of vital importance (Curio 1996). Although national and international environmental policies are setting standards in order to conserve the world's diversity at global and local scales (McLean *et al.* 1999), the standards and targets set are of debatable help for conservation if they do not take into consideration the relative distribution of biodiversity (Soulé and Sanjayan 1998) among countries and around the world. For this reason, areas of particularly high level of biodiversity are mapped globally (Myers *et al.* 2000). It is evident how a scientifically-based guide for the investment of resources in the conservation of biodiversity is needed. In the present study, it was assumed that large carnivores would represent proxies of high biodiversity areas for some characteristics that will be illustrated in the following section.

1.4 The conservation of Large Carnivores: challenges and frustrations

The conservation of species at the highest trophic level is an attempt to conserve the processes that are required to maintain all the lower levels needed to sustain the whole chain. Maintaining viable populations of predators may target the objective, but it can be particularly difficult as they are sometimes in bitter conflict with human activities (Ginsberg 2001). Included in such a group are the large

mammals belonging to the *Carnivora* family such as tiger (*Panthera tigris*), puma (*Felis concolor*), leopard (*Panthera pardus*), lynx (*Lynx lynx*), wolf (*Canis lupus*), coyote (*Canis latrans*), bears (*Ursus spp.*) and hyenas (*Crocuta crocuta*, *Hyena spp.*) among others.

Large carnivores have attracted human attention ever since human evolution started. In the culture of some Native American tribes, the wolf and the bear were considered part of nature and positive source of inspiration (Lopez 1978). The perception of western societies towards large carnivores has historically been negative, being considered as competitors for hunting species or livestock predators (Fuller 1995, Sillero-Zubiri and Laurenson 2001). The cultural knowledge of these species has been influenced by traditional stories and beliefs that pictured them as bad and generally dangerous for humans. In Europe, such view was strengthened by the Judeo-Christian belief that human beings are superior creatures empowered to dominate nature in a utilitarian fashion (White 1973). Only in the last decades has this attitude been reviewed and in some cases reverted, as indicated by the high number of wildlife protection agencies and lobbies that are now strongly active in the process of conservation (Gittleman *et al.* 2001).

Large mammalian carnivores are undoubtedly a challenging group of organisms for conservation biologists. Their ecological characteristics make them at the same time attractive and frightful for the public, they are big and fierce, rare, elusive and dangerous (Gittleman *et al.* 2001). Their role in wildlife causes them to be admired for their power, freedom, beauty, and intriguing and vulnerable nature (Fuller 1995).

Large carnivores require extensive areas of land for maintaining healthy population structures (Woodroffe 2001). Some of them are solitary animals, hunting on their own and joining individuals of their same species only during the reproduction period, while others have a social behaviour, living in groups of several individuals. Depending on their social organisation, the area required by a single individual to cover its natural needs (the *home range*) may vary from few to hundreds of square km. Although they often avoid human-dominated areas, large carnivores do not necessarily prefer wilderness areas, rather they find it easier to survive far away from human persecution and disturbance (Shaffer 1992, Ciucci and Boitani 1998).

The populations of large carnivores around the world have been declining and most of them are listed as in danger of extinction by the International Union for the Conservation of Nature and Natural Resources (IUCN

1990, Purvis *et al.* 2001).

The problem of conserving large carnivores is complex and multifaceted, and, as Ginsberg (2001) suggests, carnivore conservation is different from biodiversity conservation. This is attributable to the fact that carnivores in general occupy a particular place in the human's imaginary, culture and feelings (Macdonald 2001). Some of the forces that caused large carnivores to decline are identifiable in direct and indirect killing and habitat destruction, both attributable to human action. These activities are still operating today, although at lower rates than they were in the last century. The problem, though, would be oversimplified if were to be reduced to a cause-and-effect phenomenon induced by human action. The problem is a myriad of site-specific human and ecological forces (Clark *et al.* 1996). Clark *et al.* (2001) underline the multidisciplinary character of carnivore conservation and note that it rests on science and culture, thus highlighting the importance of human knowledge and perception of large carnivores.

The approach to carnivore conservation has hitherto focused on single species and local populations (Ginsberg 2001). Most importantly, conservation programmes have been based exclusively on scientific knowledge and biological needs. This is probably the main reason why many of them have failed to conserve viable populations of large carnivores (Clark *et al.* 1996, 2001). There is an array of factors not based upon any ecological or scientific knowledge that have a strong influence on the outcome of conservation programmes, and these are of socio-economic, political, historical and cultural nature (Clark *et al.* 1996, Bath 1998, Bekoff 2001). There is little possibility that a conservation programme with a strong scientific basis and excellent technical staff and equipment would have a positive outcome if the local population was against it, as illegal killing and poaching would be major causes of mortality that are impossible to eradicate from the system (Clark *et al.* 2001).

Because many carnivores occupy areas where human activities are present, the conflict of interests on the land is often very strong (Sillero-Zubiri and Laurenson 2001). Antagonistic attitudes toward large carnivores are based on historical and cultural fears, concerns for human safety, beliefs about real or perceived competition with humans for livestock, game and habitat, fear for losing property rights over the land, and negative symbolism such as ferociousness or viciousness (Kellert *et al.* 1996). Bath and Buchanan (1989) found that human attitudes towards large carnivores changed from negative to positive with distance from the areas where the carnivores were. There is, therefore, a spatial

dimension in the human attitude toward large carnivores, whereby people who are in direct contact with the consequences of carnivore presence are sometimes unable to adapt to it. The involvement of the public into wildlife management has become a basic requirement for developing successful programmes. Public involvement can take many forms and is essentially about redistributing power from the technicians to the public (Bath 1998, Sillero-Zubiri and Laurenson 2001). The way this is done is very much dependent on the cultural level, and the interests and the willingness of the public to be involved in the process.

The general idea that conserving wildlife is in contrast with economic development is strongly rooted in western societies, whose resource-based economy regards top predators as vermin (Rasker and Hackman 1996). Because large carnivores require large areas of wilderness, their conservation is often seen as a luxury whose cost in forgone jobs and resources cannot be justified. Nevertheless, there are some cases where the conservation of carnivores has not been an obstacle to employment and economic development. Rasker and Hackman (1996) report cases where in regions with large wilderness areas protected from human development, the income and employment growth were higher than in resource extractive regions. The authors suggest that a relationship between carnivore conservation and economic growth could not be drawn, but evidence that environmental protection necessarily harms economic performance was not found (Rasker and Hackman 1996). Tourism and its associated industries represent economic opportunities that could be enhanced by environmental protection. Some populations of carnivores could even be managed in such a way that their exploitation could represent a revenue for local communities (Sillero-Zubiri and Laurenson 2001). This is the case with bears in Romania, where they can be hunted under strict regulations, and foreign hunters are requested to pay high fees for a hunting trip (Salvatori *et al.* 2002, see chap. 8).

The effort towards carnivore conservation needs to be of such magnitude that contributions from different sources (both economic, intellectual, scientific and politic) ought to be sought for. But the very first step towards conservation of carnivores is the identification of areas where action should be focused in order to make a conservation strategy operational (Ginsberg 2001). The Ecoregional approach (Olson and Dinerstein 1997) most likely reproduce the limits posed to a population of large carnivores (Ginsberg 2001). For this reason, in the present study, the ecoregional approach to environmental analyses was adopted in an attempt to identify the areas that would be most suitable for the

conservation of three European large carnivore species.

1.5 Conclusions

The conservation of biodiversity requires a multidisciplinary approach calling for international collaboration and socio-economic inputs as well as technical and scientific studies. Identifying species that significantly contribute to achieving the aim of decreasing the rate of biodiversity loss is of vital importance. Such species need to be particularly representative of the biodiversity of a certain area, and large carnivores can certainly be adequate proxies of the Carpathian biodiversity, given their role of umbrella species, thus covering the ecological requirements of a number of other species at an inferior trophic level.

The conservation of species that bring conflicts with human activities and that roam across large areas is particularly challenging and requires the integration of science and tools that allow the consideration of social, physical and biological aspects of the environment. In this respect, a broad-scale approach is becoming essential, where pro-active management and social involvement are integrated with science.

Elaborating a strategy, though, is not enough if the area where it is to be applied has not been identified. The spatial dimension of biodiversity conservation represents a starting point upon which multi-disciplinary actions should be applied. As a support to this, the analysis of large areas has become easier with the aid of new analytical and data capturing/management tools such as geographical information systems and remote sensors. The geographical attributes of wildlife conservation will be the focus of the next chapter, where a review of the approaches and techniques used insofar will be given. The present study has a strong spatial attribute, as the main objective set is to map the environmental suitability for large carnivores in the Carpathian Mountains. The method adopted for achieving this objective will be described in chapter 4, while chapter 5 will present the results of the mapping process. The Carpathians show an excellent basis for pro-active conservation, but the time required for collecting scientific and standardised data may be too long for taking management decisions. The results achieved in this study will provide a basis for orienting managers in future decision-making processes. Chapter 6 will explore the adequacy of the spatial resolution used for this kind of study, while in chapter 7 a further exploration for using less detailed baseline environmental data will be

done. The considerations about the management of bears, lynx and wolves will be made in chapter 8, assessing the social and political contexts of the study area.