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Safeguarding the Romanian Carpathian ecological network

A vision for large carnivores and biodiversity in Eastern Europe

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Foreword

When I met Ovidiu Ionescu in 1991 I told him about my wolf research projects in Portugal and Croatia and we subsequently agreed on a collaborative wolf conservation research project in Romania, harbouring the most important reservoir for large carnivores in Europe today. We would be supported by many people and thanks to the founding of the European Wolf Network gained some funding to kick-off this project.

Later on the project expanded with conservation research on lynx and bear and resulting in a large carnivore project. It had always been a great wish of mine to study large carnivores in order to gain knowledge for their conservation. Large carnivores play without doubt a vital role in the maintenance and diversification of dynamic wilderness ecosystems. I wanted to prove to people that these animals are not creatures to fear and persecute, but animals to cherish as symbols of unspoiled nature and to co-exist with in harmony. At that time there was scope for their return to many areas now suitable or safe again in Europe. For this to be fully realized a robust ecological network suited to both large carnivores and large herbivores should be in place, providing also refuge to many other biodiversity and landscape values. This can only be achieved through the dedication of all European nations, attuning their efforts.

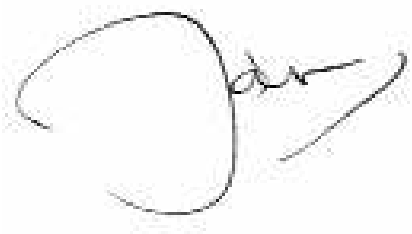
I was glad when Erwin van Maanen asked me about the possibility for an ecological network project in Romania. Reading this Vision Plan I hope you will also be impressed about the way the researchers undertook their ambitious mission to achieve the safeguarding of the Carpathian ecological network, a mission that has not yet reached its final destination and needs to be continued. Thus far an important amount of information has been collated and the importance of ecological networks in Romania instilled among many.

The next step will be to implement the Carpathian ecological network delineated in this study, by establishing a robust system of effectively protected core areas interconnected by ecological linkages that will ensure the safe dispersal of animals between viable populations. Ultimately such a network should expand all across Europe in order to restore the untamed natural dynamics now only existing in distant countries, which is a noble challenge for European society.

For Romania the challenge to conserve large-scale nature and its support factors in the current socio-economic transition is great, but not impossible. This project provides clear directions on where to start and is timely in the face of many unwise developments. It also guides the way to wise and environmentally sustainable use options, not to ravish the Carpathian nature and its supporting culture, but to nurture it.

We thank everybody who collaborated in this project and hope for greater momentum and great perseverance and positive actions by all Romanian stakeholders in the next phase, namely implementation. Europe will be proud of you!

Prof. Dr. J.L. van Haaften



Summary

This document is a Vision Plan. Like similar documents produced in North America, this Vision Plan is a science-based blueprint spelling out the desirable, site-specific ecological goals for a region. The time scale for the execution of such a plan is usually in the order of decades, but requires immediate action. The plan is inspired by the Southern Rockies Wildlands Network Vision (Miller *et al.* 2003). The goal of this vision is the preservation and restoration of large, interconnected and relatively undisturbed ecosystems within the southern Rocky Mountains ecoregion of North America, including much of the Rocky Mountain regions of Colorado, southern Wyoming and northern New Mexico. Like the current plan, the Southern Rockies vision plan focuses on large carnivores (see www.restoretherockies.org) as 'umbrella species'. Using a very similar approach we aim to safeguard 'natural wildness' in the Carpathians and conserve a high portion of its biological and landscape diversity. However, this Vision Plan differs from the North American plans because of its emphasis on also maintaining traditional cultural values supporting nature. The rural cultures of eastern European countries under past communistic rule and with high reliance on pastoralism have nurtured the natural environment to a much higher degree than developed countries in the western World.

Central to the Vision Plan is the ecological network map. That is, the Vision Plan goes beyond mere generalizations: it is relatively explicit about geographic locations of ecologically sensitive and internationally important habitat areas as far as they are known, and also the permissible land uses in these areas. Therefore conservationists, land use planners, natural resource managers, developers, as well as other stakeholders from local human communities, can easily see the ecologically important features of the land. Accordingly, the Vision Map is an important tool by which one can harmonize human endeavours with nature conservation objectives (e.g. Natura 2000) and the maintenance of ecosystem services (e.g. forests and natural rivers for flood protection). The map also reveals degrees of ecological sensitivities. Furthermore, it provides a delineation of the required ecological infrastructure for wildlife, in order to perpetuate viable animal populations in diverse natural ecological communities governed by important ecosystem dynamics.

The Vision Plan does not yet provide a detailed landscape planning for an ecological network. It serves to catalyse this goal by providing the foundation for the designation of ecological network components in the Carpathians, depending on a system of modern and environmentally sound land use planning, conservation ecology and the advanced systematic inventory of biodiversity and landscape values. As such it also promotes the important goals set out by the Pan-European Biological and Landscape Diversity Strategy (Council of Europe et al. 1996) with the objective of achieving a highly coherent Pan-European Ecological Network (PEEN). The Vision Plan also reveals the shortcomings of current Romanian land use planning and environmental protection, and the voids in the current system of protected areas and ecological knowledge. Conversely, nature conservation in Romania can provide important lessons for nature management in Western Europe, where wilderness has practically disappeared and is now a much desired commodity in light of increasing green tourism. Priority actions for the safeguarding of the Romanian Carpathian ecological network (RCEN) in face of environmentally detrimental economic developments are proposed to be implemented in a later phase.

Rezumat

Introducere

Peisajul montan şi alpin, precum şi diversitatea biologică a Carpaţilor în România sunt greu de găsit în altă parte a Europei. Acesta este un adevăr care atestă o moştenire unică din punct de vedere ecologic şi cultural şi care implică o atenţie deosebită în contextul în care ţara noastră parcurge un proces rapid de transformări, unele dintre acestea mai puţin planificate şi având implicaţii majore în ceea ce priveşte bogăţia naturală şi activităţile tradiţionale din agricultură şi silvicultură. Cele mai recente ameninţări sunt legate de procesul prelungit de retrocedare a terenurilor agricole şi forestiere, dezvoltarea infrastructurii de transport, extinderea localităţilor, abordarea pur comercială a activităţilor de administrare cinegetică şi silvică, turismul în masă şi exploatarea resurselor naturale. Există un pericol real ca, în contextul efectului cumulativ al acestor dezvoltări neplanificate, habitatele naturale să devină fragmentate şi izolate în proporţie ridicată, acest fapt având un efect dramatic asupra dieversităţii biologice. Pe lângă acest fapt, pot apărea situaţii neobişnuite ca de exemplu urşi habituaţi care se hrănesc la containerele de gunoi din localităţi, aceste situaţii generând incidente grave şi constituind un pericol real atât pentru oameni cât şi pentru fauna sălbatică.

De aceea, Carpaţii trebuie priviţi ca o reţea ecologică regională, un rezervor de biodiversitate, un furnizor de servicii ecologice diverse şi un mare parc natural al societăţii europene, care atrage dezvoltare durabilă şi activităţi socio-economice verzi (agricultură ecologică, turism, recreere, etc.).

Pentru a cataliza eforturile de păstrare pe termen lung a reţelei ecologice existente astăzi în Carpaţi, a fost realizată o viziune ecologică cu importante conotaţii legate de conservarea naturii. Această viziune a fost pregătită şi elaborată de un grup de specialişti din România, Olanda, Statele Unite şi Germania, pe parcursul a 3 ani de colaborare şi de eforturi susţinute pentru promovarea conceptelor de conectivitate a habitatelor, reţele ecologice şi abordări intersectoriale. Informaţii detaliate ale acestui studiu sunt prezentate în cartea „Păstrarea Reţelei Ecologice din Carpaţi: o viziune pentru biodiversitate şi carnivore mari în estul Europei (Van Maanen şi alţii, 2006). Această iniţiativă a fost susţinută de Ministerul Mediul şi Gospodării Apelor din România şi finanţată de Guvernul Olandei (programul PIN MATRA).

Specii cheie şi umbrelă

Carnivorele mari (ursul brun, lupul şi râsul eurasiatic) sunt ambasadori ai splendorilor Carpaţilor, găsindu-se încă în număr semnificativ în România. În mare măsură, acestea sunt specii cheie pentru păstrarea altor valori ecologice din Carpaţi. Teritoriile lor întinse şi existenţa lor stabilă în populaţii semnificative care au comunicat permanent şi au fost funcţionale din punct de vedere ecologic au acoperit zonele de distribuţie a multe alte specii din habitatele forestiere sau de păşuni şi pajişti ale României. Primul prădător sau custode al acestui sistem ecologic interactiv este lupul. Acesta îşi exercită rolul său în ecosistem prin reglarea de sus în jos a numărului de ierbivore, influenţând şi păşunatul animalelor domestice şi contribuind esenţial la menţinerea diversităţii vegetaţiei, la reglarea numărului de carnivore mici şi la asigurarea unui echilibru fin al lanţului trofic din natură.

Componentele importante ale reţelei ecologice

O Reţea Ecologică funcţională în Carpaţii Româneşti (RCEN) are următoarele caracteristici esenţiale:

- Zone de refugiu întinse, capabile să adăpostească populaţii stabile, care rezistă la influenţele din afară şi la matricea dominantă a activităţilor umane. În vederea îndeplinirii acestui rol, zonele de refugiu trebuie să ocupe cel puţin 350 000 ha., fiind de preferat zonele mai întinse. Aceste zone adăpostesc habitate de calitate, incluzând păduri în diferite stadii de succesiune până la pădurea climax, intercalate cu zone de pajişti semi-naturale şi surse de apă, îmbogăţind din punct de vedere ecologic peisajul sau ecotonele.

- Legături ecologice echilibrate şi robuste, formate din habitate naturale adecvate care conectează zonele de refugiu printr-o configuraţie neliniară, bazată pe distanţe cât mai scurte. Astfel se asigura deplasarea indivizilor între populaţii şi se previne izolarea şi posibila dispariţie.

- Carnivorele mari sunt specii cheie cu o capacitate mare de interacţiune.

- Coexistenţa armonioasă cu activităţile tradiţionale din zonele rurale poate influenţa major utilizarea terenurilor şi poate fi un catalizator pentru activităţile economiei locale. Există o relaţie benefică şi reciprocă între oamenii din mediul rural şi fauna sălbatică, fapt care constituie unul din elementele cheie în efortul de a păstra caracterul distinct al României în drumul ei spre modernizare şi integrare la nivel global.

Actiuni prioritare pentru implementarea RCEN

în ultimii ani, România a semnat şi ratificat acorduri şi convenţii importante referitoare la dezvoltarea reţelelor ecologice, inclusiv Strategia Pan-Europeană pentru Diversitatea Biologică şi a Peisajului, precum şi Convenţia Carpatica. Având în vedere apropiata aderare a României la Uniunea Europeană, ţării noastre i se cere să pună în practică o reţea de sit-uri de conservare Natura 2000, pentru realizarea unei protecţii efective a speciilor şi habitatelor importante la nivel european şi incluse în Directiva Păsări şi Directiva Habitate. Până în prezent, aceste intenţii nu au fost onorate şi angajamentele actuale privind conservarea naturii sunt mult sub nivelul declaraţiilor sau acordurilor semnate. De fapt, sistemul de arii protejate propus pentru viitoarea reţea Natura 2000 nu este suficient pentru a proteja în mod efectiv ecologic populaţiile de carnivore mari (mai puţin de 10% din populaţiile existente vor fi protejate). De aceea sunt necesare eforturi deosebite care să implice toate instituţiile importante şi relevante la nivel naţional. Cele mai urgente acţiuni sunt:

- Măsuri de atenuare a efectelor de fragmentare a habitatelor cauzate de proiectele de dezvoltare a infrastructurii feroviare şi auto (drumuri expres, autostrăzi) în vederea contracarării divizării populaţiilor de faună în părţi izolate reproductiv pe cuprinsul Carpaţilor.

- Realizarea unor planuri de utilizare a terenului bazate pe abordări detailate, intersectoriale şi integrative, la nivel regional şi naţional, care să includă planificarea dezvoltării. Aceasta va putea zădărnici extinderea actuală haotică a caselor de vacanţă, a restaurantelor şi hotelurilor pe întreg cuprinsul spaţiului rural al României şi transformarea peisajului natural într-un mozaic neatractiv.

- Crearea capacităţilor de evaluare globală a dezvoltărilor antropogenice, în special a acelora asociate cu retrocedarea terenurilor. Acestea sunt, de asemenea, cerute în legislaţia europeană legată de protejarea naturii adoptată de România.

- Crearea modalităţilor de dezvoltare a economiei rurale durabile, la un nivel superior faţă de cel existent, aceasta putând acţiona ca un motor pentru generarea unor impulsuri economice prin dezvoltarea unor activitaţi noi, de genul turismului cultural sau agro-turismului.

- Realizarea unor acţiuni directe de conservare a naturii prin intermediul înfiinaţării unor fonduri de genul „teren pentru natura României" administrate de companii specializate.

- Instituţionalizarea unui monitoring şi management modern al Capitalului Natural, adaptat schimbărilor socio-economice şi bazat pe abordări simple, logice şi efective.

- Realizarea unui inventar adecvat al speciilor şi habitatelor româneşti de importanţă europeană.

Atenuarea barierelor şi a efectelor letale ale creşterii traficului

Drumurile de orice fel ucid şi deranjează un număr incredibil de mare de specii de faună. În cazul în care realizarea drumurilor prin zonele de refugiu pentru speciile de faună nu poate fi evitată, efectul negatov trebuie atenuat prin construcţia de coridoare de trecere pentru faună. Acestea pot fi de dimensiuni mari, fiind construite deasupra drumurilor (în cazul speciilor de mamifere mari) - aşa numitele „poduri verzi" sau pasaje subterane pentru mamifere mici. Cele mai multe dintre aceste pasaje sunt necesare în zonele în care deplasările animalelor sunt mai intense.

Harta viziunii asupra RCEN

Utilizând modelarea obiectivă prin intermediul GIS, combinată cu informaţia existentă privind biodiversitatea, a fost realizată o hartă a Reţelei Ecologice din Carpaţii Româneşti. Elementul esenţial al acestei hărţi este reprezentat de zona de protecţie a reţelei (delimitată cu galben), în care se protejează 60% din populaţiile actuale de carnivore mari şi care acoperă un procent semnificativ de alte specii şi habitate, protejând peisajul şi diversitatea naturală în zone de refugiu întinse şi legate între ele (săgeţi verzi) pe tot cuprinsul Carpaţilor. Această hartă evidenţiează necesitatea delimitării unor zone de refugiu mult mai mari decât ariile naturale actuale şi care să includă cele mai bune tipuri de habitate, cele mai puţin antropogenic influenţate zone şi cele mai bine administrate regiuni. Acest sistem se poate constiui într-un mare parc european pentru fauna sălbatică şi poate fi un testament pentru abordarea viitoare durabilă şi ecologică, pentru utilizarea şi managementul resurselor naturale, precum şi pentru coexistenţa cu natura. Noi dorim ca Guvernul Român să atingă acest obiectiv nobil şi să plaseze România pe harta lumii ca o naţiune guvernată în mod înţelept.

Contributors

This project was performed in close collaboration between the Carpathian Wildlife Foundation (CWF; Fundaţia Carpaţi), the Wildlife Unit of the National Institute for Forestry Research and Management (ICAS), Altenburg & Wymenga ecological consultants (A&W) and the Wildlands Project of the U.S. represented by Prof. dr. Michael Soulé.

ICAS and the Carpathian Wildlife Foundation are Romanian organizations, partly affiliated with each other and based in the town of Braşov in Transylvania. The ICAS Wildlife Management Unit resides under the Ministry of Agriculture, Forestry and Rural Development. It is responsible for wildlife management research, largely based on traditional hunting management. Core activities of the unit include annual censuses of large wild ungulates and carnivores, habitat 'diagnosis', data management, game management and captive game breeding. New ongoing activities include the re-introduction of the beaver and alpine marmot, modernisation of wildlife management, large carnivore conservation management (including prevention of livestock depredation) and aid to the adoption of European nature protection legislation in Romania, such as Natura 2000. The CWF is a non-governmental organization (NGO) which focuses on solving Carpathian conservation issues through research and public education and awareness enhancement. They were also a key partner in the Carpathian Large Carnivore Project as part of the Large Carnivore Initiative of Europe (LCIE). Local project manager and team leader for both organizations is George Predoiu. The local project team consisted further of Ovidiu Ionescu (scientific advisor and director of the ICAS Wildlife Unit), Marius Popa (GIS technician), Ramon Jurj (wildlife management researcher), Serban Negus (forest and wildlife expert) and Georgeta "Titi" Ionescu (wildlife researcher and ecological educator).

Altenburg & Wymenga (A&W) ecological consultants is a Dutch environmental consultancy firm with its roots and heart in nature conservation. In the Netherlands the firm has a strong record in applying conservation ecology to subjects including meadow bird conservation, wetland management, vegetation management and ecological impact assessment. A&W was responsible for managing this Dutch government funded project, with Erwin van Maanen as project initiator and manager, assisted by Rogier Klaver for modelling, fieldwork and editing of the Vision Plan. Wibe Altenburg, director of the firm was also one of the editors.

The Wildlands Project is a North American NGO that emphasizes continental scale 'rewilding' with emphasis on science and the use of GIS modelling. Rewilding implies the restoration of key ecological processes through the reestablishment and protection of important natural ecosystem actors (known as highly interactive or keystone species) such as large carnivores. Scientists of the The Wildlands Project pioneered the emphasis on regional landscape connectivity, without which long-term conservation success is difficult, if not doubtful. A current board member, founder, past president, and past science director of that organization, Prof. Dr. Michael Soulé, has been involved in this project for several years and has also been a key scientific advisor, facilitator, workshop chairman, editor and inspirer for the current project.

Traditional haying with scythe. Photo: Erwin van Maanen.

1. INTRODUCTION

1.1. Rationale and goals

This project was born from the realization that despite its rich and diverse natural and cultural heritage, Romania lags behind other countries in safeguarding an ecological network for the effective conservation of landscape, biodiversity and cultural values (see Chapter 2 for an overview of ecological network developments). At present no more than 15% (about 6000 km^2) of the Romanian Carpathians is protected in 15 reserves (national parks and natural parks), Romania expects to be admitted to the European Union (EU) on January 1, 2007, depending on the adoption and implementation of EU policy and legislation. However, implementation of the nature conservation component of the EU legislation package (Habitat and Bird Directives) is at present far from complete, awaiting decisive civil society reform.

Central to the institutionalization of nature conservation and concurrent with socio-economic developments in Romania, will be the implementation of the European Habitat and Bird Directives. Under these directives strictly protected conservation areas must be designated for the safeguarding of ecological values of European importance (species and habitats) within the Natura 2000 Network. Fully protected under the Habitat Directive, the wolf, Eurasian lynx and European brown bear are qualifying species for the designation of Natura 2000 areas. Romania still harbours sizeable populations of these symbolic, awe inspiring and charismatic large carnivores, which are also of societal, scientific and economic importance. The populations of these animals in Romania present a reservoir for the supply of remnant and recovering populations in Central through to Western Europe. This is important in light of emerging positive public appreciation of large carnivores, full protection and increasingly abandoned rural lands allowing their effective comeback (Breitenmoser 1998; Linnell *et al.* 2001).

Romania is one of the few European nations where it is still possible to maintain large carnivores and wild ungulates at densities which are ecologically effective (Soulé & Terborgh 1999a; Ray *et al.* 2005). This means that the abundance of large carnivores and herbivores in the Romanian Carpathians contributes highly to the servicing of natural and biologically diverse montane forest and grassland ecosystems. Large carnivores are also increasingly regarded as ambassador or 'umbrella species' by encompassing to a high degree other biodiversity within their large home ranges (Simberloff 1998; Ray *et al.* 2005). In addition, the wolf, being a top predator, functions as a 'keystone species' of many ecosystems worldwide, including the Carpathian forests. This role will be explained further in this report. Conservation of wide-ranging animals such as large carnivores requires a broad scope (holistic approach) with high consideration for their large and usually highly natural habitats, catering for other biodiversity as well. It is believed that the present system of small and widely scattered protected areas in Romania will not suffice in conserving stable and viable large carnivore populations, it should be encapsulated in a human disturbed landscape where dispersal is difficult. The same is true for other biodiversity values requiring extensive, contiguous and highly natural or climax forests. Securing an ecological network of sufficient scale and resilience is therefore essential to conserving Romania's natural wealth.

Romania is currently undergoing economic transition and clearly struggling with societal reform, whilst also aspiring to gain many of the cultural, civil and economical values of Western Europe and North America. Major developments with great consequences are proceeding, pertaining to major transport corridor development, land privatization, forestry reforms, mass tourism, urbanization and further mining development. Most of these developments are driven without coordinated

planning and partly without enforced regulations. Hardly any attention is paid to environmental and cultural considerations. Hence the Carpathians as a unique bastion for wilderness in great harmony with traditional human culture is in danger of degradation and destruction, sacrificing great assets to Romania, including high economic potential for the green tourism industry and for organic agriculture. Thus there is a clear need for environmentally sound, integrated, intersectoral and well-balanced socio-economic development, which implies placing the protection of natural and cultural assets high on the political agenda and putting word to deed. In this respect the realization of a culturally sensitive national ecological network provides an excellent framework for the advancement in Romania of intertwined land-use and conservation planning, sustainable natural resource use and economic development.

If Romania chooses to attain sustainability and wise stewardship of natural resources, a Vision Plan is an essential first step. Such a blueprint can produce immeasurable benefits to the nation, by contributing in general to public safety, well-being and prosperity. Moreover, a proactive Vision Plan will be a start to minimize the high (external) environmental costs that so many western European countries are now paying to restore or develop vital ecosystem services and natural space.

The primary goal of this project and Vision Plan is therefore:
To provide vision on safeguarding the Romanian Carpathians as a Regional Ecological Network conserving biodiversity, landscape and traditional cultural values of European importance. The network design is based on the conservation of large carnivores that play a key interactive role in the maintenance of important ecological processes in large natural areas.
The Romanian Carpathian ecological network (RCEN) is envisaged as a cornerstone of the Pan-European Ecological Network.

The establishment of a 'Carpathian wilderness park' in Romania, equivalent to the great national parks around the World, is central to the vision. This noble achievement is dependent on a scientifically based regional ecological network and ultimately on political and public support motivated by realistic and ecologically sound or nature supportive economic opportunities. The Carpathian ecological network is the backbone for a national ecological network, including natural areas with important species and habitats outside the mountain range. The national ecological network will in turn need to connect to the Pan-European Ecological Network, which will accomplish this important mission.

Important sub-goals of this project are to:
Transfer knowledge and capacity to a key Romanian nature management organization (ICAS) in order for it to develop as an expert national agency for the design, implementation and management of ecological networks. Important knowledge areas include ecological linkage location, mitigating the effects of transport corridors for wildlife and wildlife management based on modern landscape and conservation ecology.

Provide support to ecological network development in Romania, by presenting an important case for the institutionalization of conservation planning, harmonised and integrated with other sectoral planning (transport infrastructure, tourism, agriculture, forestry and mining), and which pays attention to reconciling the needs of people with the needs of nature.

Reveal non-sustainable and environmentally detrimental developments that are currently undermining the existing connectivity of ecosystems within

the Carpathian Range. To counteract this, cases for ecological linkage safeguarding are presented.

Instil the importance of safeguarding ecological networks amongst different environmental stakeholders, scholars and decision makers in Romania.

1.2. Approach

This PIN-MATRA project proposal was prepared for the advancement of ecological network conservation in Romania, with an initial focus on the Carpathian Range, in consultation with scientists and engineers from ICAS. The project proposal was subsequently endorsed by the Romanian Ministry of Environment and Water Management and funded by the Dutch government (PIN-MATRA programme).

Activities

The project consisted of three workshops, participation of team members in international meetings, fieldwork (pilot studies), consultation with international experts and literature and GIS modelling, as follows:

Training and consulting workshops

Three workshops were organized to analyse progress, gain additional insights and inform and consult as many relevant stakeholders as were reachable. The purpose and outcome of each workshop is discussed below.

First workshop, Sinaia (12-15 February 2003)

The first workshop was held to:

1. Consult and inform key sectoral stakeholders from government agencies, scientific institutes/ universities, NGO's, public associations and the private sector on important issues and possible constraints to the design and implementation of ecological networks in Romania.
2. Provide training on ecological network construction based on European and North American experiences and insights (training provided by Alterra and The Wildlands Project).
3. Define data needs and availability.
4. Investigate appropriate modelling procedures to aid the allocation of ecological network components.
5. Develop a communication strategy and mechanisms for 'mainstreaming' and synergizing the ecological network in Romania (training provided by AidEnvironment).
6. Create a three year work plan for the implementation of an ecological network in the Romanian Carpathians.

The workshop was attended by representatives from the Ministry of Environment and Water Management, Ministry of Agriculture, Forestry and Rural Development, Ministry of Transport, the Fundatia Carpati and the Romanian branch organizations for tourism and hunting. The need for an ecological network was endorsed by all participants, but they also stressed the difficulties in achieving this goal in the face of the current political situation, lack of institutional capacities and unbridled developments. Prof. Dr. Michael Soulé and Dr. Ovidiu Ionescu chaired the meeting and Prof. Dr. Jan van Haaften, as co-founder of large carnivore conservation projects in Romania, provided an opening speech. Irene Bouwma provided an overview of ecological networks in Europe and landscape models developed by Alterra. Jan-Maarten Dros of AidEnvironment presented a reader with a communication strategy to mainstream the ecological network in Romania. A work plan was made for data collection, field study and synergy with relevant partners.

Second workshop, Piatra Craiului National Park (28 – 29 November 2003)
This workshop focused on progress and the analysis of acquired information (distribution of large carnivores and herbivores in hunting units) collated in GIS by ICAS. The project activities were fine tuned and various biodiversity experts, additionally including botanists, entomologists and ornithologists were consulted on the distribution of landscape and biological diversity under the umbrella of large carnivores.

Several presentations were given on carnivore conservation research and hunting management in Romania. Other presentations concerned biodiversity conservation initiatives in Romania including trans-boundary collaboration between Romania and Hungary on ecological linkage safeguarding (Apuseni Mountains-Hungarian Plain), the beginnings of nature restoration in Romania (pioneering work on wetland and forest restoration and biodiversity inventory by Sergiu Mihut of the Environmental Protection Agency Cluj and colleagues of the Romanian Biodiversity Conservation Monitoring Centre) and the development of an Important Bird Area network in Romania. Another presentation was given on road mitigation for wildlife and the design of a 'green bridge' in the Netherlands.

It became clear in the workshop discussions that the ecological network cannot be based solely on large carnivores and herbivores, and that habitats for biodiversity not covered by large carnivore distribution should be incorporated, such as prime bird, herpetofauna, butterfly and botanical areas. Prof. Michael Soulé provided a lecture on important conservation ecology principles and promoted the use of a suitable and freely available landscape model to help determine the best combination of ecological network components (core areas and ecological linkages). He also proposed the promotion of a Romanian Carpathian ecological network through a Vision Plan, based on the Southern Rockies Wildlands Network Vision (Miller *et al.* 2003), on which this strategic management plan is inspired. Michael Soulé and Ovidiu Ionescu chaired the meeting.

National and international meetings
The project was promoted by ICAS at several national and international level seminars and conferences, including the Carpathian Workshop on Large Carnivores (Large Carnivore Initiative Europe, Poiana Braşov, 2003), meeting for Regional Cooperation Romania-Hungary 2003, Transylvania University Scientific Conference (2003 and 2004), the Carpathian Ecoregion Initiative 2004 General Assembly Meeting (2005) and the 16th International Conference on Bear Research and Management (2005, Riva del Garda, Italy).

Study tour
Three team members from the ICAS Wildlife Management Unit led by George Predoiu visited the Netherlands from 13-16 October 2003. Their purpose was to attend a Beaver Symposium, investigate the possible use of landscape models with training at Alterra, to see a functional 'cerviduct' (a wildlife passage for animals up to the size of red deer), and to hold interviews with research student candidates for the ecological linkage pilot studies.

Field research
Members of ICAS have conducted explorative (pilot) field research to pin-point priority ecological linkages and core areas. Five probable key (core) areas were visited, including the spruce dominated region of Harghita, the Prahova Valley, the Bran-Rucăr valley, the south-western part of the Carpathians (at the Bulgarian and Serbian border) and the divide between the Apuseni and the southern Carpathian Mountains. The two areas most intensively studied were the Bran-Rucăr val-

ley and the divide between the Apuseni and southern Carpathian Mountains. Two students from Wageningen University were recruited to perform research into ecological linkage function and management for large carnivores and herbivores in a tourism development area and between two mountainous national parks near Braşov (Bran-Rucăr valley and Râşnov Plain). By snow tracking of wildlife and by interviewing local people and experts they investigated the behaviour of wildlife toward human settlements and wildlife movements between the national parks. They also prepared the modelling for the allocation of ecological network components using Marxan and least-cost-path-analysis with GIS. The preliminary results were presented in a report (Klaver & Van Munster 2004). This activity resulted in considerable knowledge transfer between young future Dutch conservation biologists and aspirant wildlife managers at the ICAS Wildlife Unit in Braşov. Much was learned about human-wildlife conflicts and the day-to-day struggles of the unit. The results of the pilot studies are presented in Appendix 4 and a discussion on the implications of the results for the effective conservation of carnivores in Chapter 4.

Modelling
In order to deal with the inherent complexity of landscapes and objectively and economically delineate core areas and ecological linkages on the basis of large carnivore range requirements, the use of two freely available landscape models (Marxan and least-cost-path-analysis) was investigated, as recommended by Michael Soulé. The step-wise use and results of these models is explained in Appendix 3. From the outset we were aware that the modelling results needed to be verified on the basis of field and expert knowledge, checking with actual habitat quality of probable cores and linkages, and the umbrella function of large carnivores for other biodiversity and landscape values. The low resolution and sparseness of available habitat data was found to be a limiting factor in the analyses. Nevertheless the available data (especially counts of large carnivores and herbivores; Appendix 1 and 2) together with the modelling results allowed us to identify ecological network components with reasonable reliability and at least prioritize their safeguarding in face of wildlife impacting developments. The analyses provided scope for further focussed research.

Synergy
Designing and then effectuating ecological networks is impossible without constructive networking between all relevant stakeholders. Therefore, collaboration with other proponents needed to be catalysed, particularly within Eastern and Central Europe. Despite the Aarhus Convention to which Romania is a signatory, it proved difficult to arrange government owned data from different ministries and agencies. Contacts on the national level have started through the workshops but have yet to gain momentum and collaborative ties. Similarly, trans-boundary collaborations are in their early stages. Hence early on in the project it became clear that most effort should first be devoted to establishing constructive working relationships at the national level. It is hoped that this Vision Plan will spark the advancement of nature conservation on the basis of sound collaboration and sharing of information between all important stakeholders, crucial in building or safeguarding an ecological network.

Third workshop, Braşov (15 July 2005)
The third workshop was the final workshop of this project. The purpose was:

1. To analyse and discuss the Vision Plan and preliminary Carpathian ecological network map (i.e. a frame or protection zone based on modelling, needing further filling in of cores and linkages).

2. To discuss implementation challenges and opportunities.

The same audience as for the first and second workshop was invited, and several previous participants took part. The results of the three year project were presented during the first half of the day, including the display of a draft Carpathian ecological network map, based on modelling and fieldwork results and distribution data for large carnivores and herbivores and other sparse biodiversity data. Constructive discourse occurred between the participants, including the issue of proper wildlife monitoring. The second half of the day was devoted to devising a framework for implementation, the results of which are provided in Chapter 6. It once again became clear during the workshop that the success of a Carpathian ecological network depends highly on the cooperation between stakeholders, government agencies and non-government organisations, and on the widespread support of the Romanian people.

For instance, it was disclosed that planning for major highways throughout the Carpathians is occurring, but apparently without open public and environmental expert consulting and practically without ecological mitigation. Thus, a great deal of urgency is now required for the incorporation of 'green bridges', particularly for the 4th Pan-European transport corridor dissecting the divide between the Apuseni mountains and southern Carpathians.

Finally, a vision was put forward of developing the Romanian Carpathians into a grand national park in which people should not be excluded but continue the role of stewards in wisely managing and utilizing the natural resources, such as traditional forestry, pastoralism and agriculture. The vision embraces the two goals of nature conservation and cultural integrity. The central concept is the creation of a regional ecological network comparable to great national parks elsewhere in the world, like the Yellowstone National Park of North America. Distinguishing this park, therefore, would be its emphasis on the Romanian tradition of harmonious relations between people and the land, and on both ecological and cultural sustainability.

The workshop participants also agreed that the project must maintain and gain momentum, under the auspices of a stable expert coordinating committee.

Brochure and poster
A brochure on ecological networks was produced in Romanian (Reţele Ecologice – Carnivorele mari şi habitatele lor naturale) and distributed widely to key stakeholders by ICAS. A poster on safeguarding the RCEN was produced in English and in Romanian.

1.3. Organization of the Vision Plan

The Vision Plan is organized as follows. Chapter 2 motivates the urgency for an ecological network in the Romanian Carpathians based on its immense ecological and cultural values and in the face of new anthropogenic developments and threats, of which an overview is provided. Chapter 3 provides at first a sketch of current ecological networks in Europe and North America, illustrated with some examples. It then explains connectivity, ecological components and other important preconditions for an ecological network. Chapter 4 presents the results of the modelling and biodiversity data collation, which combined result in a Romanian Carpathian Ecological Network Vision Map or preliminary protection zone. It also discusses what further detailing is necessary in terms of concretely designating core areas and ecological linkages within this protection zone or geographic framework. Chapter 5 provides guidance on priorities for

safeguarding the Carpathian ecological network, with emphasis on transport corridor mitigation for wildlife and organisational capacity building. Chapter 6 provides a framework for Carpathian ecological network implementation, with proposed activities as determined during the third Braşov workshop, with the underlying vision of a grand Carpathian wilderness park.

Additional information is provided in the appendices. Appendix 1 provides further reading on relevant aspects of the ecology and biology of the brown bear, Eurasian lynx and wolf. It also provides maps of the current large carnivore distributions in Romania. Appendix 2 provides maps of the current ungulate populations in Romania. Appendix 3 provides an explanation of the landscape modelling of core areas and linkages in the Romanian Carpathians. Finally Appendix 4 provides the findings of the pilot field studies on ecological linkage location and function in the Romanian Carpathians.

1.4. Acknowledgements

Special credit must first of all be given to Valeria Salvatori, the Italian researcher who began analysing the Carpathian ecological network by modelling suitable areas for large carnivores, based on geographical data and interviews with local people (Salvatori 2001). Unfortunately she was not able to verify her modelling result (Appendix 5) on large carnivore distribution data. In retrospect her modelling proved to be quite accurate in pin-pointing possible core areas only on the basis of landscape features. We hope our additional analysis with the use of wildlife distribution data will advance her groundbreaking work.

This project was not possible without financial support from the Dutch PIN-MATRA programme, an instrument for funding the execution of "The Netherlands nature management action plan for Central and Eastern Europe 2001-2004". The project received the approval and support of the Directorate for Biodiversity Conservation of the Romanian Ministry of Waters and Environmental Protection, for which we are grateful.

This project was actually initiated and inspired by Prof. Dr. Jan van Haaften to whom we owe this opportunity and encouragement. He has facilitated collaborations between western and Romanian scientists on wildlife management and conservation of large carnivores and herbivores in Romania since 1991.

We also like to thank all contributors and facilitators (support, ideas, encouragement, information, intermezzos and photos) to this project, including Eddy Wymenga, Daan Bos, Harmanna Groothof (Altenburg & Wymenga), Irene Bouwma (Alterra), Jan Maarten Dros (AidEnvironment), Joost van Munster, Annette Mertens, Sergiu Mihut, Peter Sürth, Ab Grootjans (University of Groningen), David Quammen, Anthony Clevenger (Western Transportation Institute, Montana State University), Hugh Possingham (University of Queensland), George Sarbu (ICAS), Marius Scurtu (ICAS), Irakli Shavgulidze (NACRES, Georgia) and Jan van der Winden, Fleur van Vliet and Marc van der Valk from Bureau Waardenburg.

We are in debt to The Wildlands Project (http://www.twp.org/), for the participation of Prof. Dr. Michael Soulé and for his advice on the modelling software.

Stagbeetle. Photo: Erwin van Maanen.

2. THE CARPATHIAN RANGE: VALUES AND THREATS

This section provides a concise view on the important ecological and cultural values of the Carpathian Range and its function as a large-scale ecosystem that not only has important biosphere maintenance functions but also opportunities for human prosperity alternative to non-sustainable exploitations. There are many (cumulative) impacts and threats that currently undermine the existing Carpathian ecological network, varying in magnitude and effect. These are briefly characterized in this section. At the end we conclude with implications and challenges to counteract the negative tide of anthropogenic developments.

2.1. Ecological, cultural and economic values of the Carpathians

The Carpathian Range spans across seven Eastern to Central European countries, including Romania, Ukraine, Poland, Slovakia, Hungary, Czech Republic and Austria (figure 2.1). The entire range covers around 200,000 km^2, equivalent to nearly five times the size of Switzerland. On the geological time scale the range is relatively young and supports a variety of special geological features and landscapes. They are the basis of diverse natural habitats for thousands of plant and animal species, including several rare and endemic (sub) species or varieties only found in pockets of the range (Nowicki 1998; Webster *et al.* 2001; Witkowski *et al.* 2003). For instance, a third of all European vascular plant species grows in the Carpathians, totalling 3988, 481 of which are endemic. Beside its highly natural features the range is a cultural melting pot with a multitude of old human traditions, practices and folklores. Age-old traditional and extensive land use systems in Eastern Europe, along with the geology, have shaped the natural history of the Carpathians, which is much different from the rapidly developed intensive land use systems of Western Europe. The ecosystems of the Carpathians still provide invaluable natural services and profitable novelties to human society. These include clean air and water, flood control, carbon dioxide storage, healthy recreational space or health resorts, artistic inspiration, scientific knowledge, culture and nature enjoyment through festivities, hiking, camping, mountaineering, caving, hunting and fishing, to name but a few. Timber and non-timber forest and grassland products such as medicinal plants, mushrooms, fibres, resins, honey and other syrups, cheeses and fleece are some of the possible commodities for the European organic markets.

In Romania the Carpathian Range covers 66,303 km^2 and can be roughly divided into three parts: the eastern Carpathians, the southern Carpathians and the separate Apuseni Mountains to the north. These are still covered by large expanses of extensively managed semi-natural forests with relatively large vestiges of almost natural majestic old growth forest (figure 2.2). The forests are generally highly productive and can be almost entirely broadleaved, conifer dominated or mixed, combined with many botanically rich meadows, special rock formations, and a dense system of springs, streams and rivers. Forest biodiversity is unsurpassed when compared to other great montane forests of Western Europe, like in The Alps or Pyrenees. Moreover, the Romanian Carpathian highlands still connect naturally to lowland ecosystems, including large expanses of oak forest, riparian forest and steppe, presenting interesting landscape gradients or ecotones where biodiversity can reach the highest level.

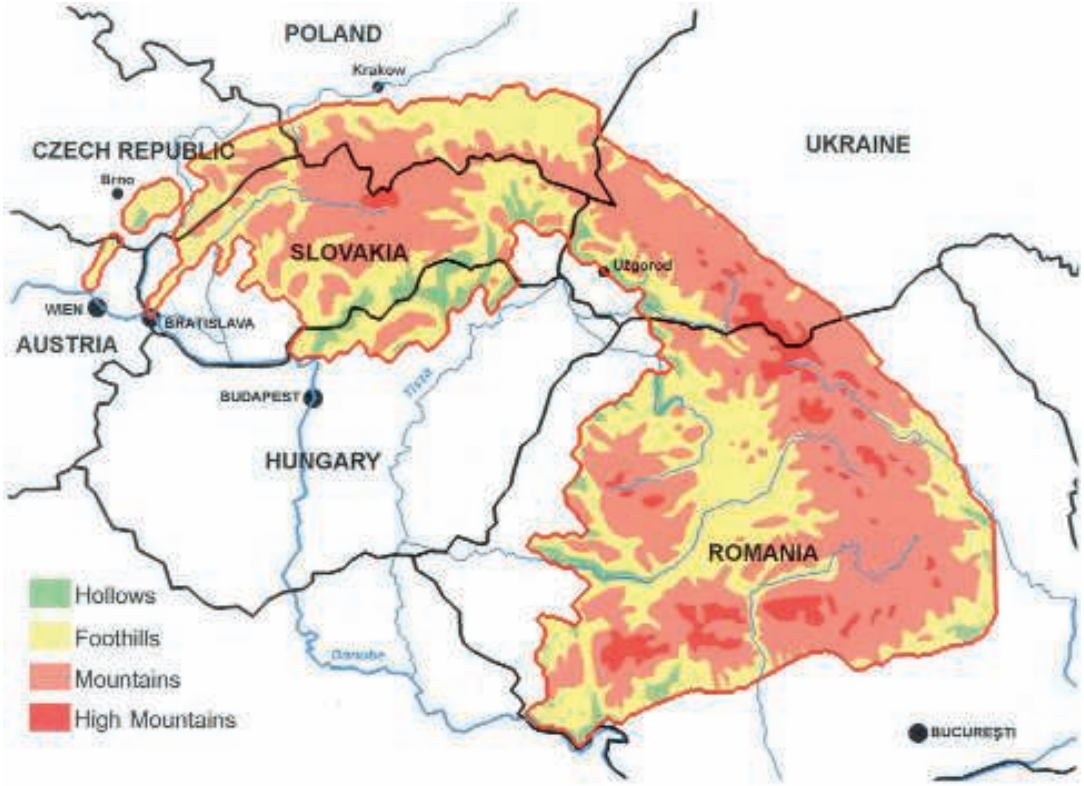


Figure 2.1 The Carpathian Range from Romania to Austria.

The Carpathian Range is one of Europe's last bastions for large and awe-inspiring carnivores and herbivores. Only in remote regions of Spain, Greece, northern Scandinavia and in the Baltic States do sizeable and ecologically meaningful populations of these animals still persist (see Boitani 2000, Wenson *et al.* 2000, Breitenmoser *et al.* 2000). Romania can truly pride itself for nurturing great numbers of brown bear, wolf and lynx and their ungulate prey (red deer, roe deer, chamois and wild boar). Of the estimated large carnivore populations of entire Europe, Romania accommodates 40% of the wolves (2750 animals), 35% of the brown bears (4350 animals) and 22% of the Eurasian lynx (1800 animals). Elsewhere in Western Europe large carnivores have long vanished or barely hang on as small practically non-viable populations as a result of centuries of persecution, prey reduction and habitat destruction. These small populations alone may not be enough to recolonise the new frontiers of increasingly abandoned lands.

The entire Carpathian Range can facilitate the dispersal of montane forest wildlife over much of central Europe and gradually into Western Europe. Dispersal can supplement the re-introduction of large carnivores, that commenced in Central Europe in the last decade of the previous century,

INTERMEZZO

Peter's Journey

Peter Sürth, a German conservationist and large carnivore researcher in Romania for the last ten years, undertook a 2000 kilometre hiking journey along the Carpathians (www.thewayofthewolf.net). His goal was to investigate the actual ability of large carnivores in the east to move gradually all the way across to the Alps in the west. What better way than to do this on foot, in direct touch with the ecology and cultures of the range. On his path he tracked animals, pin-pointed bottlenecks, consulted local communities and raised public awareness about the importance of the range as ecological network and for rich biodiversity. He started hiking in the Romanian Carpathians and then through Ukraine, Poland, Czech Republic and Slovakia. His journey ended back in his home country.

He found that although the Carpathians in Romania and Ukraine still function highly as an ecological network this is not so further west, where it became clear that many natural areas have become isolated and provide only limited conductance for large carnivores. In Romania he encountered the least spoiled nature endowed with the largest carnivores and herbivores. Ukraine also has near pristine natural areas, but he noticed that many of the forests are devoid of large mammals, presumably because of much poaching. He stresses the importance of the Carpathians as an ecological network and biological and cultural storehouse, a natural treasure in Europe holding great educational, organic agricultural and green tourism potential. Furthermore, he emphasizes the importance of the range as a reservoir for large carnivores for Western Europe and a region where western Europeans can learn to co-exist with large carnivores and from traditional land use and management practices enriching biodiversity. He noted the following encouraging words from local people:

"Wild animals have the same right to live as we".

A shepherd said: "It is acceptable to occasionally loose a sheep to a wolf or bear. After all, they need to eat something too".

A hunter said: "Wolves and lynx are very important; they assist me in keeping game species healthy, fit and strong. I'm not able to do the same".

A child said: "I saw wolves approaching our sheep. I went for a closer look and when they saw me they ran off".

Many people he spoke to were highly open to the ecological network concept and many were willing to support it.

According to Peter monitoring of wildlife movements "on the ground" is vital in order to reliably locate core areas and ecological linkages. In that sense much remains unexplored or unknown. His journey also made clear that there is much work to be done to safeguard an ecological network in the Carpathians.

Bear tracks on Peter Sürth's trail through the Carpathians. Photo: Peter Sürth.

for instance for the recovery of the Eurasian lynx (Breitenmoser *et al.* 2000), which so far has been moderately successful. Immigration of animals into reintroduced populations could well be crucial to the establishment of stable and truly independent wild populations, as long as the areas of re-introduction do not function as mortality sink, but instead present a springboard to further expansion. From then on abandoned rural areas in Western Europe can start to fulfil the role as sanctuaries for pioneering animals and eventually recover to once again become wilderness areas. Large carnivores are key driving factors for the restoration and maintenance of wilderness and for biodiversity conservation, as encouraged by a rapidly growing body of scientific evidence (Soulé *et al.* 2005; Ray *et al.* 2005).

The recipe for success is plenty of contiguous large natural spaces containing sizeable wild ungulate populations, and crucially, human tolerance. Human persecution has been the primary limiting factor of carnivores in Europe (Ebenschweiger 2003; Linnell *et al.* 2001). With persecution and the public notion of carnivores as dangerous vermin now at an all-time low, large carnivores can actually begin to co-exist with human society and move into areas from which they have long been purged. The highly dispersive wolf, for example, is making its way to the west and small packs have been observed in quiet corners of France and Germany. The founders originate from Italy and Poland (Valière *et al.* 2003). Dispersing bears are trickling back into Austria from Slovenia after a long absence (Zedrossler *et al.* 1999).

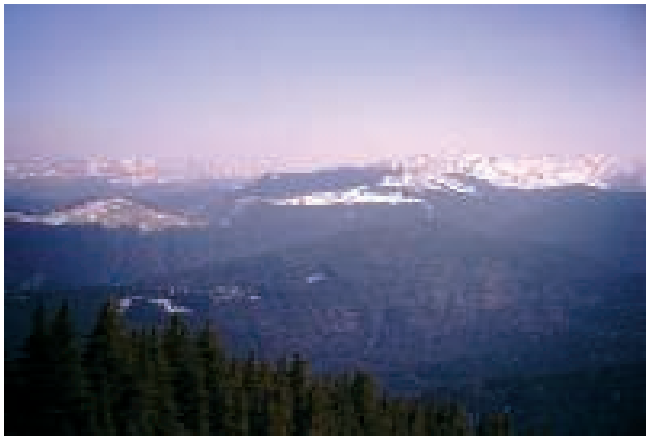
Hence, since the Romanian Carpathians probably harbour the most vigorous large carnivore populations in Europe, it is likely that these can fuel the expansion of large carnivores to new frontiers. These populations present a precious reservoir requiring highly committed conservation efforts, not only by Romania but also by other Carpathian countries.

2.2. Threats to ecological values of the Romanian Carpathians

Romania is in the midst of an unprecedented socio-economic transition that began with the revolution of December 1989. The rapid change from a centrally planned, communist economy to a liberal market economy has led to profound changes in land use, with inevitable environmental impacts (Turnock 1998). Given that accession to the European Union is imminent in the short term, Romania is facing drastic social, political and administrative reform in all layers of society, which is not without major constraints. Reforms are needed to streamline the development of various sectors into a system of good civil society and democratic governance in accordance with European norms and legislation. This includes changes that ensure the sustainable management and use of natural resources and the protection of ecological values. Unfortunately haphazard and unbridled developments are currently degrading habitats and threatening species in many areas across the country. At the Sinaia workshop in 2003 participants were consulted on what they perceive as important environmental pressures and impacts. They listed and ranked the following forcing factors for the degradation of the Carpathian ecology and stressed the urgency of mechanisms and actions for the safeguarding of a national ecological network.

Land privatization and urban encroachment

After the Land Restitution Law was passed in 1991, a third of the former state-owned agricultural and forest land was returned to 'former' owners or sold to new proprietors, including about 42% of the Romanian Carpathians. The Romanian government elected in 2004 then passed a new bill to return the remaining two thirds of forest and agricultural land to former landowners. Apparently effective and regulated land use planning is not yet in place in Romania. In the absence of enforced land use regulations entrepreneurs are free to utilize their



Large areas of the Romanian Carpathians are still covered by continuous tracts of near pristine montane forest, teeming with wildlife (left). However, this precious landscape is under threat and in the future may look more like the Apennine Mountains (right), where high deforestation and habitat fragmentation have accumulatively rendered much of the region unsuitable for large and wild mammals. Photos: Rogier Klaver.

property as they wish. New land uses can include intensive farming, exotic species farming (e.g. ostrich farming), hunting estates, industrial forestry, holiday real estate, industrial parks, malls and car showrooms, camp sites and ski resorts. Property development is currently most obvious around major towns and presents the new urban sprawl. Even in rural areas close to towns human occupancy is clearly on the increase, moving steadily onto forest fringes in the foothills and even right into the heart of 'protected' natural areas. For instance in and around the beautiful valleys of Piatra Craiului national park, holiday chalets, hotels and restaurants are popping up like toadstools. Some of the owners are apparently high officials with a disregard for the law.

There is much at stake in the most proximate places, such as the fragile stream valleys, which have high scenic and ecological values. Encroachment forces the destruction and withdrawal of many environmentally sensitive plants and animals and paves the way for so-called culture followers, which are much better adapted to the urban bustle and jumble. At this stage the wilderness is lost. Large carnivores and wild ungulates are among many ecological values that cannot persist in areas with dense human occupation.

Abandonment of traditional agriculture

Traditional farming is still practiced widely in Romania, hence the meadows almost everywhere in the mountains and valleys are still rich in flowers and the mosaic of fields, shrubs and forests are teeming with wildlife, so appreciated by hunters. With the growth of a modern economy traditional and extensive agricultural practices become obsolete or unprofitable. Most young people from the country nowadays take up a career and move permanently to the cities, leaving farming to disappear with their parents and grandparents. Eventually, with the modernization and scaling-up of agriculture according to EU standards, traditional small-scale farming systems will probably fade away, as they have in most western European countries. Similarity can be drawn with abandonment or intensification of other precious ecosystems with high biodiversity that were nurtured for eons by traditional agriculture, as for instance widely in the French countryside or in the 'dehesa' (cork oak) woodlands of central Spain. In Romania agriculture

in the near future will probably shift to the alluvial lowlands, where bioindustry can be well-located and is most productive. To what extent this scenario will proceed and what the exact ecological consequences for the Carpathians are is difficult to predict at present, but will likely affect a significant part of biodiversity, an issue that needs to be unravelled with holistic study.

New land ownership and trespass prohibition more or less restricts extensive and transient grazing over wide areas. In areas where the flocks can no longer move freely and become sedentary overgrazing and nutrient imbalance of montane and alpine grasslands could occur, resulting in soil erosion and loss of native plant diversity. The extent of the problem depends also on the continuation of pendulous sheep grazing as a major rural livelihood. Without extensive grazing by domestic and wild herbivores many meadows could slowly but surely return back into forest (Nagy *et al.* 2003). We can only guess at the consequences for biodiversity should the age-old sustainable agro-ecosystem disappear. We know that botanically rich calcareous grasslands, directly or indirectly beneficial to diverse wildlife, are dependent on extensive grazing (Fisher *et al.* 1996). Sheep and other livestock also subsidize large carnivores to a certain extent, through predation or scavenging. To a plethora of native species reliant on botanically rich grasslands and forest edges, the disappearance of traditional livestock herding can cause impoverishment. With the disappearance of livestock large carnivores may become more reliant on wild ungulates, which should then be plentiful as their availability affects the ranging and hence densities of large carnivores. It would therefore seem crucial to perpetuate the diversifying natural grazing systems, including management of preconditions that benefit both domestic and wild herbivores. Important wild herbivores that differentially graze and browse a structured vegetation include chamois, red deer, the introduced mouflon, alpine marmot and the European bison (to be reintroduced), which are regulated top-down by large carnivores and maintain vegetation mosaics and diversity. Maintaining this intricate community of interacting herbivores and carnivores benefits a wider rich community of plants and animals, and is vital for the recovery of special wildlife, like the return of the bearded vulture and griffon vulture.

Changes in forestry

The total standing wood volume in Romania is estimated at 1341 million metres and the total annual wood production is around 30 million m^3, of which half may actually be cut according to medium-term (10-yearly) management plans made by ICAS. Economically important trees are common beech and Norway spruce (each about 30% of the total tree cover). The export of raw wood and wood products provides on average one billion USD in revenue, about 11 percent of the total export. The traditional method of logging is cyclical selective cutting and removal of logs with the use of horse power, followed by natural regeneration. Clear-cutting was permitted only in some forest types (including pine forest) and to maximally five hectares. Limited clear-cutting on level areas without churning of the soil and with natural rejuvenation of the forest can actually be beneficial to wildlife, for instance by providing herbal forage to wild ungulates and bears (Nielsen *et al.* 2004). However, industrial forestry by large-scale clear-cutting of broad-leaved forest and replacement with botanically poor pine monocultures often greatly impoverishes biodiversity and creates reliance of wild herbivores and large carnivores on active management (Linnell *et al.* 2001).

A third of the Romanian forests is currently in private hands (about 2 million hectares from 6 million hectares that was state-owned). It is currently too early to properly assess the effects of forest privatization. The worst-case scenario is that private

owners can do what they want with the forest, to maximize short-term profits. One can imagine what the cumulative impacts of different forest uses are. With private ownership comes also a demand for improved access into the forest, and hence the development of more infrastructure (roads and railways) allowing more people to interfere more deeply with the forests. This can subsequently set the stage for further cumulative development and people influx, likely including poachers. Without ecological forest stewardship and biodiversity conservation habitat fragmentation, loss of natural forest quality and increased disturbance of wildlife can proceed resulting in impoverished forest fragments where large range demanding species can no longer exist.

Although rather wasteful in many respects, consistent and cohesive forest management with a sense of stewardship by the state was favourable to forests in the communist past. The substitution of this largely conservative forestry with modern, capital-intensive forest exploitation will undo the built-up natural wealth. It will be very challenging to hold many new forest owners to a common code of sustainable forest management and to the regulations of EU nature protection policy (Habitat and Bird Directives). According to the directives ecological impact assessments and protective measures are required for special species and habitats listed on Annexes I, II and IV for each activity undertaken by land owners (see also Chapter 3). An alternative is the creation of a network of protected areas that precludes mechanized, unsustainable exploitation of forest products and to establish land trusts (Chapter 5). The symbolic value of natural forests to Romania's identity should also be kept in mind.

There are currently cases of forest clear-cutting beyond the norms set by ROMSILVA (National Forest Administration), thus illegal practices. Mass logging of broad-leaved forest, replacement with pine monocultures and development of ski resorts will have the gravest consequences for Romania's natural forest capital and biodiversity. Sustainable forest management conform the Forest Stewardship Council (FSC certification) is not yet properly installed, despite some audits by forest inspectorates and promotion by ROMSILVA and the branch organization of concerned foresters. FSC certification has started in only eight regions, targeting both private and state-owned forests. A recent national plan for sustainable forest management is largely bent on solving land tenure issues, but does not counteract poor forestry practices.

Old-growth (climax) forest fragments scattered over the Carpathians (figure 2.2) are the most highly treasured of Romania's forest types and some are included in the mere 15% of strictly protected forests, which is probably not meaningful in terms of effective forest biodiversity protection.

Stream valley deterioration

The valleys of the Carpathians contain beautiful and ecologically healthy streams, accompanied by botanically rich grasslands which are maintained by rural communities through extensive haying for winter livestock fodder and careful coppicing for firewood. Semi-natural hay lands are nowadays scarce in Western Europe. In Romania natural stream valleys are increasingly affected by pollution, erosion, impoundment and haphazard exurban sprawl.

New transport infrastructure

The improvement and construction of the transport and communications infrastructure is a priority for the modernisation of Romania. The Centre for South-East European Studies (CSEES) states that "due to its strategic location at the crossroads of Europe and Asia, Romania has the potential to

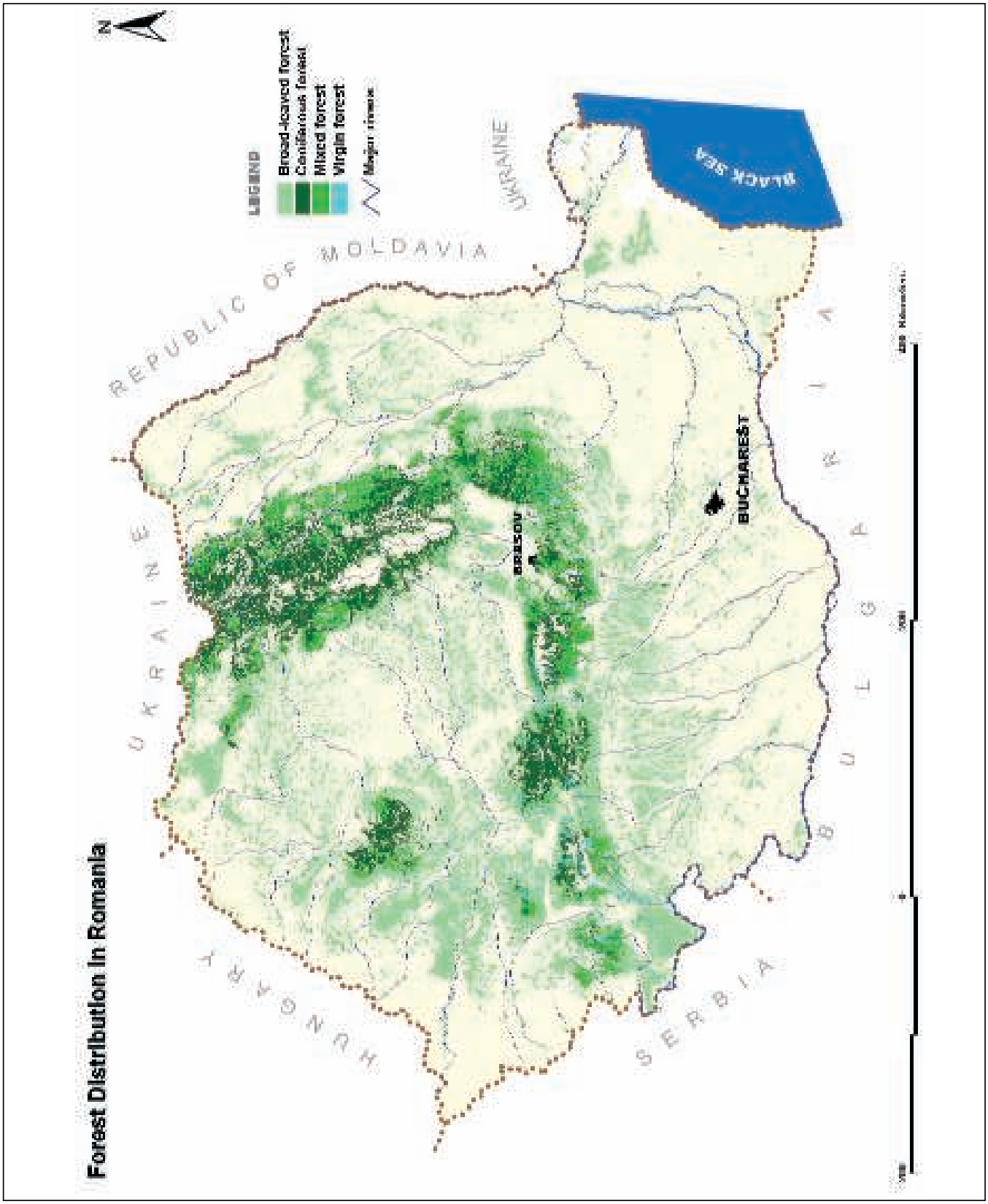


Figure 2.2 Forest distribution in Romania.

become one of the busiest transport areas in Central and Southern Europe. Improving the condition of the country's road network, restructuring railways and upgrading the seaport of Constanza have become imperative." Such statements, of course, do not address or anticipate the environmental consequences of intensive infrastructural development.

Romania has probably the lowest paved road density in Europe. At present this density is estimated at only 0.06 m/km^2. Compare this to for instance 3.5 m/km^2 in The Netherlands. However, traffic on national roads to neighbouring countries and linking the major towns is increasingly congested and presenting an increasing hazard to wildlife. Plans for major highway construction include the 415 km four-lane Transylvanian Motorway connecting Braşov, Targu Mureş, Cluj and Oradea in central Romania with Hungary (EU) (Figure 2.3). Construction of this highway by the U.S. Engineering firm Bechtel, began in 2004 and was scheduled for completion in 2012. At the time of writing further construction has been delayed due to budgetary constraints. Priority is now given to another major motorway and railway connecting

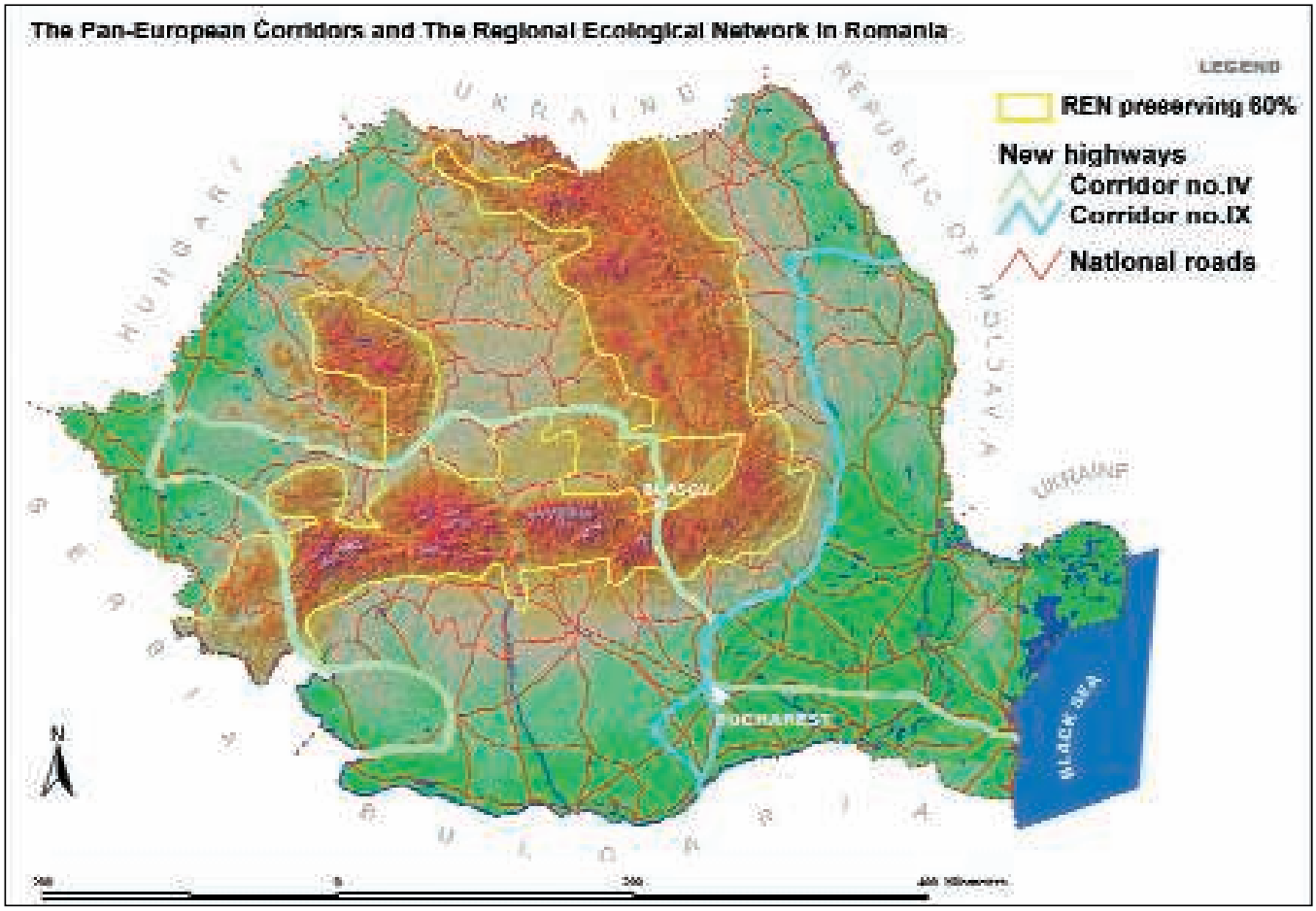


Figure 2.3
Currently planned Pan-European road network through the Carpathians, effectively dissecting the range and potentially cutting off wildlife populations to a high degree.

Bucharest with Braşov, Sibiu, Deva, Lugoj, Timişoara, Arad and the Hungarian border, as part of the Pan-European corridor number IV running from Berlin to Istanbul. Another section of the so-called corridor no. IV from Timişoara to D.T. Severin is in the pipeline, as is transport corridor IX across Romania connecting Russia via the Republic of Moldova with Bulgaria. These corridors will begin to dissect the Romanian Carpathians into four parts; Apuseni Mountains, southern and eastern Carpathians the ecological connection between with Serbia (figure 2.3).

Busy roads, particularly multilane highways with high speed traffic, are virtually absolute barriers and high disturbance sources to a broad spectrum of wildlife. Many recent studies into the ecological effects of major traffic indicate that its impact on wildlife is probably more severe than is actually registered (Forman *et al.* 2003). The Carpathians are particularly prone to fragmentation by roads and railways through the human occupied valleys running longitudinally across. When such developments are not carefully planned, but haphazard and intensive, the Carpathians will be divided in precarious ecological islands more sensitive to the brunt of surrounding human activities. The major new motorways realized in the near future will definitely dissect the populations of wide ranging wildlife, like the large carnivores. Particularly the new priority 4th transport corridor between the southern Carpathians and the Apuseni Mountains and between the southern and eastern Carpathians, in absence of tailored mitigation measures, is expected to be highly obstructive to wildlife.

During this study little information was gained from the infrastructure development authorities on the application of mitigation measures for wildlife, specifically 'green bridges' and underpasses. It was apparent that environmental impact assessments for infrastructure development in Romania are poorly made, with little or no consideration for landscape ecology, conservation of wildlife, and loss of ecosystem services.

Hunting and poaching

The hunting lobby is traditionally large and influential in Romania, and quite well organized but complex with around 200 so-called hunting associations. In Romania nature management relies solely on the traditional hunting management system (cynergetics; Quammen 2003), aimed at maximizing the harvest of wild animals. Romania is divided into 2148 hunting management districts, each managed by a hunting association (72%), state forest administration (26%) and research or education institutions (2%). According to annex I of the current Forestry Law (No. 103/1996), 84 species may be hunted, of which several according to set quota. Hunting quota's for non-protected species are controlled by the Ministry of Agriculture, Forests and Rural Development and the quotas for protected species are controlled by the Ministry of Environment and Water Management through each hunting unit administrator. However, hunting management is supervised by divisions of the Regional Inspectorates. Hunting management is therefore governed by a highly bureaucratic system and not without problems. One problem is the setting of yearly hunting quota's for large carnivores proposed by unit managers. These can be biased depending on the capacity and goodwill of the person in charge at the inspectorate. Because hunting managers profit from trophy hunting by foreign hunters, they may submit higher than realistic counts. Furthermore, the wildlife monitoring system has its flaws. Poor communication between the unit managers is believed to cause overcounting of highly mobile and wide ranging animals able to move across hunting units, considering the small size of these units (on average 200 km^2). In estimating the number of wolves for instance, it may be better to register their dens than the tracks

of wide roaming winter packs. From the workshops it also became clear that there are differences between conservation biologists and wildlife managers on the way bear numbers are estimated. Romanian wildlife management can benefit from a modernisation of monitoring methodology and the integration of conservation ecology, which requires separate attention.

It is rather awkward that as well as being strictly protected all three large carnivores are also classified as game species according to Annex 2 of the Forestry Law. The maximum yearly harvest quota (2005-2006) for bear is 250 animals, wolf (400), lynx (150) and wild cat (500). Only bear hunting provides substantial revenue from trophy hunting. Foreign hunters can shoot bears in a drive hunt selectively according to specially issued permits conform the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). It is not clear how gender and age selective harvest can be beneficial to the Romanian bear population, a subject currently under review.

Poached bear tranquilized to be freed from a snare. The aggrieved bear displayed tremendous strength by destroying the vegetation within its reach (photo: ICAS Wildlife Management Unit). One bear freeing itself from the snare during rescue was shot during this study.

Poaching of wildlife by shooting, trapping or snaring occurs widely across the Romanian Carpathians and beyond. All of the wild ungulates are frequently poached by local people for subsistence. The poaching pressure and impact on ungulate populations is not known and thus we don't know whether poaching undermines the food base of large carnivores or not. The degree to which large carnivores are poached is also unknown. In general proper statistics of wildlife mortality are not kept by the authorities.
Over the course of this project the staff from ICAS Wildlife Unit freed a number of bears from snares, amounting to 30 registered cases in the last two years. One bear that attacked his liberators after breaking free from a snare had to be shot. Although it is clear that poaching in Romania occurs widely, it is believed that due to the vastness of the forests and many strict foresters at work the overall impact is limited and less than in for instance the more accessible forests of neighbouring Ukraine where 'silent forest syndrome' has been reported (Peter Sürth).

Feral animals

Feral dogs, cats and pigs stray in unknown but presumably sizeable numbers through the edges of the forest and are to a certain degree ecologically important, by being in competition with wild carnivores, preying on wild ungulates and other prey and by transferring rabies onto wild carnivores. The magnitude of this issue needs clarification. On the other hand feral dogs and cats are also preyed upon by wolf and lynx.

Pollution

Romanian forests are not as affected by past air pollution, in particular acidification through sulphurous coal burning smokes, as large forest tracks in western and central European countries were. However, the increasing and highly congested traffic and the negligible control on vehicle exhaust,

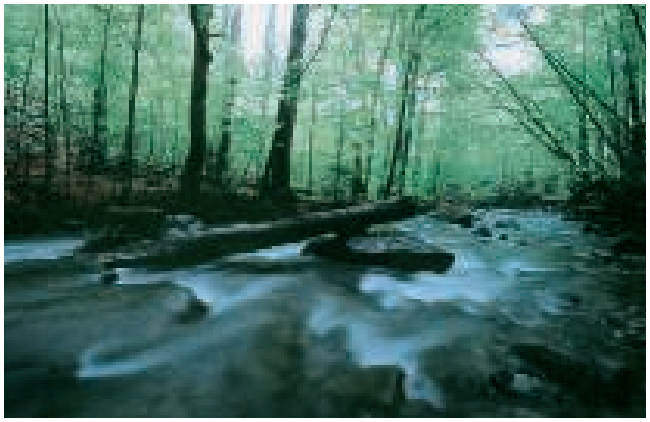
leading to high smog levels in the mountain valleys, may exert a toll on tree health.

Mining activities have led to environmental calamities in the recent past (e.g. the Tisza cyanide spill at Baia Mare) and present a chemical hazard to the waterways.

Local littering and open garbage dumps are widespread around towns, hotels and camp sites, possibly creating habituated bears.

Mining

Surface mining of (precious) metal ores and minerals is an important industry for Romania and occurs in many places in the mountains. Beside the environmental hazard of a toxic spill, surface mining definitely causes habitat destruction, more people access, wildlife disturbance and ugly scarring of landscapes. The recent controversial 'Rosia Montana' project for highly polluting gold mining in the Romanian Carpathians is a case in point (For more information see: www.rosiamontana.org).



Many fast and clean streams are part of the appeal of the Carpathians. Photo: Thilo Brunner.

Tourism

Romania has many historical, cultural and ecological treasures of great attraction to national and international tourists. Tourism intensity can vary on a scale, from green (eco-tourism), geological (e.g. speleology) and cultural tourism to mass tourism (e.g. winter sports). At present careful planning and regulation of tourist activities and facilities in relative harmony with the ecology of the Carpathians is underdeveloped in Romania. At present entrepreneurs are claiming natural areas to build facilities ranging from modest holiday chalets to massive hotels, and other attractions such as the proposed 'Dracula' theme park in the Bran area near Braşov. Foothills and mountain slopes are in danger of being turned into ski slopes, including areas bordering on or within national parks, such as Piatra Craiului (see Appendix 4). These facilities pave the way for mass tourism, which, when unregulated and disrespectful of the environment, can cause a high level of ecological degradation and disturbance, a scenario that has repeated itself in many places around the World. Instead, well-regulated and zoned green tourism with environmentally sound infrastructure and offerings can deliver important revenues to local communities and benefits for nature conservation.

Conclusion

The Romanian Carpathians, in spite of their apparent endangerment by increasing unbridled developments, still constitute an extraordinary reservoir of ecological and biodiversity values, not only for Romania and Europe, but for the World. However, without wise stewardship and the enforcement of environmental laws and international agreements, the history of other natural areas shows that little of the former ecology will persist in 50 years as cumulative impacts continue to exert their toll.

Hence, Romania needs to do even more than it has promised. It needs to embrace a positive vision of environmental protection starting with a much more generous allocation of protected areas, as the current protected areas system is not sufficient to withstand the tide of unplanned and unsustain-

able economic developments. Therefore, we urge the Romanian government to grasp what is going on and commit itself to the achievement of a Carpathian ecological network that is culturally, environmentally and economically beneficial.

There is no place in Europe with majestic forests teeming with wildlife like in the Romanian Carpathians. Source: ICAS Wildlife Unit.

The karst mountains with mixed forest and meadows of Piatra Craiului National Park with a view from Zărneşti, in Braşov County. At present tranquil meadows in the foothills as shown here in the foreground are increasingly desecrated by holiday houses and hotels. Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

3. BUILDING AN ECOLOGICAL NETWORK

In the previous section it became clear that much is at stake when many ecologically incompatible developments proceed to exert their full interactive and cumulative impacts on the Romanian Carpathians. This section describes the counteracting essentials of ecological network safeguarding by holistic design. It first of all briefly reviews the state-of-the-art of ecological network developments around the World, with some examples from Europe and North America. Relevant nature policy, legislation and conventions associated with ecological networks in Europe and specific to the Carpathians will be highlighted. Subsequently important processes on which an ecological network depends or by which it can fall apart are described. Some important principles from the sciences of landscape ecology and conservation ecology at the basis of an effective system of conservation areas are described. Finally we set important targets for an ecological network in the Romanian Carpathians.

3.1. Ecological network developments around the World

Ecological networks in Europe

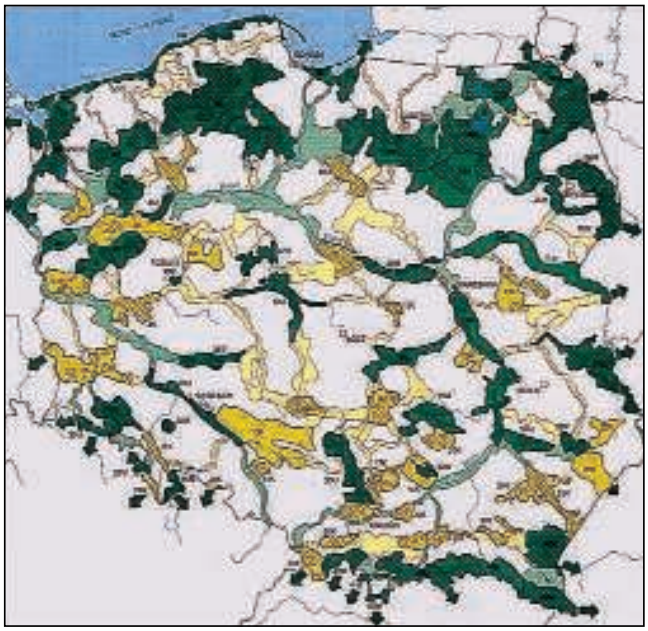
With the Convention on Biological Diversity as the major underlying driving force, several European countries are developing local, regional to (supra) national ecological networks. They are at different stages of development, are constructed on different scales and configurations, and achieved according to different scientific traditions, ecological values and environmental or land-use policies. A total of 42 ecological network initiatives currently exist across Europe. Many of these are regional and some countrywide. The urgency, necessity and protective status of ecological networks can differ among countries (Rientjes & Roumelioti 2003). Ecological network building depends highly on decisive integrated conservation planning, hand-in-hand with centralized and detailed land-use planning. Both government organizations and conservation NGO's (e.g. IUCN and WWF) are advocating the reconstruction or safeguarding of ecological networks. Thirty years ago the first European country to start rebuilding an interconnected system of nature reserves was Latvia, later followed by the Netherlands, Hungary and former Czechoslovakia. In 1995, not long after the emergence of modern landscape ecology, the Pan-European Biological and Landscape Diversity Strategy (PEBLDS, Council of Europe *et al.* 1996) paved the way for the achievement of a continental ecological network. This instrument, although not legally binding, committed 54 supporting countries (including Romania) to the development of ecological networks to be combined in the Pan-European Ecological Network (PEEN and EECONET) with an ambitious 10-year agenda. In magnitude and effectiveness of conservation, this programme goes beyond the legally binding Natura 2000 programme under the EU Habitat's Directive (see below), which does not require connectivity per se. Aims of PEEN are to ensure:

- the conservation of a full range of ecosystems, habitats, species and landscapes of European importance in national and regional ecological networks;
- the maintenance of habitats large enough to keep species in a favourable conservation status;
- sufficient opportunities for the dispersal and migration of species;
- that damaged parts of important ecosystems are restored;
- key environmental systems are buffered from external threats.

Furthermore, it envisaged that:

- a legal framework for PEEN will be developed;
- research into ecological networks is stimulated;
- cross-border cooperation is advanced;

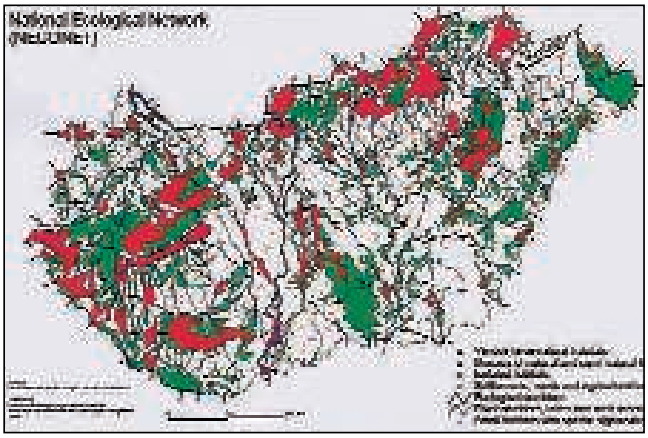
- awareness and appreciation of the concept of ecological networks is raised among the general public;
- and that the development of ecological networks proceeds top-down and bottom-up involving all key stakeholders equally.



The National ecological network of Latvia.

Since 1997 the development of PEEN, the science of ecological network design in Europe, is advocated by an intergovernmental Committee of Experts for the development of PEEN, commissioned by the Council of Europe and operated together with the European Centre of Nature Conservation (ECNC, Tilburg, The Netherlands). After almost ten years the goals of the PEBLDS have only partially been realized by several European countries. Hence there is still much to be completed by countries which have signed the strategy, including Romania. The aims of the strategy clearly set out the tasks to be achieved and are central to this study.

The National ecological network of the Netherlands.



The National ecological network of Hungary.

For further authoritative reviews on ecological networks in Europe see Jongman & Kristiansen (1998), Jongman *et al.* (2003), Rientjes & Roumelioti (2003), Bennet (2004), Jongman & Pungetti (2004). For progress in Central and Eastern Europe see Dyduch-Falniowska *et al.* (1998) and Nowicki (1998).

Natura 2000

Under Natura 2000 a constellation of Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), essentially strictly protected core areas, should be designated by each EU-state. Following from the Bern Convention the European Community has passed two Directives:

1. The Council Directive (79/409/EEC) on the Conservation of Wild Birds (the 'Birds Directive') and;
2. The Council Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora (the 'Habitats Directive').

The Birds Directive was adopted in 1979 and is aimed at long-term conservation and protection of all wild bird species within the European Union. It operates through two mechanisms. The first is that all native bird species are protected. The second is the designation of Special Protection Areas (SPAs) for birds with a special status (rare, threatened and migratory) as listed in Annex I of the Directive.

The Habitats Directive was passed in 1992. It is aimed at safeguarding biodiversity by protecting or restoring natural habitats and native plants and animals (other than birds) of EU interest at a desirable spatial or population level. To accomplish this goal each EU member state is required to protect endangered, rare/unique or particularly vulnerable habitat types (Annex I) and species (Annex II) through legislation and in Special Areas of Conservation (SACs) with all the essential ecological support factors, as set out in Article 4 of the Directive.

To define a representative amount of Annex II species of the Habitats Directive, including the wolf, Eurasian lynx and European brown bear in a network of SACs, the so-called 20-60% guidelines have been suggested. These guidelines can be interpreted to mean that when special habitats and species of a country are protected up to 60% of the current extent in biogeographical coverage or as population, sufficient representation is achieved. Below the lower limit of 20% representation is considered inadequate. A target within the 20-60% range is open to discussion. Although this is not a norm of the Habitat Directive, the guideline can initially be useful in defining preliminary conservation targets.

A shortcoming of Natura 2000 is that the constellation of SACs does not necessarily have to be coherent through ecological linkages as in a true ecological network. This poses a problem for isolated and immobile sub-populations of species within each SAC, which could face extinction if protected areas are not of appropriate size and habitat quality, and are embedded in a non-habitat to hostile matrix. In addition it does not provide clear guidelines on the reserve requirements for wide ranging species like large carnivores, notwithstanding species actions plans.

Carpathian Convention

The Carpathian Convention, or Framework Convention on the Protection and Sustainable Development of the Carpathians, which is serviced by the UN Environment Programme, is of particular relevance. Romania signed the Convention on 22 May 2003 in Kyiv, Ukraine. It pursues the protection of cultural, ecological and landscape qualities of the entire Carpathian Range through regional policy development. Of importance in connection with this study are Articles 4 and 5 of the Convention:

Article 4

Conservation and sustainable use of biological and landscape diversity

1. The Parties shall pursue policies aiming at conservation, sustainable use and restoration of biological and landscape diversity throughout the Carpathians. The Parties shall take appropriate

measures to ensure a high level of protection and sustainable use of natural and semi-natural habitats, their continuity and connectivity, and species of flora and fauna being characteristic to the Carpathians, in particular the protection of endangered species, endemic species and large carnivores.

2. The Parties shall promote adequate maintenance of semi-natural habitats, the restoration of degraded habitats, and support the development and implementation of relevant management plans.
3. The Parties shall pursue policies aiming at the prevention of the introduction of alien invasive species and release of genetically modified organisms threatening ecosystems, habitats or species, their control or eradication.
4. The Parties shall develop and/or promote compatible monitoring systems, coordinated regional inventories of species and habitats, coordinated scientific research and their networking.
5. The Parties shall cooperate in developing an ecological network in the Carpathians, as a constituent part of the Pan-European Ecological Network, in establishing and supporting a Carpathian Network of Protected Areas, as well as enhancing conservation and sustainable management in the areas outside of protected areas.
6. The Parties shall take appropriate measures to integrate the objective of conservation and sustainable use of biological and landscape diversity into sectoral policies, such as mountain agriculture, mountain forestry, river basin management, tourism, transport and energy, industry and mining activities.

Article 5

Spatial planning

1. The Parties shall pursue policies of spatial planning aimed at the protection and sustainable development of the Carpathians, which shall take into account the specific ecological and socio-economic conditions in the Carpathians and their mountain ecosystems and provide benefits to the local people.
2. The Parties shall aim at coordinating spatial planning in bordering areas, through developing transboundary and/or regional spatial planning policies and programmes, enhancing and supporting co-operation between relevant regional and local institutions.
3. In developing spatial planning policies and programmes, particular attention should, inter alia, be paid to:

a) trans-boundary transport, energy and telecommunications infrastructure and services;
b) conservation and sustainable use of natural resources;
c) coherent town and country planning in border areas;
d) preventing the cross-border impact of pollution;
e) integrated land use planning and environmental impact assessments.

Appendix 6 provides maps of a constellation of important conservation areas for the Carpathians as proposed under the Carpathian Convention.

The Wildlands Project – safeguarding and restoring huge and connected wilderness areas along the Rocky Mountains in North America.

Other initiatives in Europe

Complementary to the Pan-European Ecological Network strategy there are also other important ecological network or nature reserve constellation programmes in operation, namely the MAB Biosphere Reserves Programme (UNESCO), EMERALD (Network of Areas of Special Conservation Interest under the Bern Convention), The Carpathian Ecoregion Initiative (World Wildlife Fund), Important Bird Areas (IBAs; BirdLife International) and the protection of internationally important wetlands under the Ramsar Convention.

The Wildlands Project of North America

The primary goal of The Wildlands Project is to draft and then implement an alternative land use plan or conservation blueprint for North America. This vision is distinctive because it is bold, hopeful, scientifically credible and achievable. Proponents of the plan embrace 'rewilding' through protection and restoration/rehabilitation of native species and ecosystems within regional reserve networks, with the least amount of human interference possible (Soulé & Terborgh 1999). For a wildlands network to be functional, keystone species and crucial ecosystem dynamics are essential. Large carnivores and other highly interactive species (Soulé *et al.* 2003; Ray *et al.* 2005) are regarded as vital components in this system, because they maintain landscape and biological diversity through their actions. Only in this system can many true wilderness species find adequate refuge from the human dominated world, can natural evolution take its course and recruitment be safeguarded. This vision is currently being realized through the Southern Rockies Wildlands Network Design. This is an ecoregion-based programme that has inspired the current project.

Similarities between the Southern Rockies and the Romanian Carpathians are evident. Wolves, brown (grizzly) bears and lynx are native to both regions, although these top carnivores were extirpated in the Southern Rockies during the 20th Century. Recently, however, lynx have been reintroduced in the Southern Rockies, wolves are beginning to return and there is a campaign underway to promote the repatriation of the grizzly bear. The forest habitats of both regions have many species in common. A major difference is that humans have played a much greater role in shaping nature and its interdependencies in Romania than in North America. Currently, the Wildlands Project is focussing on the implementation of the ecological network visions.

3.2. Habitat loss and extinction risk

Habitat loss is the process whereby large natural habitats are increasingly fragmented into distant insular patches of variable ecological quality and are subsequently further degraded by various impacting external factors that normally have much less influence on large or robust natural areas. The trend is that more or less contiguous populations are increasingly subdivided into geographically distinct and often smaller subpopulations in a so-called meta-population, which can only 'communicate' (i.e. exchange genes) by way of dispersal. This process is chiefly driven by humans abruptly or gradually altering whole landscapes into predominantly non-habitat for ecological communities, interactively through factors like agricultural expansion and intensification, industrial forestry, (ex)urban sprawl and dissecting transport infrastructure. Habitat loss causes many knock-on effects. Habitats literally become islands in which only ecologically resilient species with a minimum of habitat requirements can survive or even flourish. More sensitive species persist only in habitat remnants with certain internal support factors. However, since habitat fragments have a high perimeter to area ratio they are often negatively subjected to various external influences and sub-

tractions, the so-called edge effects. Hence the extinction rate of many species can be high in fragmented habitats and recolonization of habitat fragments depends greatly on the mobility of the species from an adjacent patch and survivorship in the surrounds. Large-bodied and area demanding species and species requiring high internal habitat quality, such as large carnivores, are usually the first to disappear from fragmenting habitats (Soulé & Wilcox 1980; Andrewartha & Birch 1984; Soulé *et al.* 2003; Saunders *et al.* 1991; Hanski 1999).

Severely reduced populations can be subject to genetic drift and inbreeding depression, which diminishes population fitness through reduced genetic variability (Wang 2004 & 2005). Dwindling populations are particularly vulnerable to extinction caused by chance events such as disease, fire, poaching, pollution, competition or predation from exotic species and mismanagement. The persistence of isolated species populations in habitat fragments depends on:

- adaptability, rate of reproduction and survivorship or resilience against edge effects of the species in question. The greater the ability to reproduce and persist locally, the better the chances are for dispersal to other populations or vacant fragments;

Majestic wilderness and wild awe-inspiring animals like the wolf go to together. Romania stands before the great challenge of wisely preserving a country with great ecological and cultural assets versus turning it into dishevelled landscapes through short-term economics, mismanagement and unbridled development. Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

- the carrying capacity of the habitat fragment for the species in question. To illustrate, small and effectively isolated forest fragments cannot support a bear population, but can support a squirrel population;

- the distance separating habitat fragments with a sub-population. Short distances between sub-populations increase the chance of animal exchange and thus gene flow. The immigration of at least one individual from another population per generation is necessary to provide adequate gene flow (Wang 2004);

- the permeability of the dividing matrix. Even though the distance separating two habitat fragments may be small, the division may hamper the dispersal of a species because it contains too many hostile or obstructing factors or contains 100% non-habitat (Forman 1995). The permeability in the matrix for certain species can be enhanced with linear and/or step-stone natural landscape elements acting as refuges (e.g. hedges, pools, coppices).

Habitat fragmentation is widespread in the developed landscapes of Western Europe, but has only occurred on a large scale in the lowlands of Romania. Nature in the Carpathians, on the other hand, still exists in a robust and contiguous state and can remain so as long as habitat fragmentation, barriers and urban encroachment are curtailed. Habitat fragmentation and deterioration is highly undesirable for the Carpathians, where so many ecologically sensitive species reside.

3.3. Fundamental principles for effective ecological networks

Through a great deal of research and sharing of experiences, many leading conservation biologists world-wide agree on the need for large-scale (regional to continental) ecological networks (Soulé & Terborgh 1999b; Bennet 1999). In order to effectively preserve biological and landscape diversity and maintain important ecological services and dynamics, the following principles are fundamental:

- Species allowed to thrive and disperse in most of their native and natural ranges are much less vulnerable than species confined to small, isolated and ecologically degraded areas. This is particularly true for large wide-ranging animals and especially for large carnivores.

- Large natural habitats with large, ecologically effective, populations of key species are much more vigorous and sustainable than small blocks of habitat with small extinction prone populations. Compared to small fragmented habitats the internal habitat quality of large unfragmented habitats is usually superior and allows for important ecological processes, dynamics and states. Great size and naturalness is best.

- Highly connected habitats without intervening obstructions are much better sanctuaries for biodiversity than highly disconnected habitats; connectivity is best.

- (Semi-) natural habitat with least negative human interference or with ecologically compatible and stimulating human use is best.

- Nature reserves stewarded by dedicated individuals are better than those with minimal or no management capacity.

- Effective nature management and sustainable use of an ecological network requires professional collaboration and information sharing among all key stakeholders and should receive widespread public support.

- The more uncertainty there is in terms of present and future anthropogenic developments in areas around nature reserves, the more robust and coherent the ecological network should be.

- Ecosystems are often more complex than we realize, especially on a large scale. Management must therefore be adaptive and flexible to minimize the effects of unpredictable changes. Furthermore, maintenance of large natural ecosystems provides tremendous scope for scientific endeavours in learning about the natural world and its interactions with human society.

Safeguarding an ecological network in the Carpathians by allocating, partly restoring and preserving essential components (section 3.4) requires that we adhere to scientifically underpinned design principles derived mainly from modern conservation biology and landscape ecology. In general it is vital to minimize habitat fragmentation and deterioration and prevent mortality sink effects in the surrounds of reserves.

The safeguarding of a large scale ecological network in the Romanian Carpathians, with the exception of the traditional cultural dimension (see below), is analogous to the rewilding of the Rocky Mountains in North America, which is achieved according to the following three-track framework:

- Achieve representation of biogeographically distinct or unique habitat types (including special plant communities) and landscapes within a coherent network of core areas and with best human stewardship.

- Identify and protect representative populations of rare or endangered species and special diverse communities of species (biodiversity hotspots).

- Identify and protect essential habitat for populations of focal species that serve key facilitating and interactive roles in the natural dynamics and state maintenance of ecosystems and/or are highly indicative of ecosystem functionality or health. Focal species include umbrella, (cultural) keystone, foundation and sentinel species (Soulé *et al.* 2003 & 2005).

In section 3.4 we explain the essential components of an ecological network for a selection of important target species in the Carpathians.

3.4. Ecological network components

An ideal ecological network consists of a close-knit configuration of the following landscape components, as illustrated in the (eco)regional landscape model in figure 3.1.

Core areas

In today's drastically changing landscapes core areas ('cores') are protected, robust and resilient habitat refuges for 'healthy' populations of plants and animals with specific ecological requirements. Cores essentially function as reservoirs of species, producing surplus individuals that can effectively disperse to sustain subpopulations in an ecological network. The desired area and internal habitat quality of a core depends on the absolute requirements of the ecologically most demanding species in the ecological community and on the habitat suitability of the surrounding matrix.

Buffer zones

Buffer zones should insulate or shield cores against ecologically incompatible human activities in the surrounding non-habitat matrix and possibly against attraction into ecological sinks. Ecological sinks are areas in which animals perish to such degree that the population in the adjacent core becomes endangered. A buffer zone should be a transition from non-habitat to fully protected habitat. Only low impact and sustainable human activities are appropriate in buffer zones.

Ecological linkages

More or less continuous ecological linkages constitute sub-optimal to suitable habitat areas that facilitate safe and efficient animal dispersal between cores. The more disturbed the matrix is in a landscape, the more essential are robust and suitable habitat linkages. The ecological utility of linkages depends on both the setting and the species. Suitable linkages in the Carpathians can be forested mountain ridges, riparian forests and strips of abandoned lands or fallows with linear and patched forest and shrub zones. The dimension of a linkage depends on the intensity of human activities in the surrounds and on the habitat requirements and mobility of the target species. In the divides of the Carpathians there are still many semi-natural places that currently function as efficient ecological linkages, but they need to be safeguarded against edge-effects and barrier upheaval. To illustrate the linkage habitat needs for carnivores: forest confined marten, lynx and wild cat need virtually continuous forest cover, whereas the flexible wolf and fox often move confidently through open landscapes, as long as temporary refuges and safe passages are available and human disturbance is not too intense. To illustrate this for ungulates: red deer need more forested linkages than roe deer.

As a general rule, ecological linkages for large carnivores and large herbivores in the Carpathians should be broad, at least a kilometre wide but preferably broader, and unbroken (Simberloff & Cox 1987; Forman 1995; Bennet 1999). 'Robustness' becomes particularly important in areas where human activities from the surrounds are going to have the greatest impact. In these areas a linkage should withstand outside influences and provide adequate refuge, hence be buffered much like a core area (Yahner 1988; Paton 1994). It should be prevented that a linkage becomes a mortality sink or filter by drawing certain animals into lethal situations (Simberloff *et al.* 1992).

Ecological linkages can also be discontinuous as so-called 'stepping stones', in a matrix where developments are not too intense and linkage continuity is impossible. These are separate natural patches in a close linear arrangement, where animals can find temporary refuge when crossing the matrix. Examples of ecological step stones are wetlands (ponds or lakes) or forest patches. They function mainly for highly mobile animals like birds.

Ecological linkages can be kept continuous across barriers like major transport corridors by inserting mitigation structures or fauna passages (see Chapter 5).

Priority for the protection or development of ecological linkages should be those between core areas with important animal populations and in the most anthropogenically disturbed matrix or divides. Several potential ecological linkages for large carnivores and herbivores were surveyed in this study (Appendix 4).

Figure 3.2 summarizes the basic preconditions for an ecological network, explained in terms of best arranged and sized components versus undersized and badly configured components.

3.5 Reduction of barrier effects and landscape resistance

Landscape permeability for animals is hampered by anthropogenic structures and intensively used lands. Busy roads and railways present wildlife mortality sinks, disturbance and pollution sources and great barriers to animal dispersal (Forman *et al.* 2003). Traffic causes tremendous mortality of wild animals. In Slovenia for example, 30% of known brown bear deaths can be attributed to roads and railways (Kaczensky *et al.* 2003). The results of many studies into the ecological impacts of traffic in North America and Europe (see references) convincingly indicate that large carnivores and herbivores generally shy away from moderate to heavy traffic and are reduced in areas with a high road

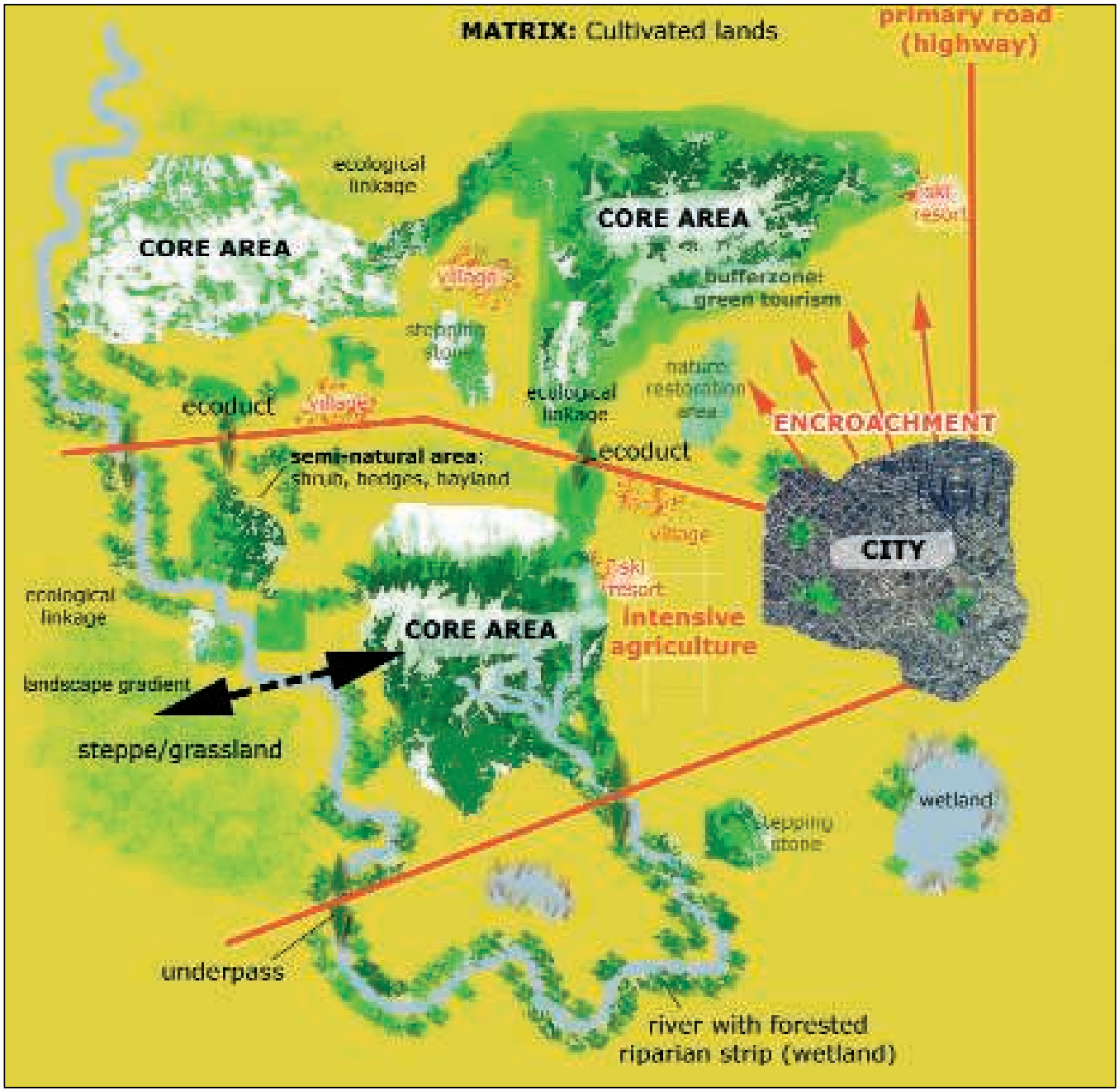
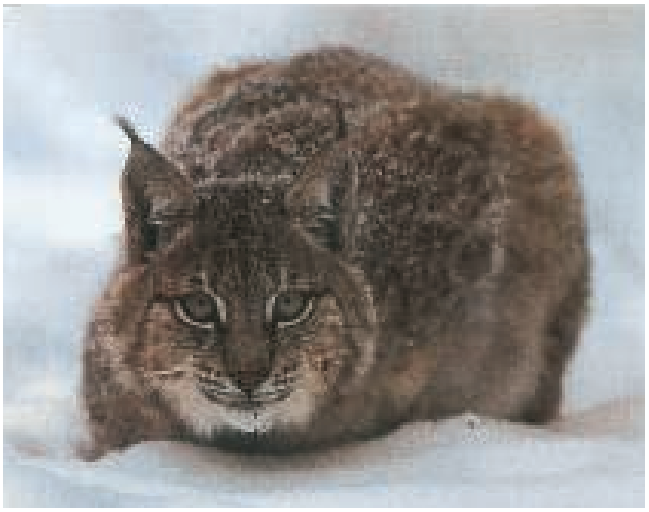


Figure 3.1
Regional landscape model illustrating the coherent configuration of an ecological network and impacting outside influences, based on the Carpathian situation. Sizeable natural cores are designated in a close-knit arrangement connected by robust ecological linkages and stepping stones in the non-habitat matrix. In this system habitats and dispersal routes for ecologically sensitive plants and animals are secured to maintain viable populations. Human activities within the ecological network should be ecologically sound and barriers should be prevented or mitigated. The network should be dimensioned according to the needs of wide-ranging animals like large carnivores and herbivores.

density. Female bears with cubs are especially reluctant to cross roads. On the other hand, bears may also be attracted to herb and berry rich verges of quiet roads and to grain spills on railways, drawing them into danger through collision with infrequently passing vehicles. Young dispersing male bears tend to cross roads more often and are thus most likely to be killed or injured as the available statistics show (Kaczensky *et al.* 2003).



The Eurasian Lynx is one of the most elusive, least known and most forest confined large carnivores in the Carpathians. It is sensitive to the loss and fragmentation of natural forest and falls easily victim to traffic. Source: ICAS Wildlife Unit.

The impacts of busy highways and less traffic intensive secondary roads are different. Highways are almost absolute barriers to wildlife, whereas secondary roads allow more wildlife to cross but can also produce more collisions between incautious animals and infrequent traffic. Even the relatively quiet country roads in the Romanian Carpathians take a toll on wildlife, including the most cunning of animals. During this study a wolf was killed by a car on a back road near Braşov. The busier country roads pose the greatest danger. For example in 2003, a bear was lethally injured by a truck on the intensifying road between Bucharest and Braşov, near Sinaia. On the same road stretch one morning in July 2005, a sub-adult bear was pacing on an elevated road verge, looking for a chance to cross. It decided that it was hopeless and retreated back into the forest. This was a clear example of the ecological barrier effect of high volume traffic roads. The deleterious effects of transport corridors can be minimized by applying various mitigation measures, which are urgent in the Carpathians in face of major transport infrastructure development.

Roads are mortality sinks for wildlife, even when traffic is not intense. This picture shows a dead wedge-tailed eagle along the Stuart Highway in Central Australia, which has infrequent vehicle passage. Eagles are killed in significant numbers along this road when scavenging on carcasses in times of food shortage, especially after the rabbit decimating callici virus was introduced some years ago. The impact of traffic kills on the eagle population is expected to be high, because the eagles only breed when they are mature at 3-5 years old. In Romania birds like the Ural owl are analogous. They frequently fall victim to traffic when hunting mice that often abound in grassy road verges (Calin Hodor, pers. com.). Photo: Erwin van Maanen.

INTERMEZZO

The lamb and the wolf

Pastoralism is an age-old traditional subsistence activity of rural peasant folk in Romania. In the past shepherds with large flocks of sheep and other livestock periodically moved pendulous long distances across the country, a journey known as transhumance. Elsewhere it is still practiced by other old human cultures dealing with extreme seasonal climate change of the mountainous regions of Southern and Central Europe, Middle East, South America, Asia Minor including the Caucasus, and Central Asia. The journeys of humans and cattle along so-called drove roads can cover hundreds of kilometres from summer pastures in the highlands to winter pastures in the lowlands.

Transhumant centres in Romania existed mainly in southern Transylvania and mostly in the counties of Sibiu, Brasov and Covasna (Mertens & Huband 2004). The winter pastures were situated in the lower south-eastern parts of the country and in the lowlands northeast of the Carpathians heading toward Moldavia. There is still some transhumance ongoing in Romania today, but its glory days are definitely over, as elsewhere in Europe. Traditional communal herding is now mainly constricted to the rotation of livestock between winter stables in valley villages and summer sub-alpine pastures. In the available five summer months cheese (brânzâ) and wool is produced in special shepherd camps called stâna. The grasslands on the lower slopes and in the valleys are then used for the growing of hay, hand harvested with the use of a scythe to serve as fodder for stabled livestock in winter.

Sheep grazing on a montane meadow in Piatra Craiului National park. Source: ICAS Wildlife Unit.

Recent socio-economic changes are forcing a slow but steady decline in shepherding in Romania, namely through:

- The new economy – Sheep herding is hard and even dangerous work and its tough business. With a modernising society and disappearing peasantry come more attractive and profitable jobs or business pursuits for young people, many of whom move to the big cities for a career and life much different from their parents. Moreover pastoralism, formerly a subsistence necessity, is becoming obsolete or unprofitable under the competitive demands of world trade, forcing many farmers to take up another trade or to modernise farming.

- A changing market - EU standards for animal husbandry and dairy product hygiene, and palatability to the western taste, make the traditional style salty cheese very difficult to market. There is a need for alternatives that cater for the taste of western European consumers, such as special subtle cheeses, yoghurts and other culinary dairy products, now increasingly being imported.

- New legislation on land ownership – This has reduced available grazing areas.

In places where grazing is increasingly restricted by new land owners, shepherds and greater combined livestock herds are forced more often onto smaller areas, in contrast to the days of communism when the land was everybody's. Overgrazing can in certain cases be detrimental to the natural vegetation and eventually lead to soil erosion. Botanically rich grasslands on limy soils are particularly sensitive.

Traditional making of cheese or brânză by a shepherd. Photo: Erwin van Maanen.

The significance of widespread traditional and sustainable livestock herding and haying for maintaining Carpathian biodiversity is not well understood but it almost certainly plays an important role, as does the extensive forestry. The resulting landscape mosaics of productive meadows and forests offer an incredible range of opportunities for plants and wildlife. There are few places in Europe where the spontaneous vegetation is as overwhelming as in the botanically rich meadows and forest fringes of the Carpathians, and the amount of animals that can be encountered there and in the forests is phenomenal. Livestock probably subsidizes large carnivores to a considerable extent, although the importance of this relative to wild prey is unknown. More likely the sustained protein-rich meadows serve carnivores like the wild cat, lynx and wolf through the sustenance of great numbers of wild herbivores and the brown bear directly. It is therefore not exactly clear if and how a decline in extensive livestock herding will affect large carnivore densities. If there is a dependency then it could mean that without active management or natural alternatives the resulting succession to woodland can cause the decline of wild large herbivores, followed by a decrease in large carnivores so that greater nature reserves may be needed to conserve their original population sizes. Holistic research is needed to clarify this issue.

Traditional shepherd camp (stâna) in Piatra Craiului National Park. Photo: Erwin van Maanen.

In Europe these measures are promoted and advanced through the programme of European Co-operation in the Field of Scientific and Technical Research (COST Action 341), in which Romania also participates. Special handbooks have been produced that are recommended to Romanian ecologists, planners and engineers (Luell *et al.* 2003; Van Bohemen 2005). Chapter 5 provides a further prioritising view on mitigation measures for transport infrastructure in the Carpathians.

3.6. Target species for the Romanian Carpathian ecological network

In realizing an ecological network it is necessary to have it based on certain target organisms, especially key species which through their population ecology and high habitat quality demands cover a high portion of the regional biodiversity. Important are ecological "keystone" and "foundation" species. Keystone species are organisms which despite their relatively low population density or biomass fulfil a disproportionate role in maintaining certain ecosystem processes and states (Paine 1966; Mills *et al.* 1993; Ray *et al.* 2005) and in driving evolution. Foundation species on the other hand are relatively abundant species that provide essential resources for other species (e.g. old oak trees). Keystone species are also known as highly 'interactive' species' and their abundance is indicative of ecosystem 'health' (Terborgh *et al.* 1999; Miller *et al.* 2001). Often they are long-lived and slow reproducing species, making them especially sensitive to environmental change and exploitation by humans.

Portrait of a wolf, apex predator of the Carpathians. Photo: Erwin van Maanen.

The wolf is regarded as a prime keystone species (Ray *et al.* 2005). Although the removal of wolves from an ecosystem does not necessarily lead to a complete collapse of an ecosystem, it can cause drastic measurable knock-on effects. Within their large territories wolf packs shift or spread the foraging by ungulates and thus prevent overgrazing of local vegetation. This phenomenon has been almost conclusively demonstrated in the United States, after wolves returned to wilderness areas that were overpopulated with elk or wapiti (Ray *et al.* 2005). Wolves reduced the wapiti herd and keep it in check. Browsing now occurs in small herds over a wider area, allowing the effective regeneration and diversification of herbs and trees.

Not only do wolves exert an ecosystem maintaining and diversifying pressure on ungulates, but they also 'down-regulate' other carnivores like for example lynx, jackal and red fox, which in turn keep smaller counterparts in check. This is an important ecological process, as the regulation of smaller and faster producing carnivores benefits the survival of a variety of rarer birds and small mammals. It can also be described as the prevention of 'meso-predator release'. Down-regulation of carnivores by the wolf in Romania can be exemplified by the relationship between the wolf and golden jackal (*Canis aureus*). In the lowlands of Romania, where the wolf is practically absent,

golden jackals are expanding. But jackals are practically non-existent in and on the fringes of the forested Carpathians, where wolves occur. In the south-eastern steppes of Georgia (Caucasus) jackals co-exist with the wolf, but in much lower densities than in wolf-devoid areas (comm. NACRES). The same relationship exists between the wolf and the coyote in North America. Wolves are also believed to keep a check on the number of lynx within their territory. In turn lynx regulates wild cats.

In general down-regulation occurs widely among organisms and contributes significantly to delicate balances within the foodchain by preventing over-exploitation by organisms occupying lower trophic levels (Terborgh *et al.* 2001; Ray *et al.* 2005). The process is considered vitally important for the maintenance of biological and landscape diversity (Soulé *et al.* 2005). In the Romanian Carpathians wolves almost certainly fulfil a crucial role in the succession to climax forests with a diversity of

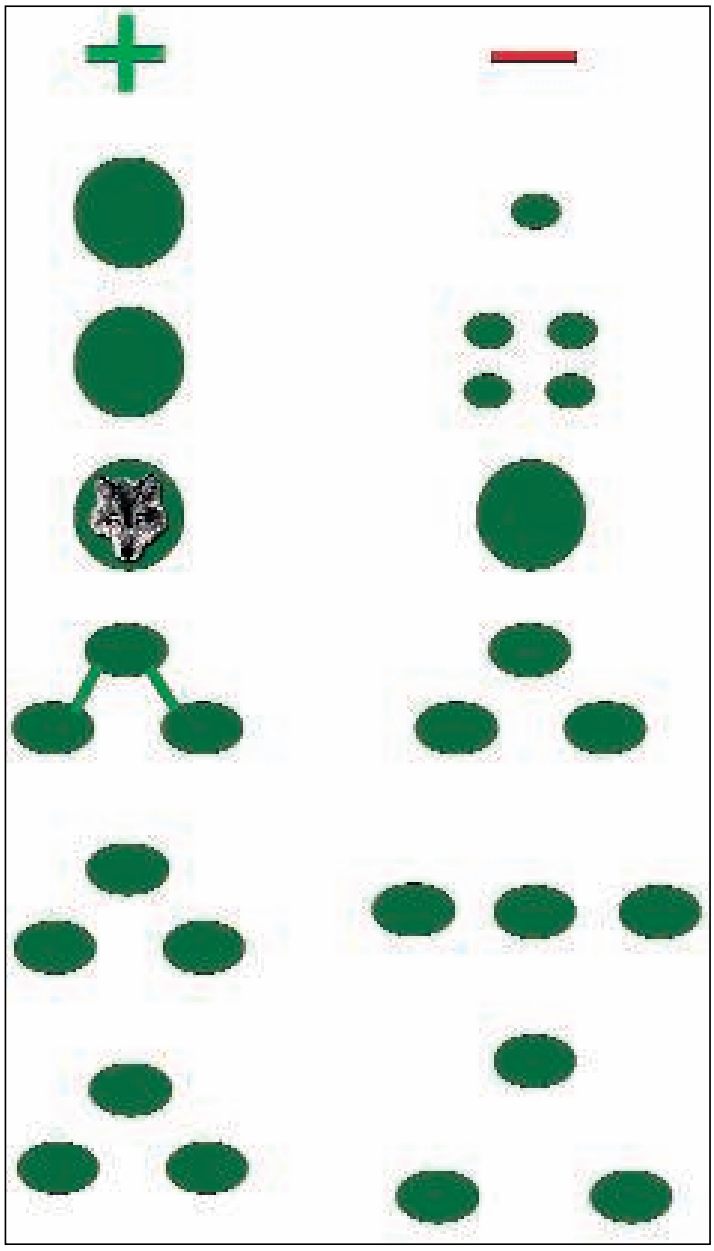


Figure 3.2
A model of good (+) and bad (-) ecological network design dimensions and configurations initially proposed by Diamond (1975). Functional ecological networks are composed of large, coherent, well-arranged and preferably buffered natural areas, based on keystone and other ecologically demanding and interactive organisms, like the wolf. Only such networks are able to support stable and ecologically effective populations of diverse organisms. Largely unsuitable are isolated or incoherent small habitat patches in non-habitat to hostile matrix. Such networks can only support the least ecologically demanding and most productive organisms with a certain mobility and affinity for drastic human altered landscapes.

plants and animals and this role can only be effective when sizeable stable wolf populations are maintained in large and highly natural cores, with plenty of wild ungulates available as prey.

Not all of the three large carnivores are truly keystone species. The mainly vegetarian brown bear, for instance, does not exert as much down regulation as the wolf. The brown bear is more important as an umbrella species, because it demands large natural and productive forests, which serves many smaller forest animals and plants.

Once fully reintroduced the lowland European bison (Bison bonasus) will make a welcome addition to the Carpathian biodiversity and complete the army of much needed natural herbivores. Source: Razvan Deju.

Other native animals of key ecological and indicative importance to the Romanian Carpathians include especially: beaver, otter, alpine marmot, European bison, red deer, chamois, Ural owl, white-backed woodpecker, capercaillie, griffon vulture, bearded vulture, golden eagle and the lesser-spotted eagle. Several of these animals should be reintroduced or better protected in Romania and all require large natural forest, riverine and/or grassland habitats. Most are protected by realizing the RCEN based on the large carnivores. The beaver and otter can be regarded as

Seemingly insignificant, the reintroduced alpine marmot (Marmota marmota) is key to the maintenance of alpine meadows in the Carpathians and an important food source for mammalian and avian carnivores, thus an example of a foundation species. Source: Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

keystone species and are highly indicative of unpolluted streams and rivers accompanied by healthy riparian forests. The lowland European bison is yet to be reintroduced outside of a few small reserves like Vânãtori-Neamt. One day free ranging this animal will complete the wildness of the Carpathians, adding a vital archetypal herbivore which can take over the grazing and browsing role of roaming domestic cattle on the lower meadows. The complete set of wild herbivores is crucial for the diversification in vegetation structure and configuration (e.g. see Vera 1997), each herbivore with a different grazing or browsing action and plant preference. Other indicator species include the Ural owl. This impressive owl prefers older forests interspersed with natural glades (Lõhmus 2003) and with a high availability of trees with wide cracks, large hollows and other suitable nesting sites, such as deserted raptor nests. Matured and highly natural forest is also favoured by several species of woodpecker, the capercaillie and small to mid-sized mammals like the squirrel and pine marten. The lesser-spotted eagle is a bird highly reliant on the unspoiled stream valleys and wetlands surrounded by natural forests.

The lammergeyer or bearded vulture (Gypaetus barbatus) once played a key role in the alpine ecosystem of the Romanian Carpathians. Nowadays it is extinct in Romania, mainly the result of persecution and poisoning campaigns against large carnivores in the early 20th century.
Together with the griffon vulture, the bearded vulture is a candidate for re-introduction so that it may once again enrich the Carpathians, provided traditional grazing systems for the supply of carcasses are maintained.
Photo courtesy of Alexander Gavasheleshvili, Georgian Centre for Conservation of Wildlife (GCCW).

There are more special ecological values waiting to return to the Romanian Carpathians and complete the wilderness appeal. Although not so appealing to many Carpathian folk, vultures like the griffon vulture and bearded vulture contribute highly to the health (indication) of montane and alpine ecosystems and to the attraction of western nature lovers. The bearded vulture in Romania became extinct in 1937. Last known pairs existed in the Retezat and Făgăraş Mountains. The griffon vulture persisted longer, until well after the Second World War. Poisoning campaigns, especially against large carnivores, led to the demise of these magnificent soaring birds.

Beside human goodwill and availability of undisturbed nest sites on mountain cliffs and in gorges, these birds rely heavily on a steady supply of carcasses. Re-introduction of both birds is presently being investigated (Annette Mertens, pers. com.). However, successful re-introduction depends highly on large and widely roaming herds of domestic and natural herbivores for an adequate carcass supply, made uncertain by the current decrease in pastoralism. Should these birds return, then the wolf is again crucial as one of the great providers of carcasses.

The red deer (Cervus elaphus) is a key browsing herbivore in the Carpathian ecosystem and a vital food source for top predators like the wolf.
Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

INTERMEZZO

The value of species-rich fen meadows

Ab Grootjans

Fen meadows are botanically rich. Here specimens of lousewort (Pedicularis sceptrum-carolinum) at Belianske lúky in the Slovak Republic. Photo: J. Ripka.

Fen meadows are amongst the most biodiverse temperate plant community types in Europe. This is due to low nutrient conditions of their soil, which are sustained by a periodic supply of high rising calcareous groundwater. Romania also harbours this special and nowadays scarce type of wetland, particularly in some of the mountain valleys. It presents an example of a separate and sensitive ecosystem that may not necessarily be protected under the umbrella of large carnivore reserves in the montane forests and requires special attention like other special and detached habitat types such as steppes.

In most of Europe fen meadows and mires are threatened by agricultural intensification, abandonment of traditional mowing and urban development. This resulted in their constriction, fragmentation and desiccation, which also affects organisms highly dependent on them, like certain butterfly species. Such impacts have occurred to a great extent in Western Europe and in North America. For instance in the United Kingdom an estimated 95-98% of the fen meadows from before 1940 have now gone. Similar figures come from France and the Netherlands.

Groundwater abstraction in the surrounds contributes greatly to the demise of fen meadows. Loss of groundwater recharge causes desiccation and loss of revitalising and acid neutralizing minerals. Inundation by streams and rivers is important as well, and loss of it, for example as a result of stream modification or normalisation, can negatively affect seed dispersal. Water quality is also crucial. Frequently inundating surface water highly enriched with nitrogen and phosphorus can easily cause the eutrophication of fen meadows, paving the way for dominance of highly competitive tall sedges and grasses. Nutrient imbalance can also be caused by changes in land-use in the surrounds, for instance changes in forestry on adjacent slopes.

In Eastern Europe traditional haying, grazing and coppicing is gradually disappearing. This results in many places in vegetation succession, with shrubs, tall sedges and grasses moving in first to displace the less competitive small sedges and herbs, particularly in desiccating areas.

The dramatic loss of fen meadows and mires in Eastern Europe can be exemplified as follows. Mires in Slovakia once covered 260 km^2, about 0.57% of the country. At present only 25.8 km^2 of peatlands (less than 10% of the former area) remain (Stanová 2000). Calcareous fens are among the most threatened wetlands. Prior to major drainage schemes, the largest of these fens in Slovakia were found in lowland Western Slovakia,

with a total area of 4506 hectares. Most fens in that region are now drained and converted into arable land. Ecologically meaningful calcareous fens are now almost entirely restricted to refuges in the Carpathian Mountains.

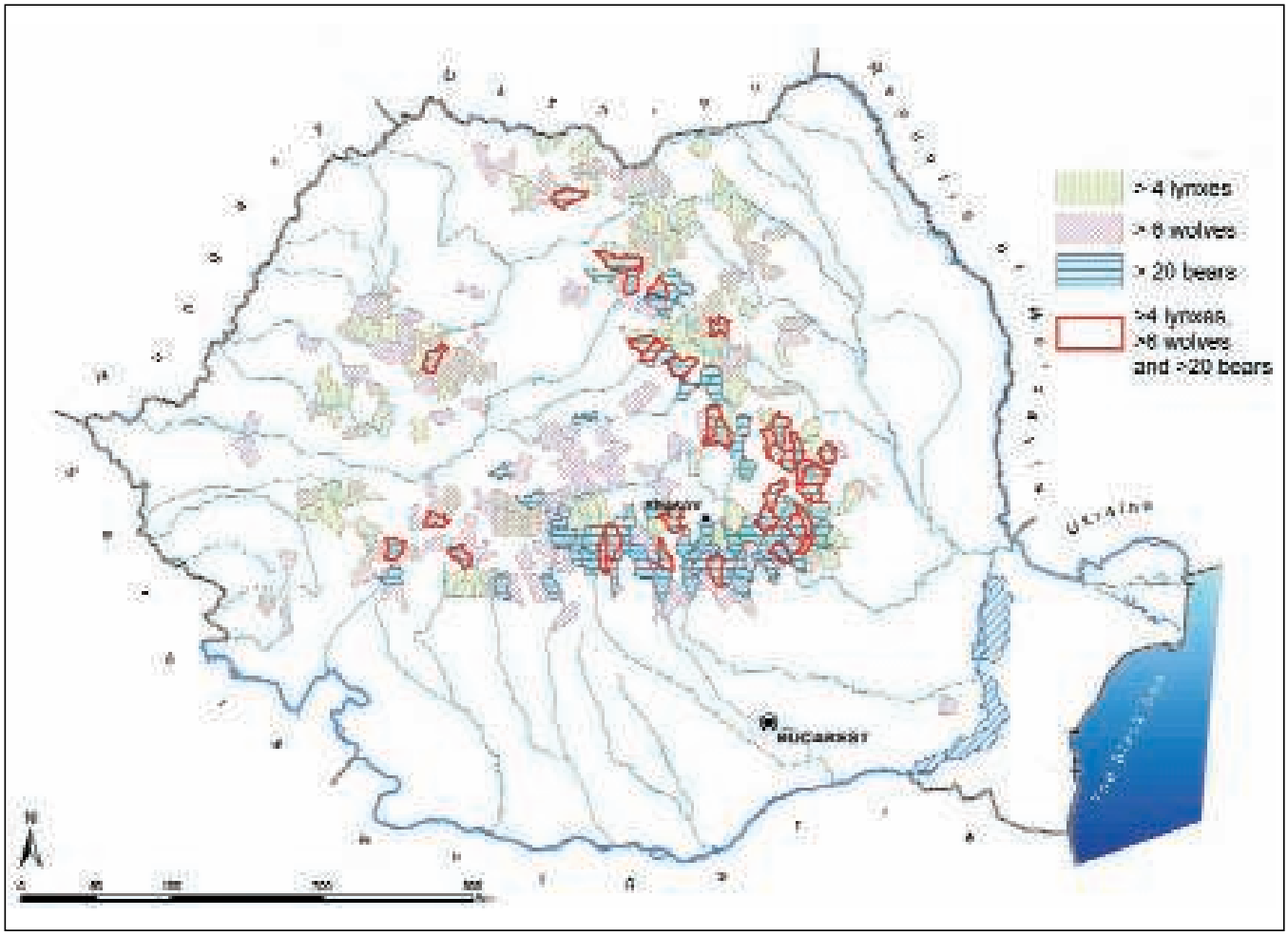
In Western Europe fen meadow restoration projects are ongoing since the 1980s. The restoration need is driven by the increasing appreciation of society for natural landscapes, not only because of the ecological values and services they provide, but also for their scenic value, attracting green tourists which provide income to local communities. Restoration and conservation is therefore facilitated by volunteers, private nature management organizations and local governments. Restoration has started from different states, ranging from abandoned or neglected meadows that were not fertilized or drained, to intensive agricultural lands with high fertilization and drainage. In general the most successful projects are those starting from lands that were least intensively used and thus closest to the natural state. These may still harbour persisting species and a viable seed bank, from which the original vegetation can re-establish itself to a certain degree. The soils of production grasslands are usually saturated with immobile phosphates, which will only frustrate vegetation recovery. Degraded (oxidized) peatland is often also highly eutrophic and an unsuitable basis for restoration. In such states a dominance of disturbance indicators such as common rush (Juncus effusus) can persist for many decades. Restoration can only be achieved if drastic measures such as the removal of degraded topsoil and reinstallment of the original hydrology are taken, with subsequent long-term regular mowing and removal of biomass.

Since fen meadow, mires and other wetlands in Eastern Europe (including the Carpathians) hold scenic landscapes and great ecological values and services, their conservation as sensitive habitat types is of paramount importance. Their loss is almost always permanent and any restoration that can be achieved very costly.

A fen meadow in Harghita county, Romania. Fen meadows and mires often accompany streams in valleys fed by seeping base-enriched (calcareous) groundwater from the elevated surrounds. These biodiverse and highly aesthetic grasslands are used and maintained traditionally as hay lands. They exist only in a few places of the Romanian Carpathians. In Europe they are rare. Although the supply of groundwater from the surrounding hills or mountains is fairly reliable, fen meadows in Romania are vulnerable to urbanization, the abandonment of traditional haying and extensive grazing, changes in forestry and stream pollution. Photo: Erwin van Maanen.

The beaver (Castor fiber) has recently been reintroduced to several rivers along the Carpathians. It diversifies riparian forests, for instance creating distinct ponds or wetlands by dam building.
Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

Figure 3.3
Hotspots for brown bear, wolf and lynx in the Romanian Carpathians in 2003, expressed as density per hunting unit with an average area of 250 km². Source: Romanian Ministry of Agriculture, Forestry and Rural Development.



Not to forget the small critters of conservation importance, including insects that fulfil key ecological roles like pollination and organic decomposition. Symbolic and highly indicative of forest quality is the wood decomposing stag beetle (*Lucanus cervus*), an insect of stature that is still abundant in many of Romania's older deciduous forests with many oaks. Again this is one of the special ecological values of the Carpathians as the stag beetle is endangered in the many impoverished forests of Western Europe. The Carpathians are also very rich in butterfly and dragonfly species, which are still being catalogued.

In the RCEN based on stable large carnivore and wild herbivore subpopulations, all of the species described above and others are expected to be insured as well. However, there are also natural areas of landscape, ornithological, herpetological, entomological and botanical importance, such as wetlands and steppe, which are separate from areas with the main target species. These areas should be delineated and included in the ecological network on their own merit, thus achieving the highest biodiversity representation possible.

3.7. An ecological network for large carnivores

In terms of important conservation targets for Europe carnivores rank high on the ladder. They require large quality ecosystems, as do their prey. They are therefore guiding in defining the dimensions and habitat quality for the RCEN. As the occurrence of all three large carnivore species (wolf, bear and lynx) in the Romanian Carpathians is widespread, but in many places concentrated (hotspots; figure 3.3), considerable range is required to effectively protect a certain large portion of the current populations. Here we will estimate the minimal core area size for an effective subpopulation of large carnivores, based on their known ecology in Romania (see Appendix 1).

Minimal viable populations are not set and one should always strive to protect the largest natural core areas in as large a coherent network as possible.

Core area requirements for the maintenance of sizeable carnivore subpopulations

All three large carnivore species profiled in Appendix 1 require large home ranges, as do most large carnivores. However the densities of these large carnivores across their biogeographical range can differ greatly, depending primarily on habitat productivity (hence prey availability) and other resource availability of the ecosystem in question and on human support or tolerance or conversely persecution. In the temperate forests of Romania unusually high densities of all three large carnivores, and especially bear, are attained through a complex interaction of ecological and anthropogenic factors. One of the anthropogenic factors is active hunting management aimed at a surplus of animals for harvest. In far northern regions with less productive boreal ecosystems the densities of large carnivore are much lower than in temperate Europe. Therefore the carnivore ecology of these northern regions is not very useful in determining ecological network requirements for large carnivores in Europe.

The carrying capacity of a core area for large carnivores is determined by how many reproductive units of each species it can comfortably support. The higher the carrying capacity of a core area, a function of available space and resources, the more reproductive units can be supported and the more vigorous will be the (sub)population in the absence of human interference. A reproductive unit for an average large carnivore consists of a dominant male and one or several females with juveniles and perhaps some temporarily tolerated sub-adults staging the search for their own territory. Territory size and intraspecific tolerance is generally deter-

The wild cat (Felis sylvestris) is relatively common in the Romanian forests wherever there aren't too many lynx. Source: Sergiu Mihut.

mined by food availability and accessibility. The home range of the dominant large carnivore male, which is usually several orders of magnitude greater than that of the female, determines the actual required territory. In the current ecological conditions of the Romanian Carpathians the standard home range for a reproductive unit or family of lynx, bear or wolf can be set at 200 km^2 per species, which is nearly equal to the average size of a hunting unit and a little more than the known average home range sizes. On top of an established reproducing population one must also cater for conflict free space for dispersing animals in search of their own territories, the so-called 'floaters'.

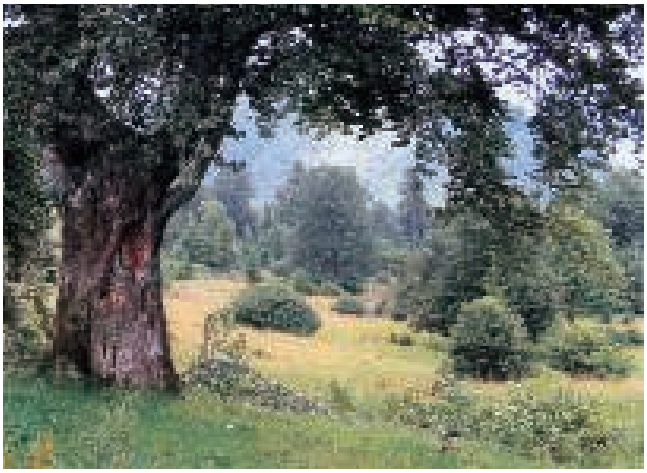
It is actually unreliable to determine how many reproductive units are minimally needed to sustain a healthy, stable and normally reproducing population. Population viability depends highly on the ecological setting and effective animal exchange between subpopulations within an ecological network (meta-population). Subpopulations in completely isolated core areas are likely to go extinct within a century, unable to maintain genetic vigour and to recover from population loss, although there are remarkable exceptions. Dispersal from birth place to new territory is not only necessary for gene flow and biogeographical range maintenance or expansion, but also provides stability to carnivore populations, especially by preventing intraspecific conflicts that can lead to cannibalism (infanticide), or to nuisance animals in conflict with humans. Established large carnivore males are fiercely intolerable of young males that have left maternal care, which need to journey in search of their own territory. There are also interspecific conflicts. For instance, wolves are highly intolerant of lynx. In Romania it is therefore important to designate and maintain the largest possible core areas to insure stable or harmonious large carnivore communities. A sufficient carrying capacity for sizeable populations of all three large carnivores must be installed, also with respect to future uncertainty about the continuance of traditional anthropogenic factors currently supporting high densities of carnivores and ungulates. In habitat areas that are too small and with insufficient carrying capacity, the incidence of intraspecific and interspecific conflict can be high, possibly resulting in a high rate of mortality, disease and infanticide. Animals chased out of small and isolated habitat areas are likely to run into trouble with human interests and can perish through starvation, persecution, traffic collision or other mortality factors.

We propose that the size of a core area should be based on at least least five reproductive units of each large carnivore species, thus a total of 15 large carnivore families. A reproductive unit for bear and lynx consists of a dominant male and at most four females, and four transient sub-adults (floaters). For the wolf a reproductive unit consists of an averaged size pack of seven individuals and at most four transients.

As we also need to account for competition between the three carnivore species, we arbitrarily add 500 km² as avoidance space, to be on the safe side. Required carnivore home range (200 km² per reproductive unit) is based on averaging the spacing known for the three large carnivores in temperate and productive montane forests of Europe and Romania (see profiles in Appendix 1). Hence a core area should at least have an area of 3500 km² of suitable habitat to likely support a stable subpopulation of each carnivore (i.e. at least fifteen large carnivore families). This is about 14 combined hunting units. The Romanian Carpathians (66,303 km²) under ideal conditions can maximally fit in about ten of these core areas, taking into account unsuitable alpine zones and human settlements. Preferably greater core areas should be designated to support larger and ecologically effective populations if land-use economics allows it; in the order of 5000 – 10,000 km². At least one, but preferably many more animals per generation should be able to cross between two subpopulations to prevent genetic erosion and too small populations vulnerable to stochastic events (e.g. poaching sprees, fire, disease, mismanagement) (Mills & Allendorf 1996; Wang 2004). The lynx and bear, both highly dependent on forest and much less inclined to traverse long non-habitat divides than the adaptable and mobile wolf, need particular attention in this respect. Hence the habitat requirements for these two carnivores are guiding for the internal natural quality of the ecological network.

Habitat quality

Besides sufficient space all three large carnivore species in Romania, but especially the lynx and bear, require semi-natural forests as sanctuary. The highest quality habitat is offered by large tracts of extensively used older forest with a high percentage of broad-leaved trees. These forests produce a steady abundance of vegetable forage (shoots, roots, nuts, fruits and berries) for bears and prey for all three predators. The forests should be interspersed with small semi-natural grasslands that are extensively grazed by livestock or a variety of natural herbivores in a landscape mosaic. Human activity inside core areas and ecological linkages should be confined to hiking trails and camp sites. Forestry inside the core area is allowed as long as it is ecologically sound and caters for wildlife by restoring exploited patches, through continuance of the traditional forestry and forest stewardship. Access roads should be kept to the current minimum.



Wildlife in the Carpathians profits highly from a mosaic of great patches of structured montane broad-leaved forests in combination with fringes of shrub and semi-natural grasslands. The interactions between large carnivores and herbivores are key to the continuation of these attractive landscapes. Photo: Erwin van Maanen.

Conclusion

Two guidelines for an effective ecological network for large carnivores and herbivores are derived:

- The greater the size and habitat quality of linked core areas, the greater the availability of prey and other resources (e.g. dens, mates, hiding places) and hence presumably sufficient carrying capacity for a stable large carnivore (sub)population.

We recommend the safeguarding of huge wilderness cores with highly productive natural ecosystems set in a mosaic of montane forest and grasslands. A wilderness core should be at least 3500 km^2. Preferably wilderness cores should be much larger, in the order of 5000 – 10,000 km^2, to insure greater and more robust subpopulations able to stand the test of time and resistant against developments outside.

- Core areas should be as close to each other as possible and connected by robust ecological linkages of high habitat quality within an ecological network, allowing effective exchange of animals between subpopulations. The greater the connectivity between core areas the smaller the likelihood animals will perish in mortality sinks and the greater dispersal success will be. Dispersal and gene flow is vital for the genetic replenishment and stability of animal populations.

Having provided indicative minimal core area sizes the next section will examine the adequacy of the current system of protected areas and present a Carpathian ecological network vision map, based on the above guidelines, modelling and known distribution of ecological values.

Traditional livestock herding is believed to be a crucial factor for the maintenance of montane forest and grassland mosaics as support for wildlife in the Carpathians, but is also a source of conflict between humans and large carnivores.
Photo: Erwin van Maanen.

Papilio machaon.
Special sites not containing large carnivores, but with unique ecological communities also deserve conservation within the Romanian Carpathian ecological network, such as prime areas for birds, reptiles, amphibians, insects and plants. Photo: Erwin van Maanen.

4. CARPATHIAN ECOLOGICAL NETWORK VISION MAP GENERAL

4.1. General

The central objective of the Vision Plan is to arrive at a blueprint for an ecologically effective and coherent Romanian Carpathian ecological network. It provides the geographical framework for further delineation of conservation areas for landscape and biodiversity values, with large carnivores as guiding umbrella species. Further detailing is a process that depends on land-use planning and proper biodiversity inventory. Here we present the essential delineation of the network based on:

- The ecological network design principles and guidelines described in the previous chapter;
- best available information from landscape and biological diversity inventories and ecological monitoring in Romania, as provided by experts, and;
- an objective spatial model coupled to a Geographical Information System (GIS).

The Vision Map also reveals the inadequacy of the current Romanian protected areas system for the ecologically effective protection of large carnivores and the sensitivities of the Carpathian natural landscapes and biodiversity to current and future developments.

Before presenting the Vision Map, a general description of the modelling used in this study is provided, described in more detail in Appendix 3.

4.2. Modelling of the ecological network

Due to their inherent complex relationships and features (land-use, geology, ecology, hydrology, etc.) landscapes are difficult to analyse without the use of computerized tools like GIS (figure 4.1). With enough data at hand GIS coupled with spatial models can be used to project future anthropogenic developments and their impacts on biodiversity and landscapes. Subsequently, with knowledge of the conservation ecology of species the delineation of essential conservation areas can also be determined and 'fitted' into the human dominated matrix.

Objective computer modelling was used to determine the dimension of an ecological network able to durably withstand anthropogenic developments in the surrounds and to insure the effective conservation of biodiversity under the umbrella of large carnivores. The modelling is based on the current CORINE Land Cover database for Romania (Appendix 3, figure A3.1). The tools used to obtain an objective delineation of the network, which is most ecologically effective and economic, are a model called Marxan and Arc-GIS cost-distance analysis.

The first steps of Marxan revealed the spatial limitation of large carnivores in Romania exerted by disturbing land features and non-habitat such as transport infrastructure, urban areas and rural settlements and intensive agriculture (figure 4.2). The model then delineates suitable cores for large carnivores in the ecologically most effective arrangement, much according to Diamonds model in figure 3.2, to sustain a certain chosen percentage of the current large carnivore populations (target percentage). Since the Carpathians still consist of large consolidated natural areas only interrupted by scattered human settlements, the model can present several possible reserve constellations using different conservation targets.

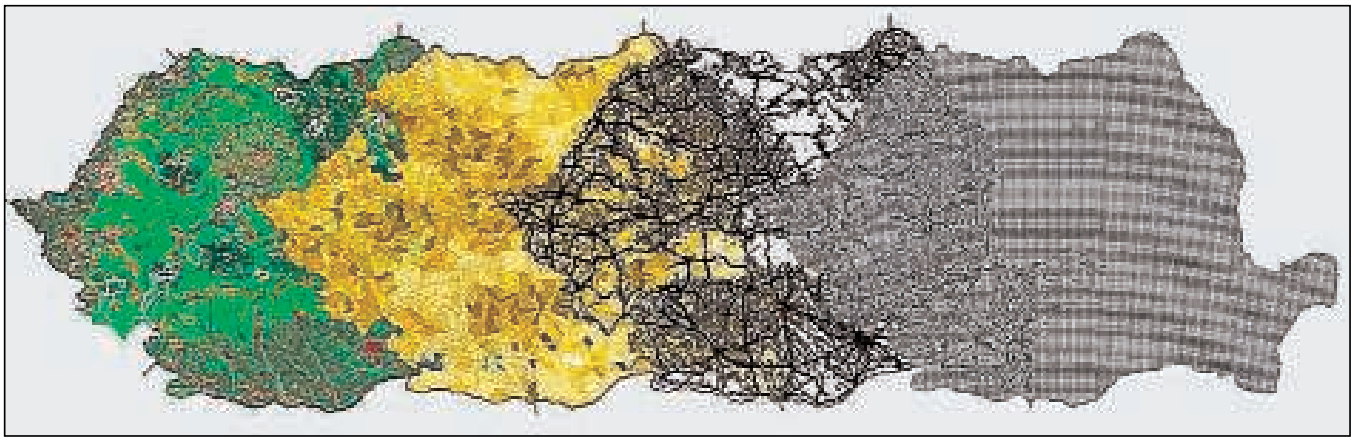


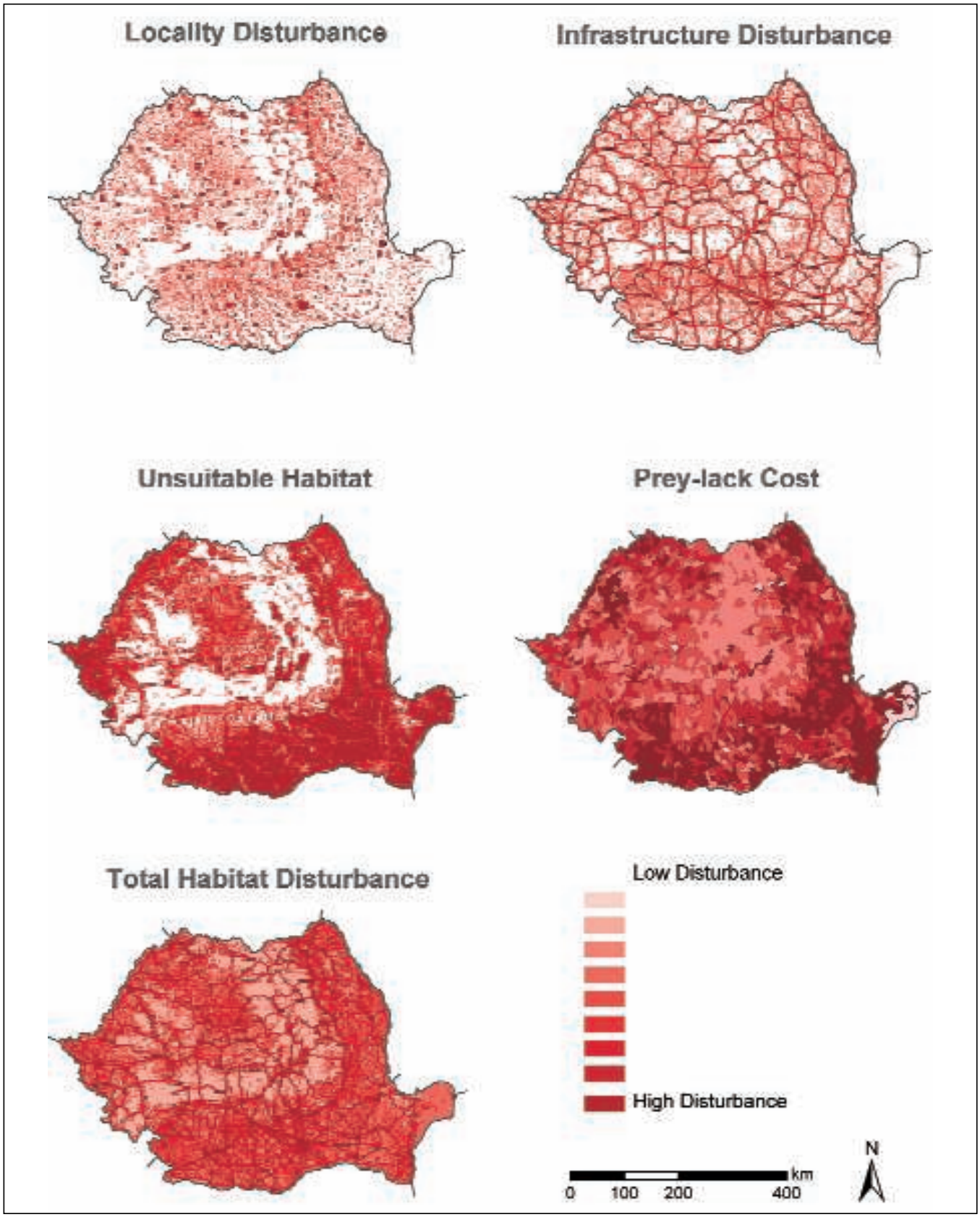
Figure 4.1
By superimposing natural land features and anthropogenic land utilization in GIS, conservation problems and tasks can be revealed and spatially analysed to determine and prioritize conservation actions.

4.3. The Carpathian ecological network vision map

The current Vision Map is based on conserving at least 60% of the existing large carnivore populations in the Romanian Carpathians as modelled with Marxan (see figure A3.3 in Appendix 3) and adjusted with the incorporation of known biodiversity hotspots and important landscape ecological relationships not included in the model simulation. Figure 4.3 shows the outline of the resulting protection zone in which protected core areas with hotspots of large carnivores and other biodiversity values connected with robust ecological linkages can be designated as part of detailed intersectoral land-use planning.

The green arrows in figure 4.3 indicate candidate areas for robust ecological linkages, as determined from landscape permeability analysis and known relations between wildlife populations. Appendix 4 presents field surveys of several candidate linkages in the Brasov area and the divide between the Apuseni and ¸southern Carpathian mountains shown on this map.
Figure 4.4 shows the same protection zone with a graphic presentation of the currently known hotspots of large carnivores and herbivores and several other species of conservation importance. It is recommended that most of these hotspots are protected within the ecological network. Although the known occurrence and distribution of other biodiversity values in the Romanian Carpathians has many gaps, it indicates that the 60% 'large carnivore umbrella' modelled with Marxan can cover many important ecological values. The border of the protection is not rigid, but can be shifted to include new biodiversity values revealed by inventory and monitoring.

Figure 4.2
Marxan reveals the restrictions or 'costs' exerted by transport infrastructure, urbanization and rural settlements (locality disturbance), unsuitable habitat features (i.e. unsuitable CORINE Land Cover features) and lower availability of ungulates on large carnivore ranging across Romania. The restrictions combine into a map of 'total habitat disturbance. The darkest red areas indicate areas least suited for large carnivores. White or whitish areas are most suited, actually revealing possible core areas. The map also reveals the environmental sensitivities with respect to further sectoral developments and conservation of natural space demanding species.


Locality Disturbance
Infrastructure Disturbance
Unsuitable Habitat
Prey-lack Cost
Total Habitat Disturbance
Low Disturbance
High Disturbance
0 100 200 400
km
N

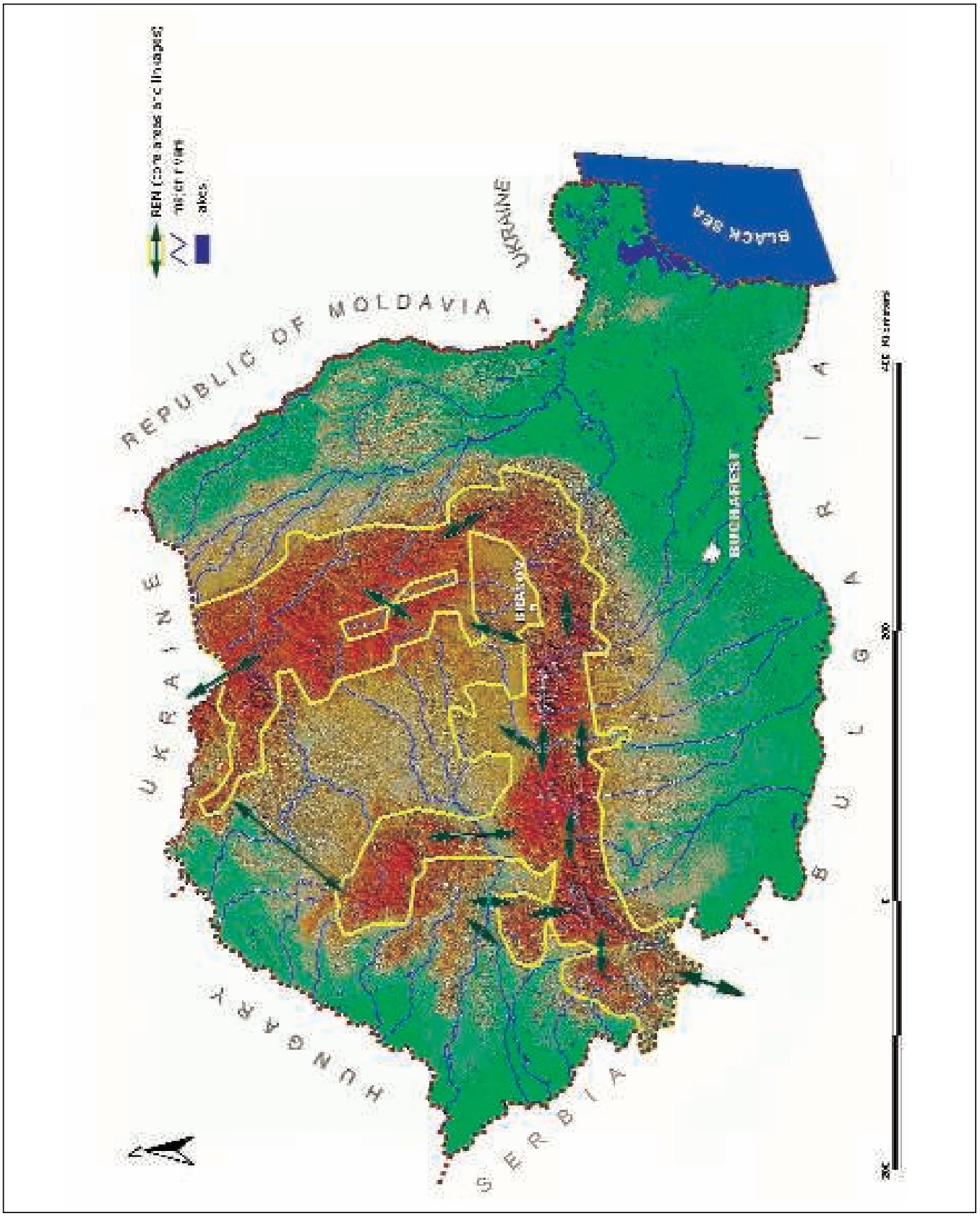

BLACK SEA
UKRAINE
REPUBLIC OF MOLDAVIA
BUCHAREST
HUNGARY
SERBIA
BULGARIA

Figure 4.3
Protection zone or preliminary Carpathian Ecological Network Vision Map for the safeguarding of at least 60% of the current large carnivore populations as determined by the model Marxan (Appendix 3) and the inclusion of other known important biodiversity and landscape values. The yellow line marks the indicative border of the zone and the green arrows within and extending outside represent candidate locations for robust ecological linkages.

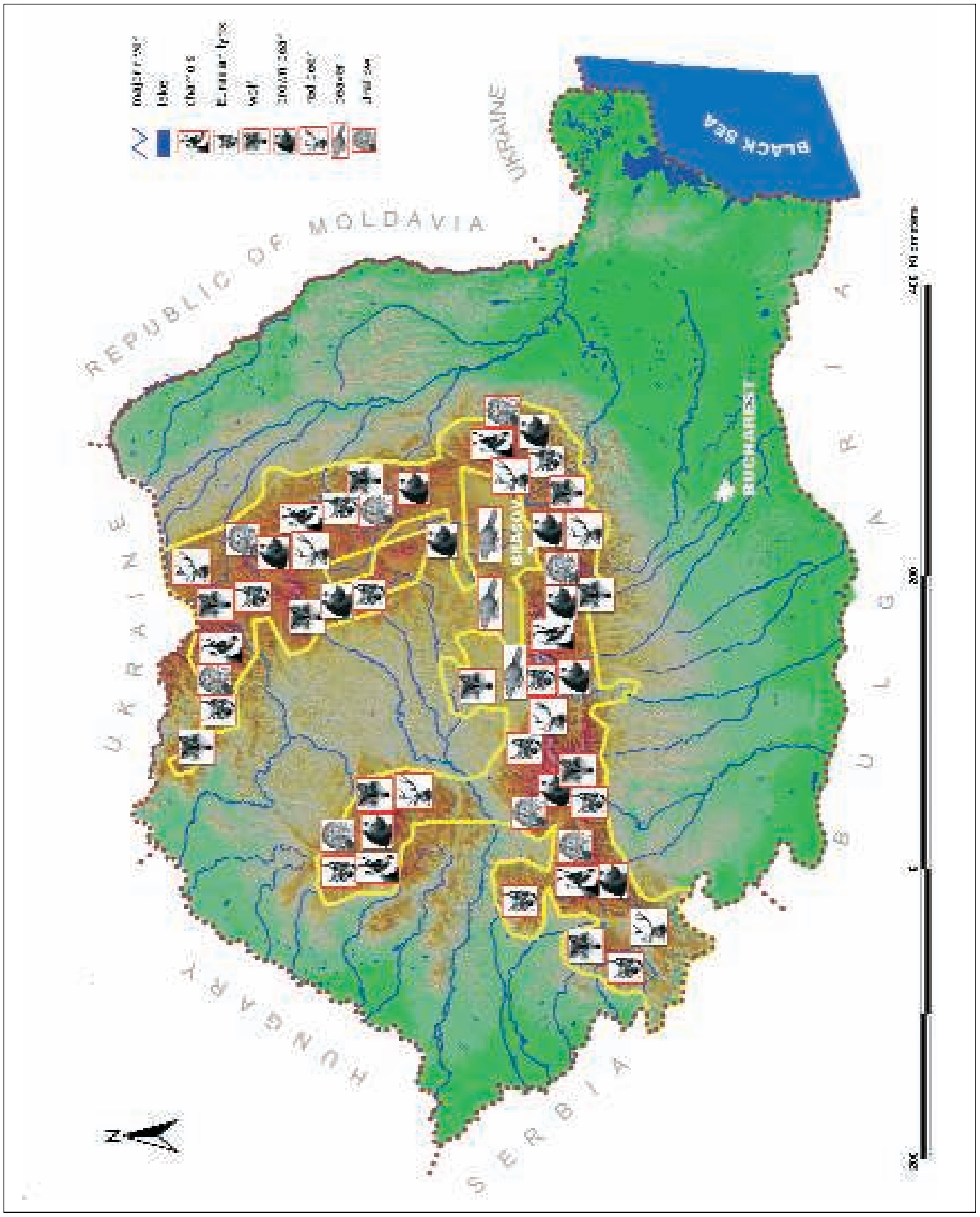

major rivers
lake
chamois
Eurasian lynx
wolf
brown bear
red deer
beaver
otter
UKRAINE
REPUBLIC OF MOLDAVIA
BLACK SEA
BUCHAREST
BRASOV
HUNGARY
SERBIA
BULGARIA
N

Figure 4.4
The protection zone contains many hotspots (sizeable populations) of large carnivores and herbivores and other ecologically important species like the reintroduced beaver, which should be conserved in the eventual ecological network. Centre of the hotspots is graphically indicated with a panel for each species.

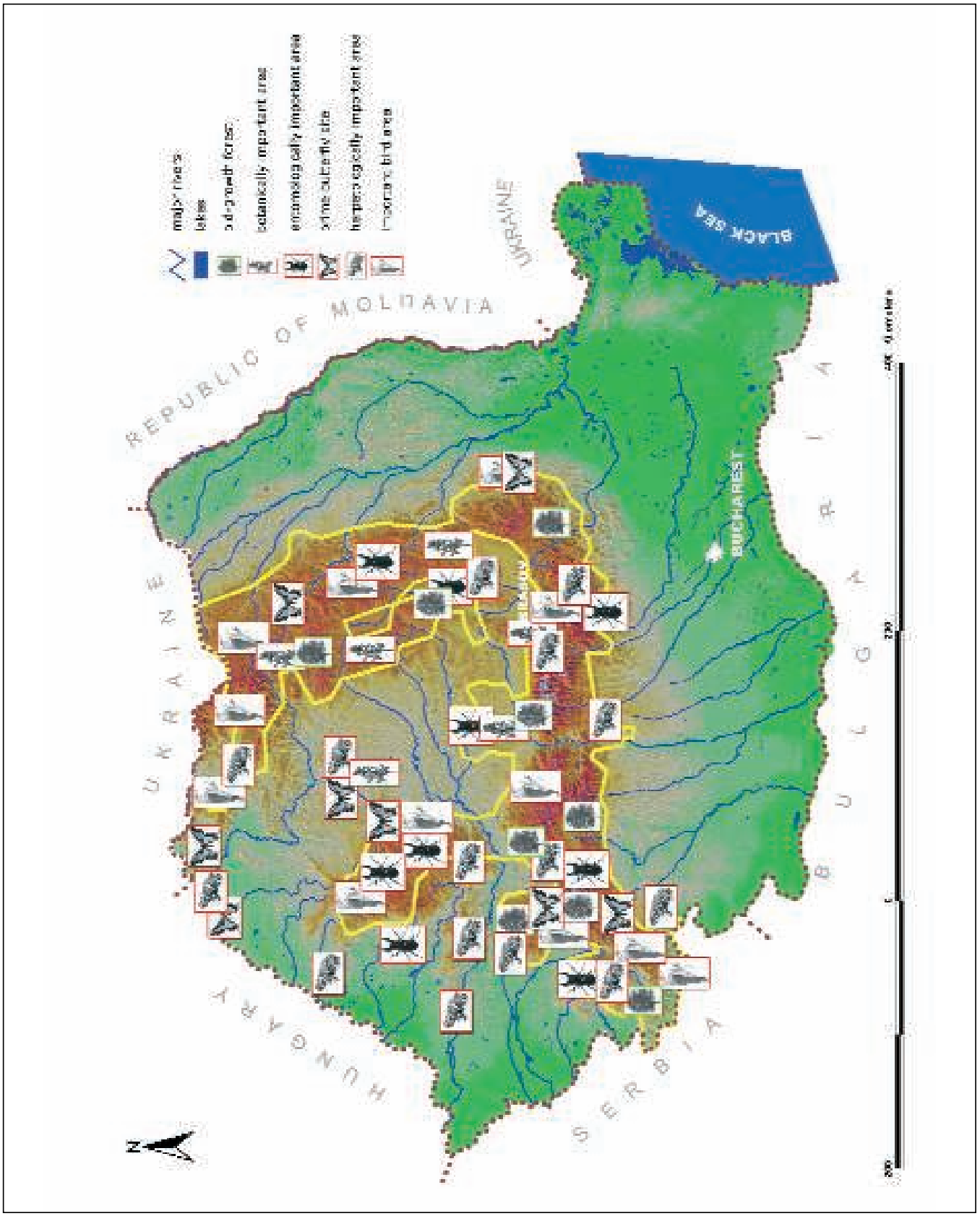

major rivers
lakes
old-growth forest
botanically important area
ecologically important area
some suitable site
herpetologically important area
transboundary area
BLACK SEA
UKRAINE
REPUBLIC OF MOLDAVIA
BUCHAREST
BULGARIA
SERBIA
HUNGARY
UKRAINE
N

Figure 4.5
The protection zone or 'large carnivore umbrella' protects hotspots of other biodiversity and landscape values, including old-growth forest (primary forest), insects, butterflies, vascular plants, herpetofauna (amphibians and reptiles) and birds. However, there are also hotspots that are excluded and these should be protected in the national ecological network, of which the Carpathian ecological network is the backbone.

Biodiversity hotspots far outside the Carpathians should be preserved as core areas of the wider national ecological network.

The floral diversity of the Carpathians is phenomenal. This late summer bouquet, including the medicinal Arnica montana (bottom right), was taken from chalk grasslands and forest fringes of the Apuseni Mountains. Photo's: Erwin van Maanen.

4.4. the Carpathian ecological network and current protected areas system

We recommend that at least 60% of the current (2005) large carnivore populations in Romania is conserved in a Carpathian ecological network, covering most of the protection zone in figure 4.3. This target is believed to be a reasonable achievement and in accordance with the guideline of Natura 2000 (see section 3.1). It should insure that large carnivores can prosper and effectively fulfil their key roles in the maintenance of dynamic large-scale alpine-montane to lowland ecosystems. Preferably more biodiversity should be preserved if possible, to fulfil the ecological sanctuary and reservoir function of the Carpathians for Europe. Below the recommended target level of 60% it is likely that in a worst-case scenario of unbridled developments in the Carpathians large carnivore populations will become too fragmented and isolated, and can thus weaken to the point of extinction. Conserving less than 60% of the current large carnivore populations in less and/or smaller and more widely scattered core areas automatically implies the need for greater connectivity (i.e. more robust ecological linkages) to maintain sub-populations. Effective exchange of individuals is then most crucial, particularly for forest dependent animals like the lynx, bear, red deer and the still to be fully reintroduced European bison.

The current protected areas system of the Romanian Carpathians (figure 4.6) is similar to the lowest conservation target (15%) modelled using Marxan (see Appendix 3, figure A3.3). This raises the question of whether this system will effectively protect large carnivores, should protected areas become highly isolated. Moreover, most of the known large carnivore hotspots occur outside of the current protected areas, particularly in the eastern Carpathians. In fact, the current 15 protected areas (total area about 5911 km^2) contain less than 10% of the large carnivores in Romania. We can estimate the carrying capacity of the current protected areas using the reproductive units defined in section 3.7. The largest protected area (Porţile de Fier, 1156 km^2) can, under well-managed, productive and undisturbed conditions, support around 3-6 carnivore reproductive units, compared to the theoretical fifteen large carnivore families in a sizeable core area of 3500 km^2, considered an adequate sanctuary for stable and ecologically meaningful populations. In addition, the protected areas probably contain many non-habitat features for large carnivores such as steep geological formations and tourist facilities and are therefore limited as sanctuary.

Mainly confined to the alpine zone, chamois need special conservation measures. In Romania these animals are currently threatened by poaching. Source: Source: ICAS Wildlife Unit/Fundaţia Carpaţi.

4.5. Conclusion

The modelling results and biodiversity distributions indicate that the current protected areas system in the Carpathians, also proposed for the Natura 2000 constellation, is a serious shortcoming in protecting large carnivore populations in Romania and other biodiversity under their umbrella. It most probably protects less than 10% of the large carnivore population currently existing in the Romanian Carpathians. We recommend that at least 60% of the current large carnivore populations are protected in a coherent system of large robust ecological core areas and linkages to ensure their perpetual survival and function as reservoir. This however requires a new protected areas system much larger and coherent and better planned than the current system, preferably covering most of the protection zone presented in figure 4.3. Core areas with suitable habitat (Appendix 1) should be no less than 3500 km^2 each and preferably up to three times greater. It is estimated that at least around ten core areas of the minimal size should be allocated within the protection zone, in the least disturbed areas (figures 4.2 & A3.3), and containing the greatest amount of landscape and biological diversity (figures 4.4 & 4.5). The ecological linkages should be robust and incorporate many of the habitat qualities of the core areas.

The choice is up to the Romanian government to allocate the detailed ecological network within the protection zone, hopefully with great generosity and stewardship for the natural environment, to safeguard one of Europe's greatest cultural and ecological treasures. Important targets and preconditions have been provided in this Vision. The Carpathian ecological network should be managed for conservation and sustainable natural resource utilization, a difficult but noble challenge that when fulfilled can put Romania on the map as a great nation and example for the World.

The effective instalment of the exact ecological network now ultimately depends on the following:

- Decisive environmental and nature management policy and legislation supported by other sectoral policies.
- Sustainable natural resource use in combination with the conservation of traditional forestry and agricultural practices.
- Sound detailed intersectoral land-use planning.
- Widespread public support and collaborative involvement of all stakeholders.
- More detailed knowledge of the landscape and biological diversity values of the Romanian Carpathians and beyond.
- The institutionalisation of modern conservation management.

These changes are fundamental and urgent, but not realized overnight. Thus in the next chapter guidance is provided on how these changes can be catalysed and on priority actions, as part of the next implementation phase.

INTERMEZZO

Treasure of the forest

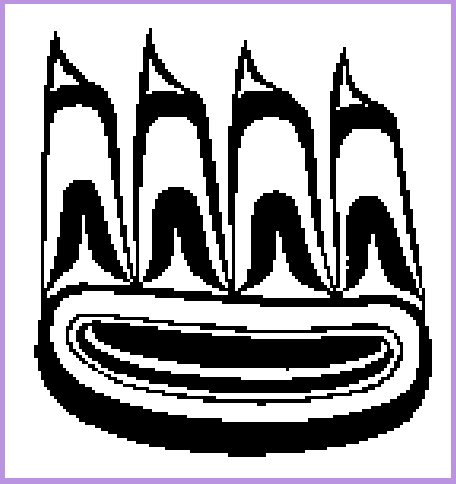
David Quammen *(natural history writer)*

The common supposition, among distant people who don't know better, is that eastern Europe, after decades of communist-style mismanagement and exploitation, might be the least likely place on Earth to harbour great areas of forest filled with magnificent wild beasts. But the common supposition is wrong. Just as gold is where you find it, so are biological riches. And in Romania, as one instance, reside some of the biggest populations of large, carnivorous mammals surviving anywhere between the Atlantic Ocean and the Russian border. Most notably: five thousand individuals of Ursus arctos, the brown bear.

When I first learned this fact, about eight years ago, I was thrilled, fascinated, and puzzled. My first reaction was: How can it be – five thousand brown bears in Romania? My second reaction: I've got to go there and find out. So I began visiting Romania, travelling by car and by foot through the Carpathian Mountains (where most of the large carnivores are concentrated), talking with biologists, forestry officials, gamekeepers and other people, searching for explanations.

Throughout all my conversations and interviews, I kept returning to three general questions:
1) How did it happen that Romania has retained such a sizeable abundance of bears?
2) What are the urgent challenges involved in preserving this population into the future?
3) How do the people of Romania–especially the rural people, such as shepherds cope with the inherent difficulties of sharing landscape with Ursus arctos?

The answers I heard were complicated and various. Anomalies of Romanian history (in particular, the anomaly named Nicolae Ceausescu) had played a crucial role. Opinions were divided as to how bear management should be conducted now. However, the response I remember most vividly came from an elderly shepherd named Ion Dinca, whom I encountered one day on a patch of high meadow near the Trans- Făgăraş Highway, just over the pass from Transylvania. He was sixty-seven years old, retired from the Forest Department, and shepherding again, as he had in his boyhood, not for income but because he enjoyed it. Mountain air. Freedom to walk. Fresh cheese. True, this work was hard and occasional bear attacks on the sheep and donkeys he tended made it harder still.
"What if the bears were gone?", I asked. "What if they disappeared? Wouldn't that make life easier and better?".
His life? "Well, yes", Ion Dinca admitted, "it would". But this shepherd was a man of sensitive imagination. There was more at stake than the convenience of his life. The bear, he told me, it's podoaba padurii, the treasure of the forest. "If you lose this, you lose the treasure," he added. "A forest without bears – it's empty."



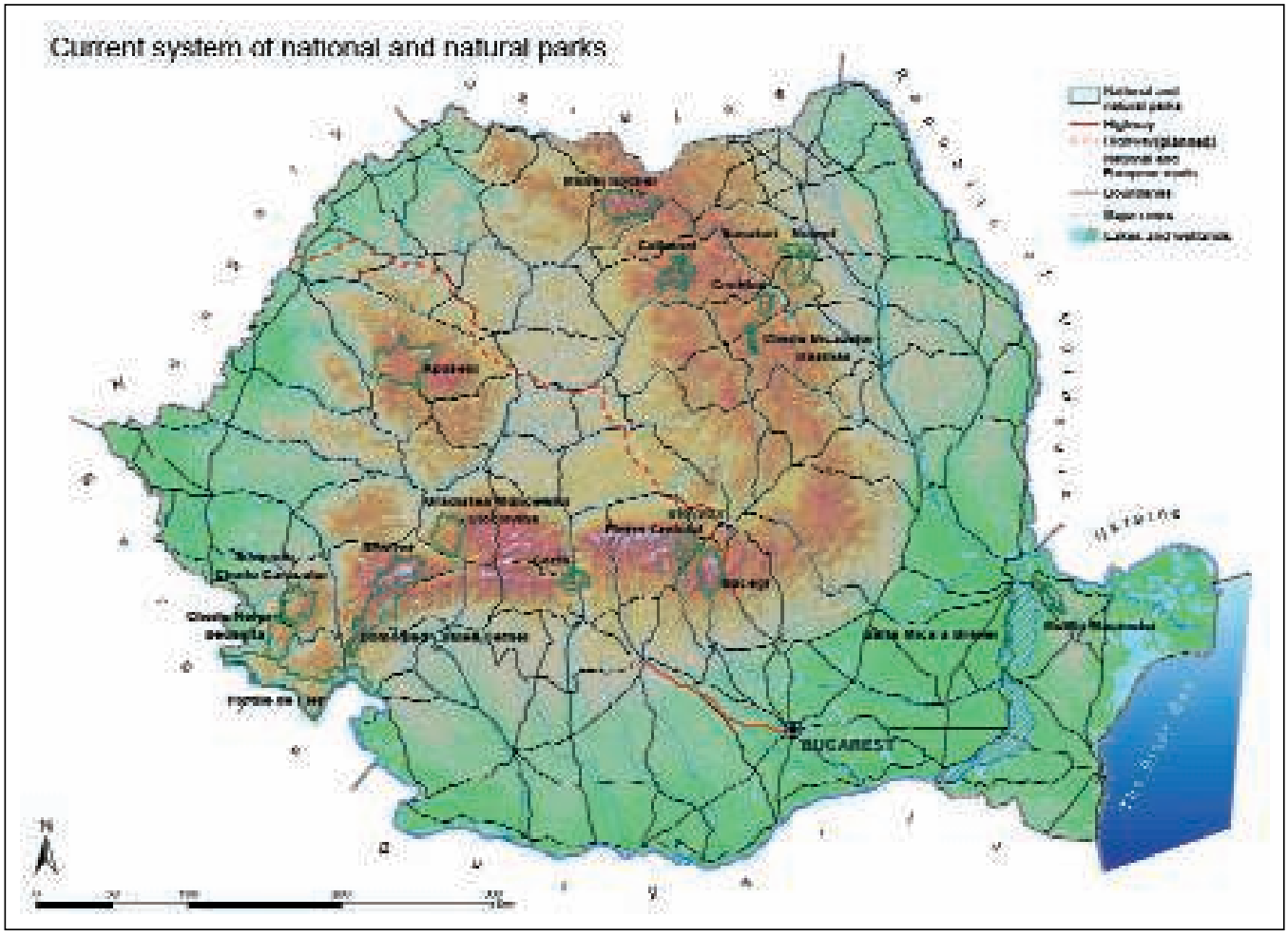


Figure 4.6
Current protected areas (natural and national parks) of Romania.

The various ecosystems of the Carpathians require specific conservation management, including the sensitive alpine zone, here in the Făgăraş Mountains.
Photo: Erwin van Maanen.

6. IMPLEMENTATION

Participants of the evaluation workshop (14 July 2005) at the Transylvanian University in Braşov agreed that the following actions and activities are critical for safeguarding and sustainable management of the Romanian Carpathian Ecological Network (RCEN), going from vision to implementation.

Creation of a Coordinating Committee

The role of the Coordinating Committee, led by devoted and inspiring individuals, would be to decisively promote and coordinate the safeguarding of the Romanian Carpathian Ecological Network and manage the important information synthesis. Among the entities that should be represented on the committee are truly dedicated RCEN proponents from all the leading and relevant conservation NGO's (including WWF), research institutes (including for instance ICAS, Danube Delta Research Institute), academia, government ministries, environmental protection agencies (national and regional) and relevant stakeholder groups (e.g. sectoral or branch organisations). Furthermore, it is recommended that the Coordinating Committee is supported and stimulated by international experts on conservation ecology, land use planning and environmental policy and legislation.

The work of the Coordinating Committee should include, but not be limited to, the following actions:

Vision advancement

Updating and adjustment of the current vision as new information, opportunities and challenges emerge.

Facilitate policy development, legislation enforcement and public support

The RCEN should be realized through proper nature management policy and safeguarded with enforced legislation. Its realization should be acted upon by parliament, requiring effective lobbying. The priority projects are:

1. A review of the current protected areas system in light of effective conservation of important landscape and biological diversity values, as required under legally and ethically binding European agreements like the Habitat and Bird Directives and the Pan-European Biological and Landscape Diversity Strategy (PEBLS) and Carpathian Convention, signed by Romania. The protection of ecologically effective large carnivore populations presents an important central case.

2. A scoping study for a Romanian Carpathian Wilderness Park as a grand sustainably used nature heritage for Europe. This also requires great media promotion, for instance though a television documentary.

3. The creation of codes of conduct for nature conservation and management on private lands and the effectuation of instruments such as conservation easement through a land trust.

4. Establishment of a 'land for Romanian nature fund', possibly stimulated by the European Union or individual states. Ecological linkages should be purchased first.

5. The mitigation of major transport corridors for the protection of wildlife populations, requiring immediate funding for the design and construction of green bridges.

6. Promotion to gain wide support of the RCEN among key Romanian and European government and public proponents.

Detailed integrated land use planning and ecological assessment
It is absolutely vital that relevant governmental and non-governmental organizations collaborate on the creation of a Carpathian land use plan detailing the robust embedding of the RCEN within the lands with changing land uses, presenting a prime catalysing case for integrated land use and environmental planning in Romania. The main objective is to ensure that socio-economic development projects in the Carpathian region are compatible with the ecological functions and services of the RCEN, according to holistic ecological assessment and scientific elucidation of crucial ecological relationships. Sustainable land use should be realized through national policy and then effectuated through regional (county) planning (figure 6.1).

Biodiversity assessment and management
Considerable gap analysis of Carpathian ecological values is required, as well as enhanced scientific insight in crucial ecological relationships for effective nature management. At the basis for this is sound collaboration and information sharing, which requires considerable impulse in Romania.

Achieving the European Wilderness Park
Central to the Vision is the realization of the RCEN as a Carpathian Wilderness Park for Europe, a bastion of relatively untamed wilderness rife with high biological, landscape and cultural diversity. The vision for such a grand park needs to be mainstreamed in Romanian society and indeed Europe to gain its vital support. To kick this off an international conference on the scope for realistic opportunities is needed. Important subjects to address in an integrated fashion include:

Instruments and preconditions for installing the RCEN
- Incorporation of the RCEN into the national policy-cycle, legislation and land use planning down to the regional level (figure 6.1).
- Harmonization of land privatization and conservation.
- The application of EU nature legislation in safeguarding the RCEN.
- The meaning of European agricultural and other land-use policy for the RCEN, to solve possible constraints and elucidate clear opportunities in light of the approaching EU accession.
- Opportunities for conservation easement.
- Establishment of a 'Romanian land for nature fund' to secure priority components of the RCEN and counteract the most proximate threats.

Sustainable use options for the RCEN
- The crucial continuance of local communities as stewards of the RCEN through traditional agriculture and forestry, by consulting regional representatives and the grass-roots.
- The scope for realistic and profitable green (sustainable) economic activities in support of RCEN components and local communities (reciprocal benefits).
- Co-existence with large carnivores.

For this conference all important national and international stakeholders and potential donors will need to be invited.

Workshop on wildlife mitigation for major new transport infrastructure

Urgent is the effectuation of wildlife mitigation measures for the major transport corridors about to be constructed. A workshop will deal with this issue by fine-tuning where ecological linkages and wildlife passes across transport infrastructure should be realized and how this can be funded. The following bodies will be crucial in defining and supporting concrete actions.

- DG Transport (EU).
- DG Nature (EU).
- European NGO's (e.g. CERI).
- Experience sharing experts of countries where mitigation measures have been effectively taken and monitored.
- Engineering and construction companies involved.
- Romanian conservation NGO's and research institutes.
- Relevant ministries.

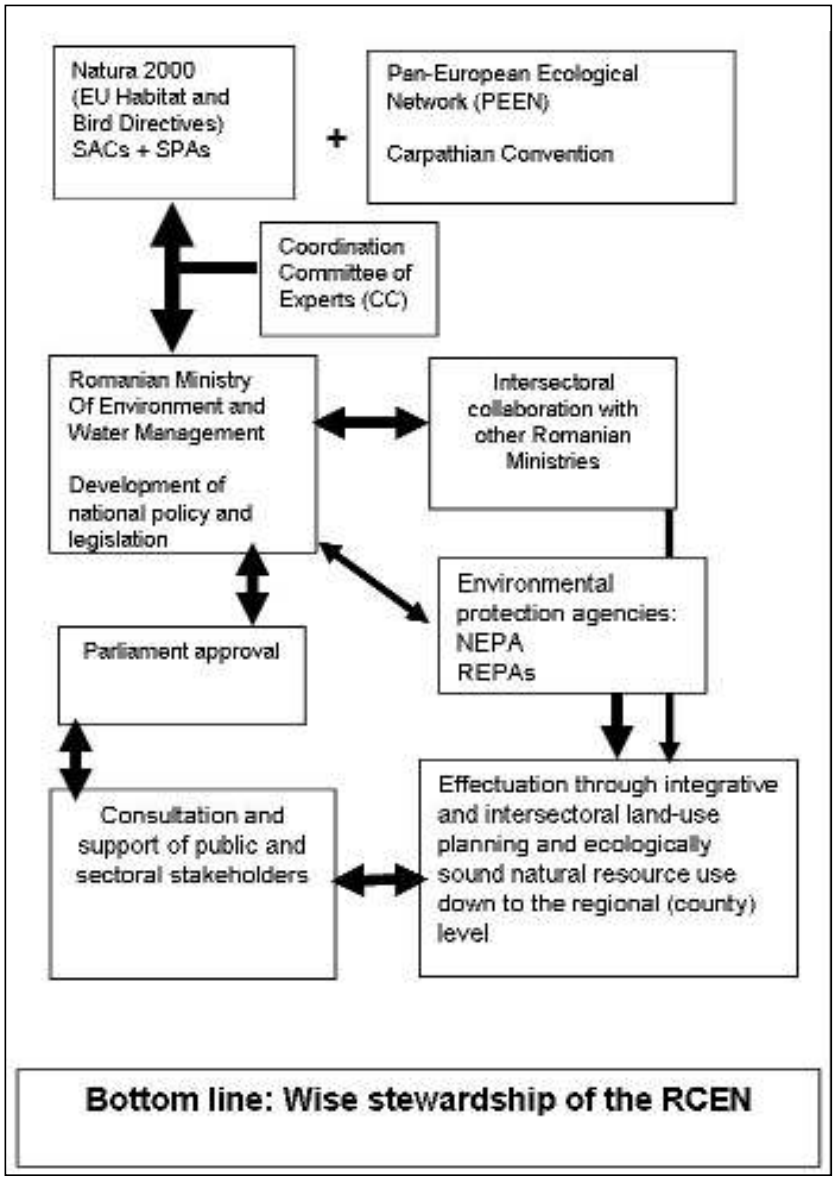


Figure 6.1
Proposed scheme for the realization of the Romanian Carpathian Ecological Network (RCEN) by mainstreaming into policy, legislation and society.

“If you only knew how beautiful my country is”
Nicolae Grigorescu (Romanian painter and poet, 1838-1907)

5. SAFEGUARDING THE CARPATHIAN ECOLOGICAL NETWORK

In the previous sections important quality and spatial preconditions for a coherent Romanian Carpathian ecological network, based on large carnivores as umbrella species and ecological key species, were motivated. To reiterate, the following four interrelated goals, also known as the Four C's, are considered fundamental to the success of this wilderness network, namely:

1. Recognize and rehabilitate or maintain the fundamental role of top-down regulation by large Carnivores.

2. Secure and preserve large and coherent Core habitats, undisturbed by negative anthropogenic developments.

3. Secure and maintain Connectivity between core areas according to the ecological needs of focal (or target) species.

4. The continued Co-existence of nature and people in harmony, which is important in light of the age-old nature sustaining traditional culture-nature relationships in Romania.

It is recommended that at least 60% of the current large carnivore populations is protected in this network. So there is much work to be done if the Romanian government and nature advocates are committed and collaborate closely. Here we present priority actions and recommendations for improvement, to decisively start implementing the vision of a Romanian Carpathian Wilderness Park set in a grand ecological network.

A green bridge for the conduction of wildlife to the size of red deer across a busy highway and within a Natura 2000 area (The Veluwe) in the eastern part of the Netherlands. This so-called 'cerviduct' is shown shortly after it was constructed. It is now covered with shrub and high grass, allowing frequent sheltered passage of red deer, roe deer, wild boar, red fox and pine marten. Green bridges optimal for big ungulates like red deer are at least 50 metres wide. With a road density of 3.5 km/km^2, the natural environment in The Netherlands is highly fragmented, which can only partly be restored at great financial cost. Photo: Henry Cormont, Rijkswaterstaat, Delft, The Netherlands.

5.1. Safeguarding connectivity

Safeguarding ecological linkages

As the Romanian Carpathian Range is essentially an existing ecological network, it is vital to start protecting and possibly strengthen the most vulnerable and ecologically important ecological network components. The ecological linkages conducting wildlife movements are the first in line, as they are soon going to be dissected by busy transport infrastructure.

Important ecological linkages are located by mapping intensive wildlife movement patterns. This can be achieved by using more or less laborious traditional and modern wildlife research techniques such as snow tracking, tapping of local knowledge, telemetry and photo trapping. So far in this study several important linkages for priority protection were located using mainly wildlife distribution data, landscape properties and modelling of landscape permeability and human disturbance (Appendix 3 & 4).

Further location of ecological linkages should be investigated as part of integrated land-use planning. Once located an ecological linkage should be delineated and configured according to a design plan providing a detailed approach for internal and external nature management. The proper dimensions and habitat quality of the linkage are determined according to the dispersal needs of target or guiding species and resilience against external influences. A rule of thumb is that the longer the divide is, and more intense disturbances are in the surrounds, the more robust the ecological linkage should be; at least one kilometre wide when the length of the divide is more than a kilometre. This dimension is particularly important in case of habitat demanding and reclusive large carnivores (bear and lynx) and herbivores (red deer). The internal habitat quality should be optimized with sizeable linear strips and patches of shrub and dense forest alternated with grassland, at least functioning adequately as refuges for target species. Enough refuge and space for the avoidance between predators and humans is vital. Small specialized target species like butterflies, amphibians and reptiles require very specific habitat qualities, which should be catered for, like special food plants in the vegetation and a coherent system of pools. The deterrence of negative outside influences may be needed, such as stray dogs. Again, by making ecological linkages wide enough such problems can be countered.

A high priority area for ecological linkages is the valley between the Apuseni Mountains and the Southern Carpathian Range, where the 4th Pan-European corridor is going to dissect and create a major barrier (see figure 2.3 and Appendix 4). Wherever roads and railways cut through natural areas tailored mitigation measures are required, this is the subject of the next paragraph.

Another example of a green bridge, in the Bow River Valley of Banff National Park, Canada. Compared with the previous shown passage in the Netherlands, this is a relatively cheap and versatile construction. It is used by black bear, grizzly bear, coyote, wolf, mountain lion and wapiti. The same setting can be envisaged somewhere in the Carpathians.
Photo: Erwin van Maanen.

Avoidance, mitigation and compensation of transport infrastructure

The evidence that transport infrastructure impacts negatively to a high degree on large carnivore and herbivore populations and their distribution is overwhelming (read for instance Forman *et al.* 2003). Although no statistics are kept the amount of wildlife killed and restricted on the current Romanian country road network is believed to be quite low, but expected to be major when intensified with traffic and to a large extent replaced

with highways. The planned transport corridors go right through important wildlife areas in the Carpathians and connecting divides. There are steps to prevent and soften the environmental damage of transport infrastructure, which still need to be applied in Romania. Firstly, one should avoid constructing major transport corridors through wildlife hotspots. This is difficult with respect to the currently planned corridors in Romania, so that one must resort to mitigation.
The impact of transport corridors as effective barriers and mortality sinks for wildlife can be mitigated to a high degree by incorporating wildlife passages to continue the ecological linkage in which they are located. There are several solutions that can be applied according to target species requirements:

- A 'green bridge' (other names: wildlife bridge, ecoduct, cerviduct, ursiduct) spanning across the barrier, is a bridge designed with natural features to allow optimal wildlife crossings.

- An 'underpass' or tunnel underneath a road or railway, sized according to target species. A viaduct of several meters wide and high can be used by small to large animals (e.g. red deer and wolf) and concrete tunnels by only small to mid-sized animals up to the size of a fox.

- A land bridge is usually a natural ridge that is tunnelled through, thus preserving a major landscape feature as part of the ecological linkage, often the best solution in mountainous or hilly areas.

Where large populations of wildlife are at stake, as in Romania, it is crucial to incorporate as many well located and tailored wildlife passages as possible. This is also in the interest of traffic safety, to avoid potentially lethal and expensive collisions with large mammals. A generous instalment of wildlife passages will ensure high permeability of transport corridors. As wildlife passages are costly they should be located in places where they are most effective, in bottlenecks with high wildlife movements and as part of ecological linkages. Furthermore, they should cater for the target species at stake according to established road ecological and ecological engineering principles (see for example Forman *et al.* 2003; Luell *et al.* 2003; Van Bohemen 2005). The internet provides numerous examples of functioning constructions for large carnivores and herbivores, mainly trialled in North America. The pioneering work of Dr. Anthony Clevenger and colleagues from the Western Transportation Institute in Canada provides many highly relevant insights in this respect.

Fate of wildlife in a modern Romania?

In the interest of wildlife protection, traffic safety and minimizing insurance expenditure it is essential to incorporate many wildlife passages for large mammals into Romania's new major transport infrastructure. (Photo: Chuck Bartlebaugh)

In Romania green bridges for large mammals should be spaced no more than ten kilometres apart. For smaller animals the spacing of passages (e.g. badger tunnels) is maximally two kilometres. Many passages are also needed to account for possible opportunistic predation of herbivores by large carnivores at green bridges and fences. In Canada, for example, coyotes learned to trap herbivores against fences. Scent marking on a green bridge by frequently passing carnivores may deter herbivores (Little *et al.* 2002). Hence a few green bridges along long roads will not suffice.

A wildlife passage is ideally located on traditional wildlife trails or the most attractive crossover sites. Carnivores, lynx and bear in particular, prefer to cross divides in places with adequate cover (Clevenger & Waltho 2000) on both sides of the barrier. Deer on the other hand prefer to cross spaces they can overlook and where the chance of surprise attack by a carnivore is minimal.
A lot goes into the design and construction of wildlife passages and there are certain standards for road safety and ecological functioning, as well as (landscape) architectural considerations. Sturdy wide green bridges on which the ecological linkage can continue to the fullest are preferable.

Forested land bridge in the Harghita area. This area is rich in brown bears, which can currently still move relatively safely between forest areas across the quiet main road at night. If this road becomes part of a major transport corridor, the land bridge will be important as ecological linkage. Photo: Erwin van Maanen.

For green bridges to be effective for traffic of shy animals like the red deer they must be at least 50 meters wide, but ideally they can be wider. For instance recently in Croatia six green bridges of 120 metres wide were constructed for the target species wolf and bear, thanks to the large carnivore conservation work of Prof. Dr. Duro Huber of the University of Zagreb. Therefore there is considerable scope for Romanian conservation biologists in collaboration with road engineers and landscape architects to achieve similar or even better feats.

Ideally wildlife passages should be incorporated in the design of new infrastructure, to prevent the high additional costs of embedding them afterwards, often requiring major adjustments. As many new roads and road improvements are in the pipeline in Romania this is an important recommendation. Figure 5.1 provides a map with priority locations for the first green bridges in Romania, as determined with the scouting work in this study. However, it is important that more are incorporated once traditional wildlife movements in the Carpathian divides have been further investigated, a task for wildlife managers.

A 120 metre wide 'ursiduct' in Croatia (Photo: Prof. Đ. Huber, University of Zagreb).

Beside major transport corridors there is the accumulative impact of increasing secondary road density to counteract. Crossable secondary roads can exert a disproportionate impact on wildlife when compared to highly obstructive highways. Wildlife is more likely to cross more infrequent traffic on secondary roads than the highly deterring highways and thus wildlife mortality on secondary roads can be higher. It is impossible to span secondary roads with many green bridges and underpasses. A cheaper alternative is to apply warning signs and traffic calming (speed reduction) on road sections with high wildlife crossing. In addition wildlife can be funnelled to these crossings with fencing. The use of natural features is also cost reducing, such as making underpasses under bridges over rivers and streams, by including wide banks.

A wapiti 'photo trapped' whilst crossing the green bridge of the Bow River Valley in Banff National Park in Canada. The top of the bridge is openly vegetated providing a clear view for crossing deer. Photo courtesy of Dr. A. Clevenger.

Avoidance is always the best option, so the expansion of secondary roads into remote wilderness areas should be limited, particularly in core areas. Roads into wilderness areas bring negative forcing factors like hunters and mass tourism, lethal and disturbing to wildlife. Roads should preferably lead only to small recreational centres and always circumvent wildlife refuges.

5.2. Safeguarding large core areas and habitat quality

Core area size, shape and configuration

The restriction of natural areas combined with intensifying resource exploitation and urban encroachment in the surrounds will likely reduce the carrying capacity for wildlife and cause species to withdraw; large carnivores and herbivores in particular. Reduced populations in too small and isolated reserves are vulnerable to edge effects and to high poaching, disease outbreak, fire, floods and mismanagement (Bengtsson *et al.* 2003). Large wilderness areas on the other hand cater for ecological dynamics and disturbances, thus creating a variety of (cyclical succession) states within the ecosystem, to the benefit of biodiversity and evolution.

Warning signs for wolves crossing a road in Jasper National Park, Canada. Photo: Erwin van Maanen.

Within the delineated protection zone we recommend the designation of large ecologically managed core areas of at least 3500 km^2, but preferably much larger (section 3.7 and Chapter 4). The simple model of Diamond (figure 3.2) can be of guidance in determining the proper configuration of ecological network components. As the Carpathian Range is elongated and barriers (roads and human settled river valleys) dissect it mostly perpendicular, the linear arrangement of core areas along the range is unfavourable. It is therefore better to arrange core areas in a close three-way or triangular configuration in the broader sections of the range. This will connect three core areas with three ecological linkages instead of two core areas connected with only one ecological linkage. The gene flow between core areas connected in a three-way arrangement is probably the best. Core areas in three-way arrangement can be designated around urban and agricultural areas, with broad buffer zones in between. Such a system should be incorporated into a sound intersectoral land-use system.

Internal habitat quality and integrated nature management

Not only does the spatial arrangement and size of core areas matter, but also their internal habitat quality. Large carnivore and herbivore densities in the Carpathians are maintained through high productivity and ecological diversification, which is to a high degree reliant on traditional extensive and cyclical forest, agricultural and hunting management systems. Only by maintaining this ecological state can a high carrying capacity for wildlife be maintained. Abandonment of traditional management practices is likely to result in ecological shifts. Ways should be sought to counteract negative changes, based on a holistic understanding of the relative contributions of interacting agriculture, forestry and wildlife to the maintenance of the Carpathian ecosystems.

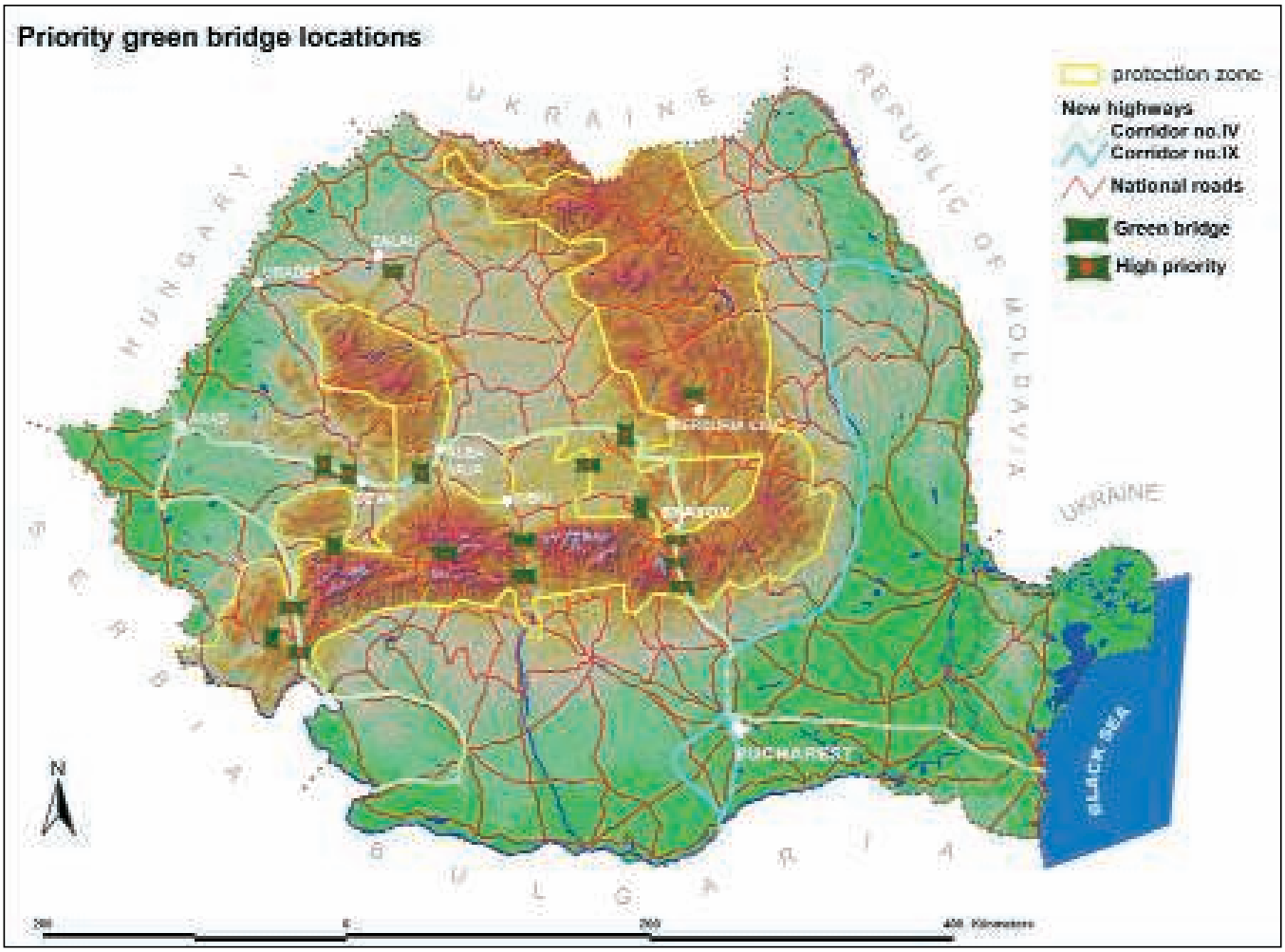


Figure 5.1
Map showing priority locations for green bridges for large mammals on existing and planned major roads and railways. The exact positioning needs to be determined according to animal movements and lay of the land.

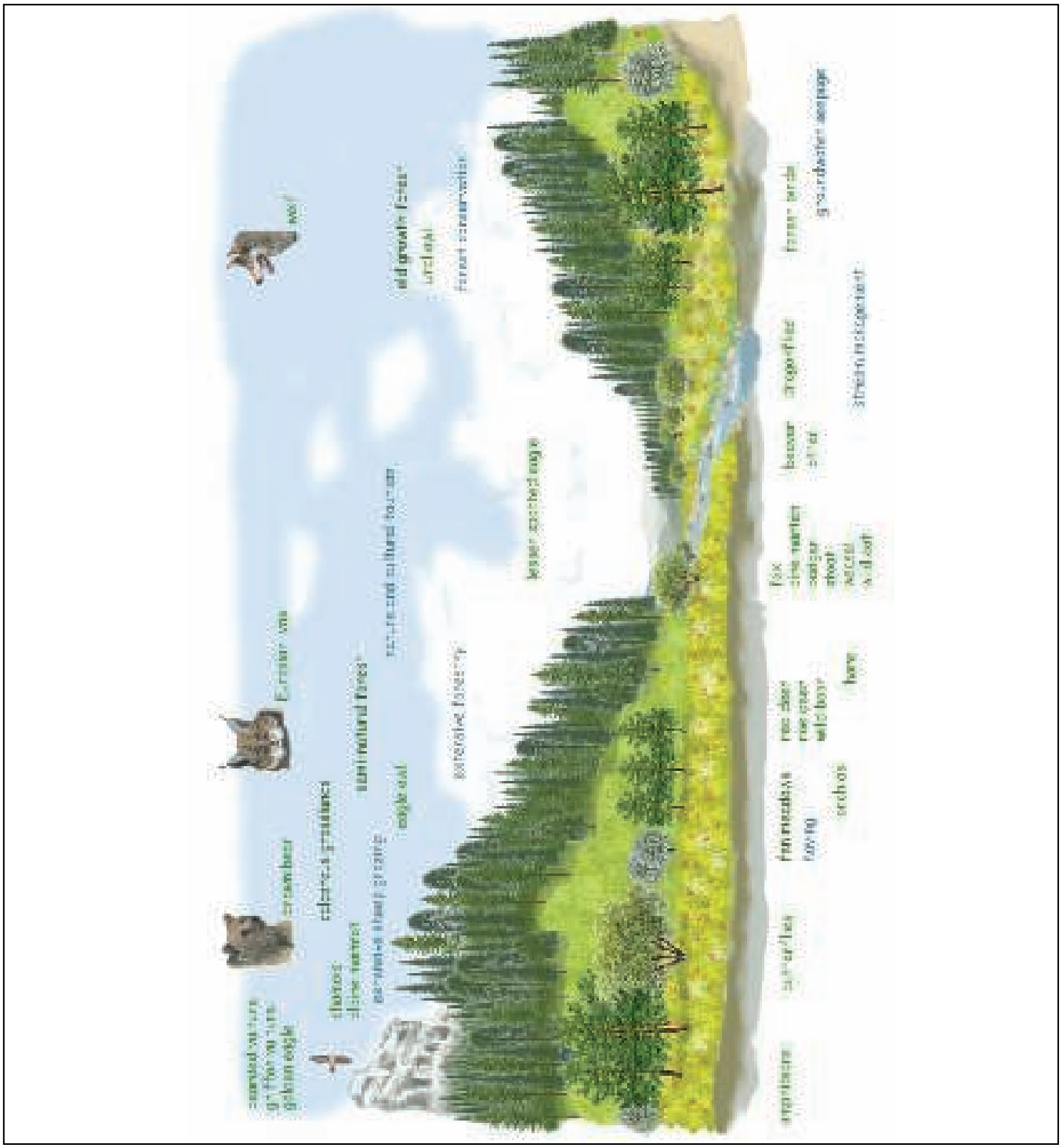


Figure 5.2
A range of ecological values and targets for integrated conservation management in the Romanian Carpathians on the sub-regional or landscape-level with large carnivores as umbrella species. Core areas should conserve landscape gradients from the alpine zone to whole stream valleys, covering a wide spectrum of biodiversity.

Conserving landscape gradients

Landscape gradients often harbour higher biodiversity by offering a conglomerate of differing habitats for specialized animals and plants. Mountains in natural connection with lowlands contain many ecotones that are used differentially during the season by migrating wildlife. For example, from spring to autumn bears utilize changing food sources between high and low areas of the mountains. Red deer also traditionally migrate between the highlands and lowlands. It is thus essential to conserve broad ecotones in the Carpathians, from the alpine zone down to the stream and river valleys as graphically illustrated in figure 5.2. Stream and river valleys are high on the list for landscape restoration and conservation as they have already undergone considerable modification and are further threatened by urban developments such as holiday houses and resorts.

5.3. Land privatization and land use planning

Land privatization will very likely alter the current natural state of the Carpathians and can drive habitat fragmentation and impoverishment to the exteme. Much of the Carpathian land is currently sold off for housing or land speculation by Romanian or foreign entrepreneurs. Very little to no land is placed in the care of proper stewards. Without correct enforced regulations and intersectoral land-use planning the new landowners are expected to variously break down the coherent ecology of the Carpathians, which is a tragedy of the commons. Beside returning lands to eligible heirs or selling it off, a great deal of the best natural lands should be set aside for nature, indeed as heritage for Romanian and European society.

Sustainable forest and grassland management

Natural forests and grasslands are reliant on coherent nature management and wise utilization systems that maintain biodiverse states. It is greatly feared that the current forest privatization will result in forests and grasslands that are differentially managed and exploited to intensive levels. This has also been the trend in forestry and agriculture in Europe since the end of the Second World War. However, the tide is now turning with many EU governments increasingly devoted to developing nature areas in combination with ecological farming and forestry, and Romania should follow this new trend. However, traditional agriculture and forestry cannot be maintained without profitable incentives and without dedicated farmers.

For forests it is important to prevent illegal logging, industrial exploitation and mismanagement by owners without ecological forestry skills or forest stewardship attitude. In the past the Carpathian forests flourished in large areas by the grace of a more or less coherent and a relatively extensive state forestry system. Ecologically sound use of the forests under supervision of the national forestry service should be further developed and according to environmental certification like that of the Forest Stewardship Council (FSC).

For agriculture Romania could gain an important stake in servicing the growing market for organic produce and perhaps promote excellent opportunities for people from all over Europe seeking a career in organic farming and/or alternative living, taking on the role of nature stewards.

Land for nature purchase and conservation easement

It would be ideal if land is set aside or purchased for the ecological network like in many European countries but new for Romania. As land in the Carpathians is still relatively cheap, there are excellent opportunities for philanthropic conservation minded organizations to join hands and purchase or lease vital components for the Carpathian ecological network. Such organizations can operate as so-called ‘land trusts’.

In the United States 1500 non-profit and non-governmental land trusts operate (see http://www.lta.org/). They may protect land through working with landowners that can either donate or sell so-called 'conservation easements', or by acquiring land outright to maintain working farms and forests with ecological values or wilderness areas. A conservation easement (or conservation restriction) is a legal agreement between a landowner and a land trust that permanently limits uses of the land in order to protect its ecological values. In Europe such a system would be in accordance with EU nature legislation (Habitat and Bird Directives). It allows a landowner to continue to posses the land, make certain use of it, and to sell it or pass it on to heirs. When one donates a conservation easement to a land trust, some of the rights associated with the land are surrendered. For example, one might give up the right to build additional structures, but retain the right to grow certain crops. Future owners also will be bound by the easement's terms, which can include a nature management practice, as audited by the land trust. Conservation easements offer certain flexibility. An easement on property containing species or habitats with high conservation status might prohibit any development, while on another property the ecological values are such that certain activities may be continued. An easement may apply to just a portion of the property and does not need to have public access. If the donation benefits society by permanently protecting important conservation resources they should be made tax-deductible as charitable donations. In many European countries organisations similar to land trusts operate and in addition foundations which accumulate natural reserves with sponsorship from the public. An example of such a foundation is the Foundation for the protection of Natural Monuments (Vereniging Natuurmonumenten) in The Netherlands, which owns 366 nature reserves (88.500 hectares) and is sponsored by almost one million members.

A 'land for Romanian nature' fund should be established, with money for the purchase and subsequent management of conservation lands. Funding can be raised from national and international donations, taxes and subsidies. This fund can be managed under the auspices of an international foundation or perhaps even the European Union. Funding is also necessary for further research into proper management and profitable sustainable use of the Carpathian natural resources, to benefit biodiversity, traditional culture and local communities.

It is urgent and crucial to first obtain funding for the purchase of the priority ecological linkages and construction of green bridges that will safeguard animal movements.

Local traditional people play a vital role as stewards for the ecological network. Photo: Erwin van Maanen.

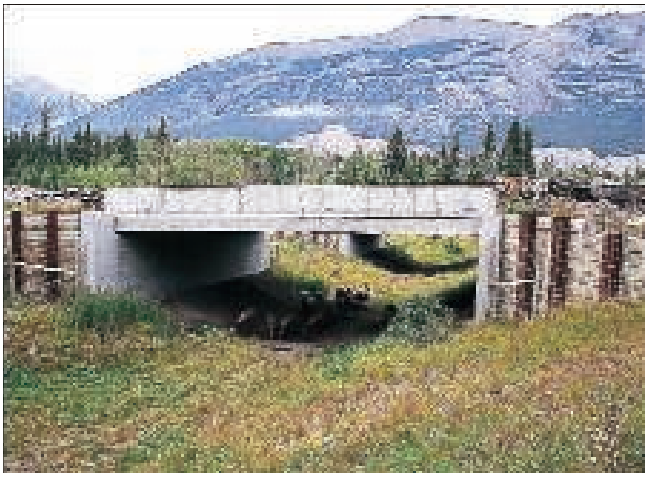
The importance of intersectoral land-use planning

The haphazard and highly unregulated developments and exploitations currently proceeding in many places in the Romanian Carpathians exert a cumulative ecological impact that is hardly surveyable. It is clear that modern intersectoral or integrated land use planning needs to be adopted

by Romania, up to western European standards and by involving all important sectors for land management, water management, agriculture, forestry, housing, transport infrastructure, tourism, industry and last but not least nature management. This requires a highly concerted effort, currently insufficient to lacking. With respect to nature management, there is as yet no government organization in charge of this sector in Romania. It is highly recommended that this sector is institutionalized in a ministry and integrated with closely related sectors like water management, agriculture and forestry. Only with new proper land-use planning and management systems can the expected adverse effects of privatization and unbridled exurban sprawl on nature values be curtailed; this is fundamental.

The arrangement of an ecological network needs to be harmonised with diverging socio-economic interests. Due to the complexity of administrative units and many opposing sectors in Romania, its achievement is constrained. Land management and environmental monitoring can be simplified and more effective if administrative units are combined and focus on solving common problems in larger but better surveyable sub-regional units, for instance at the county level. Such management units should then be governed with less bureaucracy and resource waste and bring more stakeholders together to solve common problems in an integrated fashion.

Without integrated land-use management the likely unfolding scenario is that unbridled or unplanned developments at the current or higher level will create ugly hotchpotch landscapes. These stand in high contrast to the current widely dispersed rustic settlements with many traditional values against the backdrop of wild mountains and vast expanses of forests and fields, which make Romania so attractive to foreign tourists.



Example of an underpass for wildlife underneath a road in the Canadian Rockies.
Photo courtesy of Dr. A. Clevenger.

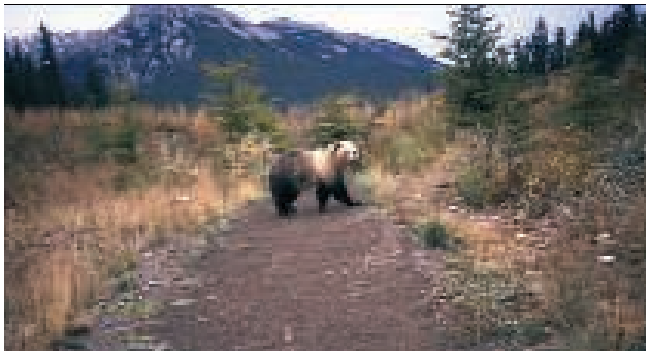
5.4. Ecological impact assessment

In reading several environmental impact assessments it became apparent that environmental impact assessment falls greatly short of the mark in Romania. It is in fact a requirement of democratic civil society and ecological assessment of anthropogenic activities and developments, including many effects likely to culminate from land privatisations, and is compulsory under the EU Birds and Habitats Directive. Tremendous effort is required to advance this up to EU standards and to train qualified personnel to perform it.

5.5. Public awareness, participation and education

At the basis of it all is widespread public support. Romanian society in general is still rather indifferent or ignorant to the conservation needs for the Carpathians and the environment. Symptomatic, for example, are the piles of rubbish left by recreational users in many places. There is prevalent disrespect for environmental laws across all levels of society. Enhanced environmental education and more media attention to environmental problems have the potential of raising public awareness,

goodwill and participation. Organised NGOs with strong voicing concern on environmental issues and lobbying for better environmental planning, regulation and protection are still to emerge in force.



A grizzly bear on the green bridge of the Bow River Valley in Banff National Park in Canada. Photo courtesy of Dr. A. Clevenger.

Without a collaborating force of politicians, scientists, jurists, natural resource managers, journalists and teachers devoted to environmental protection and conservation in Romania, matters will not improve. The current curricula of (technical) colleges and universities in Romania do not cater for such a force, but stick to the in many respects outdated utilitarian system. There is a great need to train and empower many specialized professionals in modern science and technology and in the judicial and social disciplines to balance the main current might of entrepreneurs, many of whom are careless or even disrespectful of the environment, and to stop the national brain drain. Cross-cutting specialists are needed within the corresponding fields of environment, (conservation) ecology, agriculture, forestry, sociology and land and water management. Without this intelligentsia little stands in the way of the current negative developments and there is no manpower essential for the achievement of the sustainable ecological network or 'Carpathian Wilderness Park' with economic profitability. The intention to improve this situation by the Transylvanian University in Braşov is encouraging, but needs great impulse and support.

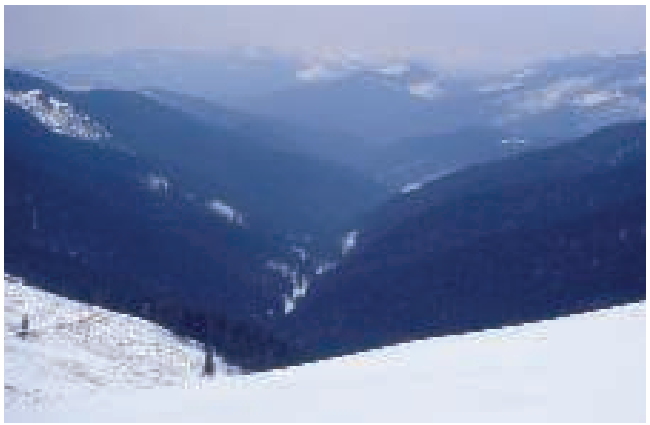
Rural people in the Carpathians can play a vital role as stewards and their support for the ecological network is crucial. A code of ethics, also known as the 'Law of the Mountains', instilled respect for nature in country folk in the past. This is nowadays fading and should be revitalized. To raise enthusiasm and participation in stewardship of the ecological network and sustainable land use, rural communities should be informed and consulted through public seminars and workshops. These should provide important feedback from concerned people on the solving of specific ecological issues, to be tackled in integrated and socially sensitive land management plans.

The general public can gain appreciation and produce proponents for the ecological network through school projects, newspaper and magazine articles, special publications (e.g. natural history books and nature guides) and television documentaries. As a start a pamphlet and poster on the importance of safeguarding the Carpathian ecological network have been produced in this project.

Traffic calming for bears on the Trans-Canada Highway through Glacier National Park (British Columbia, Canada). Photo: Erwin van Maanen.

5.6. Managing tourism and recreation

The Romanian Carpathian ecological network or 'Wilderness Park' would be a great attraction for green and cultural tourism. Well-regulated and carefully zoned recreation can certainly take place within core areas, but should not in ecological linkages. Ecologically sound tourism is important in order to gain widespread conservation support and provide revenues for local communities. The network should cater greatly for people who enjoy the outdoors with great respect for nature. The attractiveness or fun of the network can be enhanced by a myriad of facilities and activities including: wildlife observation sites or trails, fishing spots, hiking trails, camp sites, health resorts, visitor information centres or museums, restaurants, extreme sports, cultural festivities, rustic hotels, living-with-farmers, art or craft workshops, religious workshops, team-building, stress therapies, local produce and handicrafts markets. When properly zoned or located these are ecologically compatible businesses. Much is possible as long as it is not overdone and occurs without impacting wildlife and vegetation. Highly impacting mass tourism facilities, like ski resorts, should not be within the network. The revenues gained from eco-tourism should broadly support communities of nature stewards and partly flow into a fund for nature management of the network. Inspiration can be taken from the management of the great national parks around the world.



The densely forested hills of Maramures, one of the least populated regions in the Carpathians, located in the northern part against the border with Ukraine. Here true wildness and peculiar old traditions in highly picturesque villages and special monasteries can be experienced to the fullest. Photo: Peter Sürth.

A family of wolves on the green bridge of the Bow River Valley in Banff National Park in Canada. Photo courtesy of Dr. A. Clevenger.

5.7. Sustainable use options

The scarcity of almost untamed wilderness and old traditions in Europe implies that Romania is endowed with great natural and cultural assets. When wisely managed in an ecosystem-based way and with certain respect for the endeavours of rural people these assets can quite certainly provide considerable revenues. It may well be that the revenues are higher and more sustainable than those from current haphazard and hit-and-run developments, which benefit mostly a wealthy few. Substantiating research is needed on wise and ecologically sound utilization of Carpathian natural resources with the involvement of all relevant stakeholders.

Already the Carpathians and traditional use are known to offer a range of ready and potential natural goods and services to society, including:

- Fibres, fabrics, resins, dyes, medicinal plants, flowers, fodder, mushrooms, honey, fruit syrups, furniture, wood carvings, game, fish, Christmas trees and mineral water.
- Culinary dairy products organically produced.
- Ecosystem services like the supply of clean fresh air and clean water, regulation of water flow (flood control) and the storage of carbon dioxide against global warming.
- Energy through environmentally tailored hydroelectric and wind power generation.
- A source for scientific knowledge, artistic inspiration and wisdom.

5.8. Ecological information

Despite the recognition that the Romanian Carpathians are biodiverse, the actual distribution and conservation status of many species and habitat types is insufficiently known or poorly documented. Modern insights into important ecological processes and states are also lacking. Only the variously estimated numbers of typical game species across most of the 2148 hunting units are registered by the authorities. To establish an ecological network that effectively conserves landscape and biological diversity, the collection of information relevant to conservation instead of only estimating game species surplus, is vital. Systematic inventories of the extent and quality of habitat types and species and a greater understanding of the cultural and ecological relationships are therefore necessary. This however depends on skilled manpower and good collaboration between key experts and managers, currently lacking.

The monitoring of wildlife should be improved according to modern scientific standards and data centrally managed and freely accessible. This is also in the interest of effectuating EU nature legislation.

Habituated mother bear with four cubs feeding on garbage in the suburb of Răcădău on the fringe of Braşov. Habituation of bears to human society is highly undesirable and may lead to conflicts. The key to solving this issue is proper garbage management. Photo courtesy of nature photographer Martijn de Jonge (www.martijndejonge.nl).

5.9. Transboundary cooperation

The Romanian Carpathians are part of a greater range spanning all the way to the Alps and there are direct ecological relations with neighbouring states, for instance surplus wolves and lynx emigrating to Serbia. Romania has started preliminary discussions on solving common nature conservation issues with Bulgaria, Ukraine, Hungary and Serbia, including the connecting of ecological networks across borders and ecologically sound planning of developments such as transport infrastructure. This requires considerable impulse to lead to decisive actions.

There is a great interdependency between large carnivores and herbivores and the biodiverse ecosystems of forests and grasslands in the Romanian Carpathians, held in great esteem by traditional rural practices. This should be cherished for European society.

Onychomphus forcipatus. Photo: Erwin van Maanen.

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APPENDIX 1
Large carnivore profiles

The story of large carnivores in Romania is remarkable. Owing to the high ecological productivity and the great chunk of relatively unspoiled Carpathians within its borders, Romania is one of the few countries in Europe where bear, wolf and lynx roam in unusually high numbers together with a range of abundant prey species, to a high degree stimulated by traditional agriculture and active wildlife management.

Below we highlight aspects of the biology and ecology of the three carnivores, most of which are relevant to their umbrella and/or keystone function for the Romanian Carpathian Ecological Network.

The grey wolf (Lupul)

Female wolf. Photo: Erwin van Maanen.

Population

In Romania the grey wolf (*Canis lupus*) has survived against many odds in remote areas of the country. The official estimate of the current wolf population in Romania is 2750 animals. This is very high when compared to recent estimates for other Carpathian countries: Poland (250 animals), Slovakia (300-450), Ukraine (350) and a handful of animals in the Czech Republic. The Romanian population represents about 40% of the total European population. Only Spain (1500-2000) and Greece (500) support other sizeable populations in Europe, not counting the immense populations of Russia and the Caucasus. The Romanian population accounts for almost 2% of the estimated World wolf population.

Habitat

Wolves are eurytopic but in Romania they reside mainly in highly natural montane to lowland forests with semi-open areas. Wolf presence in an area can be predicted using the following terrain and habitat characteristics, used by ICAS as so-called 'habitat diagnosis keys':

- *Relief* – hill sides with a multitude of cavern providing rocks and cliffs or erosive formations with deep gully's covering at least 10-20% of the area.

- *Forest cover* – For wolves that live in montane forests tree cover should be at least 60% of the area, with a minimum area of 200 km^2 to support at least one pack. At least 20% of the forest should be mature to aging. Alternation of with semi-natural grasslands and streams (at least 10% of the area) is highly favourable.

- *Prey availability* – Red deer is a chief prey species and should be present in a density greater than 10 animals per 10 km^2. There should also be an abundance of other prey species, including roe deer, wild boar and middle-sized to small animals like the hare.

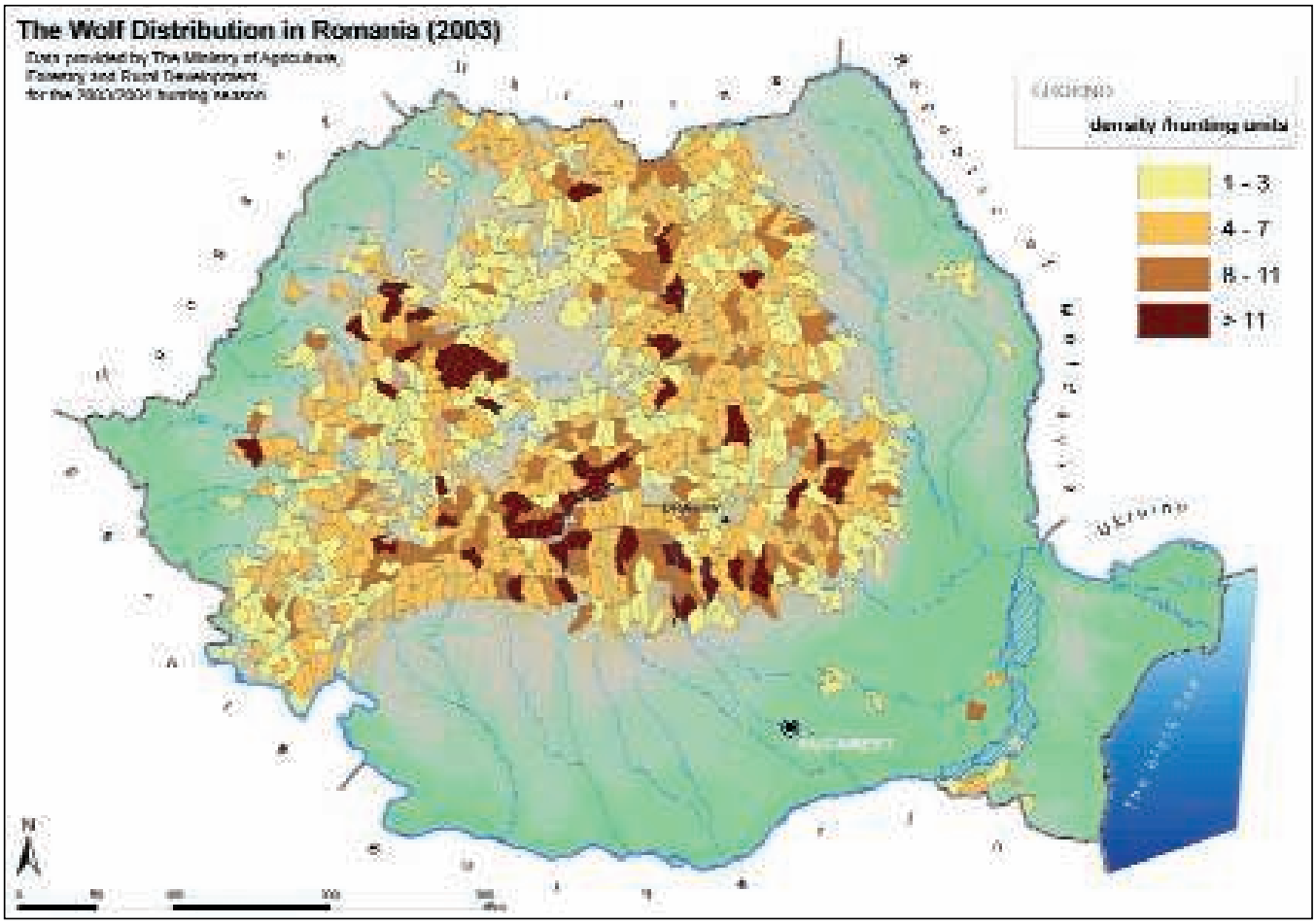


Figure A1.1
Wolf distribution and reported numbers per hunting unit in Romania in 2003. Source: Romanian Ministry of Agriculture, Forestry and Rural Development.

- *Human activity and related factors* – Sheep, other livestock and dogs occasionally supplement the natural diet and are readily caught when encountered unprotected on the edge of the forest and also close to villages. The other side of the coin is that feral dogs can bring rabies to wolves and livestock depredation can fuel human versus wolf conflict. Wolves also undesirably profit from scavenging at garbage dumps and open offal at abattoirs and chicken farms. Another negative factor is that increasing roads in remote forested areas bring wolves within range of hunters and disturbing factors like mass recreation. Busy roads can be lethal to wolves that occasionally dare to cross, as at least one traffic victim during this study showed. Ecologically sound forestry is favourable to the wolf in contrast to largely detrimental industrial forestry.

Distribution

Wolves occur widely across the Romanian Carpathians (figure A1.1). In the old days the wolf was even more widespread in Romania. Its distribution probably coincided with the seasonal (altitudinal) movements of important prey animals like the red deer, not to mention the great sheep flocks of the transhumance. After World War II wolves were regarded as abundant, and in 1955 livestock and game depredation by wolves became an issue. The government consequently sponsored a vermin control campaign. Intensive hunting, trapping and

pup killing followed. Poisoning of wolves became a standard practice, with the side-effect of killing various other mammalian and avian scavengers (e.g. vultures, golden eagle). By the late sixties wolves were severely reduced and had completely disappeared from the lowlands, where jackals then got free play and are fairly common today with about a 1000 jackals recently reported (E. Popescu, pers. com.). Under the Ceausescu regime hunting was restricted to the few elite, and thus the wolf was able to recover, no longer being hunted intensely by peasant folk as in the previous decades. Wolves nowadays primarily inhabit the dense and steep montane forests and the dividing hilly expanses with relatively low human occupation and sparsely dissected by secondary roads and tracks. Although occasionally reported, they are practically absent in the more intensely cultivated lowlands of Romania. They are incidentally noticed in the lowlands of the eastern part of the country, for instance along the Prut River and in the Danube Delta, and occasionally in the Romanian plain around Bucharest. Mobile wolves can cover large distances in a short time, able to cross large expanses of unsuitable habitat, (e.g. see Valière *et al.* 2003). The maximum reported dispersal distance in Europe is 886 km (Boitani 2000). It is thus likely that wolves venture far into lowland areas mainly as dispersing sub-adult individuals, occasionally establishing loose small packs which are probably quickly eradicated when discovered by shepherds or poachers. Wolves are not naturally limited to the mountains and can actually occupy a wide range of landscapes in Europe, including semi-deserts, steppes, wetlands, forested river floodplains and taigas. They can even survive in quiet corners of highly cultivated landscapes, such as in the glowing grain belts of Castilla-Leon in the northern part of Spain near Madrid, or the military practice zone of Muskau heath of northern Saxony in Germany (Stoepel 2004). They are in fact the most adaptive and opportunistic of Europe's large carnivores. Suitable habitat can be anywhere where human interference and persecution is low and where water availability, prey and carcass base and cover is high enough.

Aspects of wolf biology

A pack of wolves constitutes at least a dominant mating pair - a leading alpha male and alpha female - and can maximally include up to ten sons and daughters of several ages. The social bonds within the pack are hierarchical and strong (Derix 1994). Members often hunt cooperatively. The average pack size in Romania is 5.5 animals. A wolf litter can contain 1 to 11 pups and generally a pack cares for one litter. Wolf density is significantly correlated with prey abundance or availability. Low prey capture can restrict territories and limit pack size by the forcing away of young maturing animals. Outcasts may remain for a time on the borders of their natal territory or disperse directly far away to establish their own pack. Packs demarcate their area and show group strength with howling at special rendezvous-sites or at a kill. Territory boundaries are regularly patrolled and certain spots demarcated with scent-marking (urine and scats) to warn and deter intruders. Figure A1.2 shows the ranging of six wolf packs near Braşov, determined with telemetry by Peter Sürth. The size of these packs varied from 2 to 9 individuals. Their average range was 170 km^2; the minimum range was approx. 120 km^2 and maximum range approx. 250 km^2. These ranges are very small when compared to wolf ranging in boreal and sub-arctic habitats, where a pack can patrol up to several thousand square kilometres.

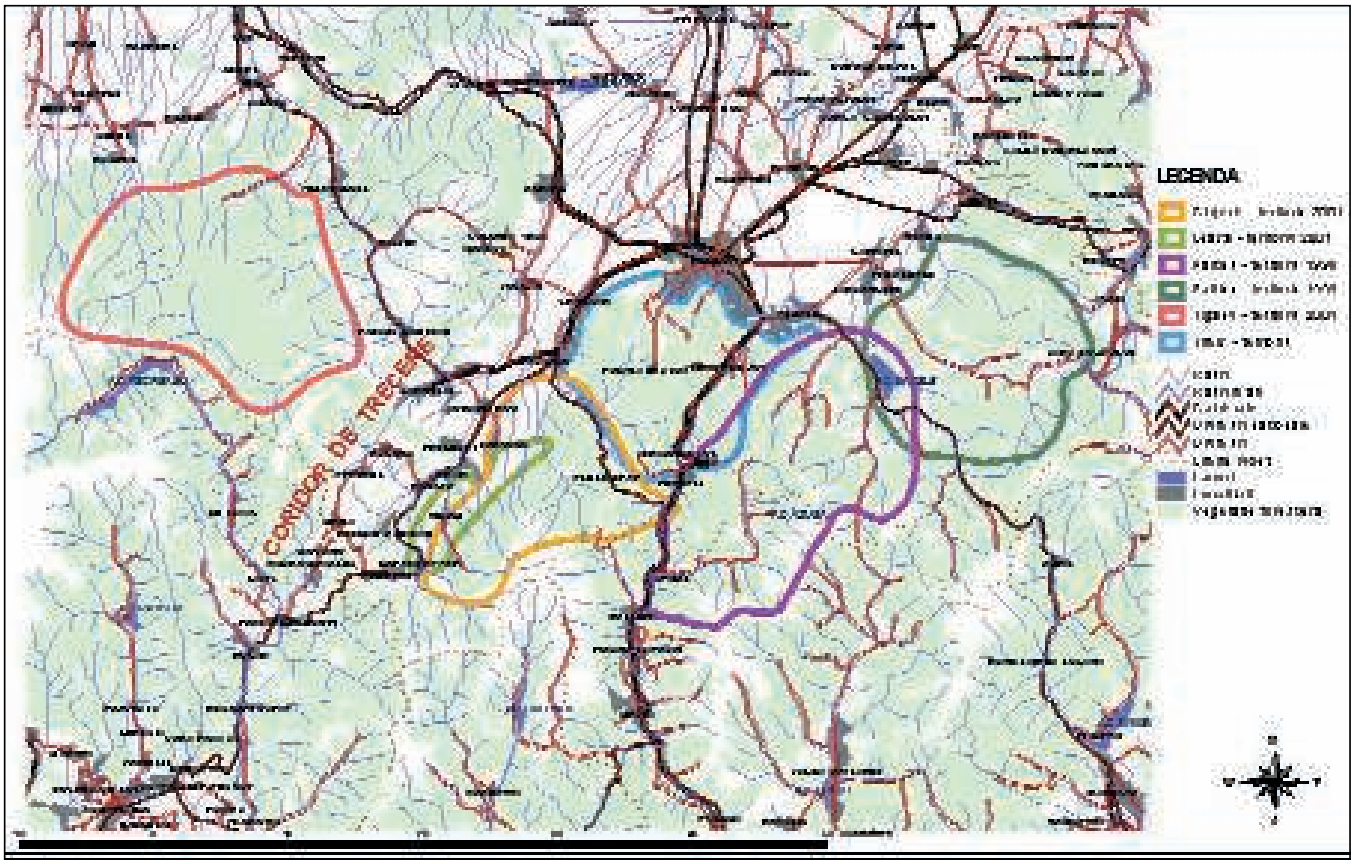


Figure A1.2
Results of telemetry studies of wolf pack home ranging near Braşov in 1998-2001 (ICAS, unpublished).

Food

A wide range and abundance of wild prey is available to wolves in the forests of Romania. Red deer, roe deer and wild boar present the staple diet, followed by smaller animals ranging from hare to mice, and also including smaller carnivores like the red fox. Given the opportunity domestic animals including sheep and dogs are readily taken, but particularly in areas where wild ungulates are scarce and persecution is high. Meat is supplemented with vegetables and fruits.

Relation with humans

In Romania wolves often venture close to human settlements, especially in autumn and winter when packs can cooperatively hunt wild ungulates, dogs and livestock in the lower forest fringes and right onto the edge of farms. They are master in avoiding humans and often venture unseen into towns. Several years ago, the BBC filmed the nightly outings of a radio-collared female wolf named Timiş. As member of a small pack she occupied a den underneath some rocks in a hillside quite close to the busy road next to a railway from Braşov to Bucharest, just south of Braşov. Wounded on one leg she would limp along the railway, passing through drainage ditches and quickly across roads, but avoiding underpasses. Her nightly journeys led her right through the outer southern suburb of Brasov, to reach fields with a garbage dump where she hunted small mammals (hares, rats) and scavenged on leftovers to feed her 10 cubs. She would even pass humans unnoticed in the morning rush hour, taken for a dog with a collar. She was not the only wolf in the area. The fields with shepherd

camps on the southern edge of Brasov were frequently visited by wolves from packs near the town (Peter Sürth). Nowadays wolf visits to the area are probably limited by the expanding shopping mall and car showrooms. There are more stories of wolves roaming around settlements near Brasov (pers. comm. Peter Sürth). In the Bran area a wolf pack occupied a den about one kilometre from the village of Simon. This pack visited houses in the surrounds almost every night. A radio collared wolf called Leassa from this pack was even found hiding just 100 meters from a farm during the day. The pack killed 150 dogs in the area during one year! In other places in Europe similar behaviour is observed, for instance in Abruzzo, Italy. Despite their age long persecution, wolves in Europe, Russia and the Caucasus have a remarkable tolerance toward humans.

Roe deer doe killed by wolves.
Photo: ICAS Wildlife Unit.

Conflicts between wolves and humans still arise in the Carpathians, varying in seriousness. In areas with many wolves and great sheep flocks, interactions are inevitable. Only proven livestock depredation is compensated through a national scheme supervised by the hunting unit administrator. Mainly sheep or goats are sporadically killed by wolves, most often at night in late summer and autumn. Shepherd camps without proper protection can provide easy picking for both wolf and bear. Prevention by deterrence is the best solution against predation. Large fierce (special breed) shepherd dogs with sharp collars are used to guard flocks against wolf attack. Guarding livestock with electric fencing is also a good modern method, but is still largely applied experimentally and thus not yet widely available or accepted by Romanian shepherds.

The Romanian public attitude toward the wolf varies between sympathetic, neutral indifference to complete aversion. Through centuries of co-existence, the wolf is accepted to a high degree by country folk, as long as livestock predation is within reasonable limit. The wolf is 'protected' in Romania but may nevertheless be hunted according to a yearly set quota during a 5.5 month season. For example, in 2003 thirty wolves were legally shot. Special hunting permits can be issued in areas where wolves predate overly on livestock. Poaching of wolves is rarely registered and believed by the authorities not to have great impact.

The wolf suffered relentless persecution in the past, but maintained a stronghold in the vast forests of Romania. Today hunting pressure is much less, reduced to the killing of 'nuisance' animals and pleasure hunting of a set quota of animals. Eventually 'wolf watching' can bring more income than the undesirable killing of large carnivores.

Threats and conservation

A major threat to the wolf across the Carpathians is habitat loss and fragmentation through development of busy transport infrastructure and urban expansion. Habitat deterioration through intensive forestry, declining wild prey populations through poaching and other human impacts, and high level persecution can also hamper the species. The relative contribution of different mortality factors for the wolf in Romania is not well documented. However a good account of wolf mortality in Eastern Europe is provided by Huber *et al.* (2002), updated by 'Conservation and Management of Wolves in Croatia' in 2004. Of a total of 115 dead wolves recovered in Croatia during 1986-2004, 84% died as a result of human activity, with 56% due to persecution and 28% due to traffic. The other mortality was due to 6% rabies, 9% unknown natural cause, 7% disease other than rabies and 2% due to intraspecific conflict. In Romania only one dead wolf due to traffic was reported during this study.

It is a shame that many Romanian hunters still argue that wolves overly predate on game and livestock, regarding wolves as enemy and competitor. This is contrary to the general consensus of many ecologists studying wolves around the world: carnivore populations are kept in check by prey availability. Wolves only regulate or limit prey populations to a certain level (Mech & Boitani 2003), depending on prey availability. In productive areas with high ungulate densities, the predation pressure by wolves is usually a fraction of the total ungulate mortality. Only at low ungulate density, for instance due to human interference (e.g. poaching), can predation pressure become significant. Also, when packs are scattered by the killing of the leaders the disbanded members can resort to excessive raids on livestock. In the natural situation wolves help to maintain healthy ungulate populations and thus prime game reserves. In the words of a wise Romanian hunter who understood this relationship: "Wolves keep game populations vigorous".

In Romania wolves can be shot in organised trips from September till March, by drive hunt or shooting of animals attracted with bait from a hide.

The wolf benefits greatly from full protection in large interconnected expanses of suitable habitat, where it can keep out of conflict with human interests and fulfil its ecology interactive role.

Protection status of the wolf in Europe

According to the IUCN-World Conservation Union's 1996 Red List, the wolf is to be treated as a 'vulnerable species'. It is listed as a 'strictly protected species' on Appendix II of the Bern Convention of the Council of Europe, also known as the Convention on the Conservation of European Wildlife and Natural Habitats (issue 19.09.1979). This agreement was ratified by Romania in 1993 and published in the 'Monitorul Oficial' as Law 13/2/1993. The wolf is also listed on Annex II and IV of the EU Habitats Directive or Conservation of Natural Habitats and of Wild Fauna and Flora (issue 92/43 of 21.5.1992). According to this agreement EU member states should take appropriate measures to ensure full protection of the species and its habitat. Special conservation measures are provided in the wolf action plan for Europe (Boitani 2000), and should work through a national action plan, currently being prepared. The Habitat Directive Annex II listing also implicates that Special Areas of Conservation (SACs) should be designated for the wolf as part of the Natura 2000 constellation of protected areas. The Annex IV listing applies to "animal and plant species of community interest in need of strict protection" throughout the country. According to EU legislation wolves may only be killed when public safety or high economic interests are truly at stake.

Although the Romanian wolf population should benefit from European conservation legislation, effective protection will largely depend on widespread public goodwill, image improvement and adequate protection and compensation against livestock depredation. Large-scale, prey-rich and undisturbed remote habitats for wolves should be set aside. The importance of the Romanian wolf population as vital stock for the European wolf population should be fully appreciated and fostered by the Romanian government.

Further reading

Further reading on the biology, ecology and conservation management of the wolf is recommended in Mech (1974), Mech (1981), Okarma (2000), Mech & Boitani (2003), Boitani (2000), and MacDonald *et al.* (2004).

The European brown bear (Ursul)

Population

Brown bears (*Ursus arctos*) reign in the Carpathians since prehistoric times, and once lived alongside the even greater cave bear. The Carpathian brown bear population currently amounts to about 8100 bears and its bulk is spread over Slovakia, Poland, Ukraine and Romania. After the great Russian population this is the second largest bear population of Europe (Swenson *et al.* 2000), followed by the Scandinavian population. In pockets elsewhere in Europe the numbers vary from a few to tens of individuals. For the Carpathians three subpopulations are recognized: a Northern Slovakian population, a Southern Romanian population and a separate Apuseni population (Zedrosser *et al.* 2001).

Brown bears, a mother with two cubs, in the truly wild Greater Caucasus Range (Georgia). Photo courtesy of Alexander Gavasheleshvili, Georgian Center for Conservation of Wildlife (GCCW).

The Romanian brown bear population in 2003 was estimated at an astounding 4350 individuals, mainly confined to the Apuseni and southern Carpathian mountains. This population represents about 35% of the European population west of Russia. This number is close to the maximal national carrying capacity estimated at 4500 animals, although an incredible 8800 bears was reported for 1988! The highest densities are found in the counties of Braşov, Harghita, Covasna, Vrancea, Sibiu and Arges. One cannot help to think that the populations are overestimated, also motivated by the apparent inconsistencies of monitoring across many hunting units, most of which are as big as the maximum male bear territory in Romania. Nevertheless with an arbitrary error margin of 25%, the population is still substantial. Bears truly are exceptionally common in Romania because they are actively managed for hunting, as is most other wildlife. This reached absurdity in the Ceausescu era. Ceausescu was keen on exceptionally large bears, which he sized using a measuring rod along a hanging carcass before shooting them in trophy competition with the president of Bulgaria. After the revolution the population dropped close to the current level, probably due to increased poaching, reduced supplementary feeding and culling through trophy hunting.

Habitat

Bears in Romania prefer habitats with the following features:

- *Relief* – Steep slopes with cavy rock formations and gorges covering at least 10-20% of the area, providing daily refuge and dens for hibernation and breeding.

- *Forest cover* – Optimal habitat is provided by mature to aged forests covering at least 70% of a large area, with sufficient shelter and hideouts provided by dense forest, shrubs, fallen trees, gullies and gorges. There is no real preference for forest composition in terms of the predominance of spruce or broad-leaved trees. Highly natural forest should be combined with patches of rejuvenating forest, glades and streams that provide a multitude of different foods variously throughout the summer months, and fresh water.

- *Food availability* – Bears are chiefly omnivorous and kill wild ungulates only on occasion. They scavenge readily on carcasses. As bears eat themselves to high obesity (hyperphagia) during the summer season, there should be a continuous abundance and variety of food available. High protein foods consist of ungulates, middle-sized to small animals, ground-nesting birds (eggs), beetles (grubs) and colonies of red forest ant, bees and wasps. The vegetable diet consists of fresh leaves, mosses, fungi, nuts, berries, fruits, herbs and grasses. Hence the forests need to be highly productive, as they are to a high degree on the predominantly rich clay and limy soils in the Carpathians. Native fruit trees like crab apple, common pear and myrobalan plum add enormous value to the habitat, as do crops (corn) and orchards especially maintained for wildlife. A combination of common beech, chestnut, hazel and sessile oak provides hard mast in autumn, required for the final fattening for hibernation.

- *Human activity and related factors* – Easy to catch livestock supplements the natural diet of brown bears. They benefit to a certain extent from extensive and rotated grazing by livestock, maintaining meadows with continuous regrowth of nutritious grasses and herbs. Within maturing forests extensive forestry by selective cutting and small scale clear-cutting without soil disturbance can be beneficial to bears, stimulating herbal and sapling growth (Nielsen *et al.* 2004). Generally not favourable are roads in the mountains. Depending on density and intensity of use, roads

provide better access to hunters, bring more disturbances through recreation and stimulate the invasion of holiday homes and hotels. Bears are normally reluctant to cross roads with moderate to high traffic volume. Quiet roads on the other hand provide herbs and berries in the sunny road verges, which may attract bears. Bears are highly attracted to open garbage and other concentrated food sources around human settlements, which is highly undesirable as it can lead to nuisance bears through habituation (see below).

Distribution

In Romania 85% of the total bear population resides well into the more remote forested montane areas, with the remaining 15% roaming in the outer foothills and connecting lowlands (figure A1.3). The cultivated lowlands beyond are practically devoid of bears. The highest densities occur in the 'elbow' of the Romanian Carpathians, where the distribution is almost continuous in large and highly contiguous forests, like in the spruce covered county of Harghita. The population (around 275 animals) of the Apuseni Mountains is more or less isolated from the populations in the main range. About 29% of Romania's landmass is occupied by bears.

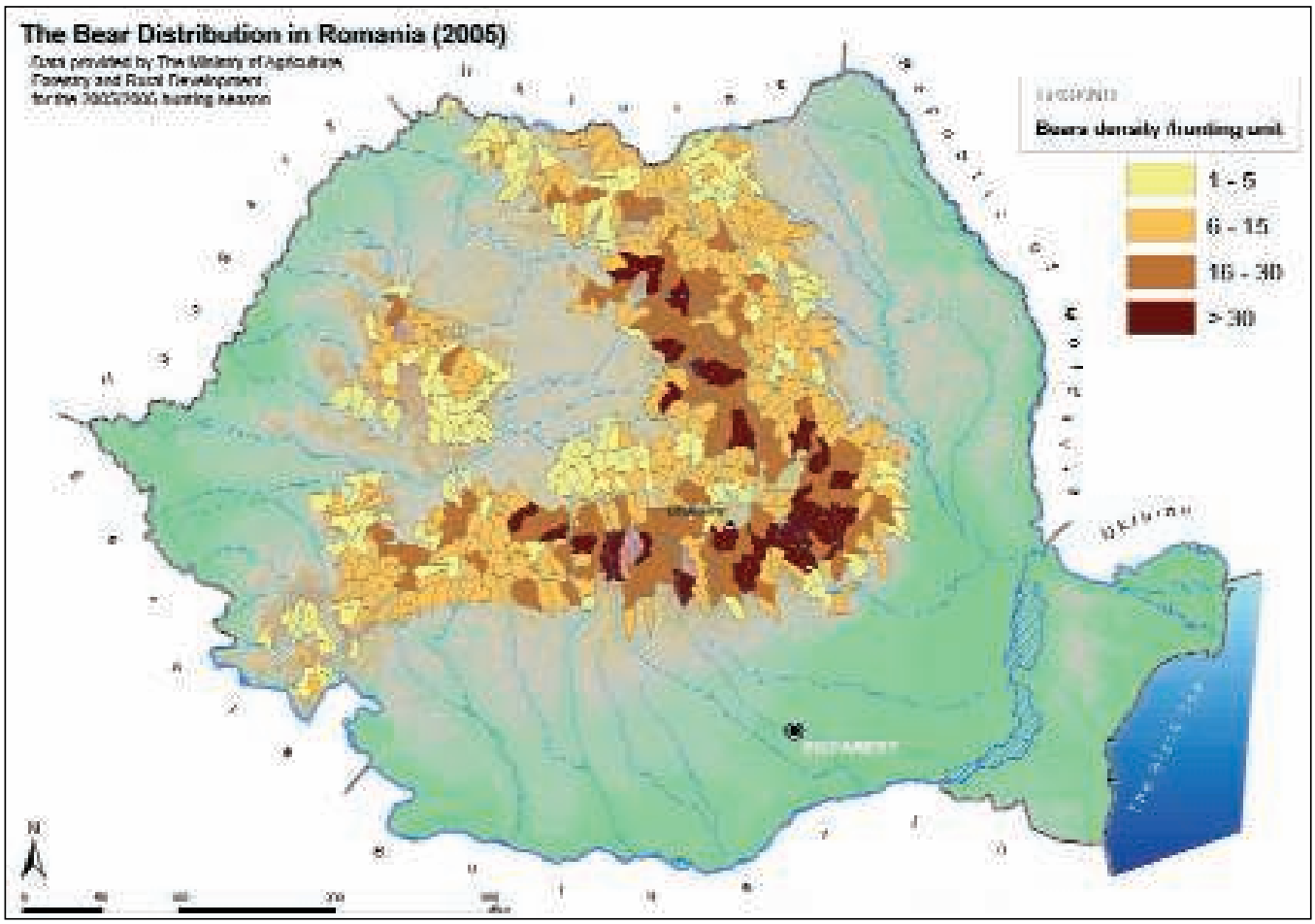


Figure A1.3

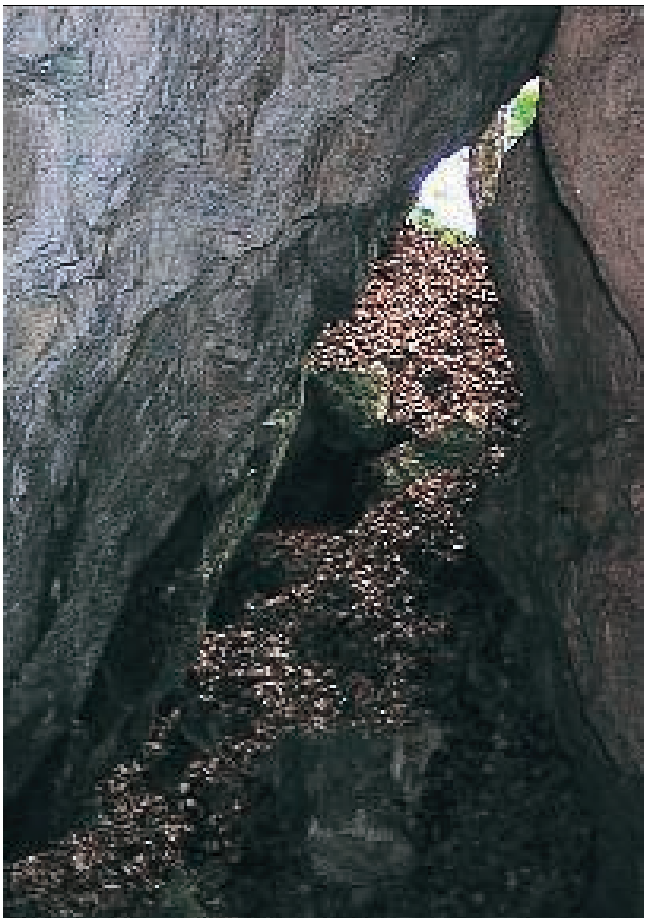
Brown bear distribution and reported numbers per hunting unit in Romania in 2005, with almost all hunting units monitored. Source: Romanian Ministry of Agriculture, Forestry and Rural Development.

Aspects of brown bear biology

The biology and ecology of bears is well-studied in Romania and especially for the purpose of hunting management or cynergetics (Quammen 2003). Bears hibernate through the long and cold Romanian Carpathian winters. Their winter and maternity dens are mostly located in caves in remote and steep forested hillsides, and to a lesser extent in ground hollows, for instance underneath the root system of a large fallen tree.

As soon as bears awake in early spring they start feeding intensively to quickly replenish their metabolized body fats. From late summer to late autumn they must feed continuously until an obese state is reached to sleep through next hibernation.

The variety of nutritious food available in the productive temperate forests of Romania allows bears to attain high population densities in relative harmony. This is in contrast to the cold boreal forests of the far north, where bears need to defend and forage in much larger territories to obtain the same nutrition. The average density in the Romanian Carpathians is estimated at one bear per 10 km^2. In some areas where conditions are over-optimal (i.e. with food supplementation), the density can reportedly be up to five bears per 10 km^2! This is very exceptional and involves bears congregating peacefully in areas where a lot of food is on offer, such as orchards, garbage dumps and feeding stations. Worldwide the home ranges of male and female brown bears can vary considerably in size (up to nine-fold), with often huge home ranges reported in northern Scandinavia, Siberia and northern Canada. Several female territories are contained in the often much large territory of a male, so that the male can maximize his reproductive potential. As females are usually sexually receptive once every three years, it pays to have females in different maternity stages. In Romania brown bear home ranges are quite small. The estimated maximum home ranges needed for male and female bears in the Romanian Carpathians are respectively 200 km^2 and 50 km^2.



Inside a bear winter den with view to the entrance just outside Piatra Craiului national park. Protection of areas with secluded undisturbed caverns is of paramount importance to bear conservation. Photo: Erwin van Maanen.

A female brown bear (sow) delivers 2-5 cubs. Bear fecundity and cub survival in Romania is very high because of the abundance of natural food and additional feed provided by humans. Litters of 3-4 cubs are practically the norm. The cubs stay with their mother until they reach sexual maturity at age three or four. Young males then often disperse far away from their father's territory in search for their own. Females often stay within or close to their

mother's territory. Dispersal in bears is an important process to consider for the requirements of an ecological network. Young males need to disperse to areas without too many other males competing for females. If an area is overcrowded with young males intraspecific conflicts arise, and livestock predation and even aggressiveness toward humans may increase. In core areas with adequate carrying capacities brown bears do not usually pose much of a problem.

Food

The life of a bear revolves around feeding. Although bears are well-equipped to be prime carnivores, they are not strictly flesh-eating. A determined bear can kill an animal up to the size of a bull. During the summer months bears exploit mainly fruits, berries and the fresh shoots and roots of shrubs, herbs and grasses. This vegetable diet is supplemented by colonial insects, rodents and carrion. In autumn and in mild winters they switch mainly to hard mast such as acorns, beechnuts, hazelnuts and chestnuts. Fatty meats are then also relished. Wild ungulates are opportunistically killed, often in a weakened, disabled or ill state. Large bears occasionally raid shepherd camps for a sheep, a horse or a cow. The left-over carcases are usually cached underneath leaves, sticks and rocks. In Romania and the Balkans it is common practice to supplement bears with carcasses at so-called feeding stations. Here hunting managers observe the status of 'their bear population' and select individuals for hunting. Supplementary feeding is believed to keep bears within the forest and out of harms way. Nevertheless, many bears still take the opportunity to raid honey farms and orchards.

Relation with humans

City folk, especially the younger and more educated generation, hold bears in higher esteem than country folk. In the country the raids of bears on orchards, beehives and shepherd camps has led to some unpopularity of bears. Problem bears are removed. At the same time the bear can be appreciated as guardian of the forest, wilderness spirit, and an actor in folklore and children's stories; a cultural keystone species in the truest sense (Garibaldi & Turner 2004). Instead of right-out persecution most shepherds accept occasional livestock depredation by bears and other large carnivores as part of life, and take preventive measures by guarding their flocks closely with the help of fierce dogs.

Bears are 'protected' in Romania, yet they are drive hunted according to a yearly revised quota. Only 'surplus' and problem bears may be killed by qualified Romanian hunters and rich western trophy hunters. According to official record a 133 bears were shot legally in 2003.

Threats and conservation

Brown bears everywhere are threatened by the loss of habitat in both quantity and quality, chiefly caused by the development of transport infrastructure, industrial logging, mining, ski resorts and by urban expansion.

Their acute smell attracts bears to garbage disposals or other concentrated food sources associated with human settlements. Well known are the bears raiding garbage containers in Răcădău, an outer suburb of Braşov right in the middle of forested hills, from which bears emerge as soon as it is dark to haul over garbage containers and consume edible remains from scattered rubbish. This has been going on for many years and has now grown into a tourist attraction. People drive by the bears continuously, spotlighting them. Some locals even dare to feed immature bears with cookies and other sweets. Presently up to four sows with 4-5 cubs, and several solitary sub-adult bears scavenge the area simultaneously. The authorities have tried to discourage some bears with rubber bullets or translocated them, without much effect. Several

persistent bears were even shot. Without proper garbage containment new bears arrive with their cubs, habituating a new generation. The bears are remarkably tolerant toward human spectators. However, two serious bear attacks occurred in 2004. The first attack happened in July, slightly wounding two young men. On their exit from a flat building they where 'surprised' by a bear around the corner. The second attack on a morning in October was fatal. One version of this attack (pers. comm. Ovidiu Ionescu) is that a bear, diagnosed by the authorities as rabid, went on the rampage in a forest close to Răcădău, ultimately injuring several recreating people and killing two. The bear was shot. A slightly different account is given by Rigg (2005). The area is now policed by gendarmerie, warning spectators against feeding or provoking the bears. The problem of easily accessible garbage containers has partly been solved with the donation of sturdy closed containers by the World Society for the Protection of Animals (WSPA). But still many open containers remain, which are more frequently emptied by the municipality. As a result some bears are now venturing further into town to raid other open garbage containers, with one bear reported almost right in the centre of Braşov.

Another bear attack that year, elsewhere and in a different situation, involved a farmer investigating with a torch what he thought was a wild boar raiding his garden and orchard at night. Instead he met with a surprised bear that consequently mauled the man's head severely.

Apparently Răcădău is not the only place in Romania where bears raid garbage. 'Garbage bears' are also reported in the nearby town of Sinaia, and there are certainly more places. In North America the habituation of bears became a serious problem when several grizzly bears and black bears lost their fear of humans and some attacked hikers, many of the maulings gruesomely fatal (Herrero 1985). Black bears feeding on garbage in suburbs change their behaviour. They become completely nocturnal and hibernate much shorter than usual or not at all (Beckmann & Berger 2003). If they do not attack people or pets, they can certainly do a lot of damage to property, for instance by breaking into cars. Since the European brown bear is presumably less aggressive than its North American and Siberian cousins, one can only guess for Romania what bears will do to people and property, and how their natural rhythms will change when garbage mismanagement continues widely. From the viewpoint of conserving wild animals it is certainly unacceptable to allow the habituation of bears to continue. Rubbish kills bears. In November 2005 a sow was found dead near Răcădău, leaving her three cubs orphaned. Autopsy showed that her stomach was filled with plastic, to the point that it ruptured. Keeping bears out of rubbish is the motto. Key to solving the problem is proper garbage management and strict prohibition of littering. Bear proof containment of garbage does not need to be reinvented in Romania; Carpathian municipalities can adopt bear proof containers straight from North America.

The Bear Management Plan of Croatia provides reliable statistics of bear mortality in Eastern Europe (Dečak *et al.* 2005). Of 211 bear deaths reported in Croatia between 2000 and 2002, 5.6% were contributed to car traffic, 6.2% to railway traffic and 78.7% to hunting. Of the bears killed by traffic and trains, respectively 63.6% and 41% were young males. It appears that in Eastern Europe females are more reluctant than males to cross busy transport corridors (Kaczensky 2000; Kaczensky *et al.* 2003). This suggests that roads are effectively obstructing female bear movements from one population to another, and to a high degree preventing the dispersal of female bears to

vacant areas, where less restricted males could then predominate and clash. In 2003 a sub-adult bear was reported fatally wounded by a truck on the busy road between Bucharest and Braşov. On the same road in July 2005 a young bear was seen on the side of the road, pacing left and right but unable to evade the traffic in order to cross; subsequently it retreated back into the forest.

Bear require large natural forests. It has been indicated that traditional forestry by small-scale clear-cutting and aftercare for the forest soil and vegetation can be beneficial to bears (Nielsen *et al.* 2004). Conversely, intensive exploitation of forests and replacement with structureless pine stands results in habitat impoverishment. Clear-cuts should be partially replanted with fruit trees to enhance their value for bears and the soil treated carefully to allow natural regeneration of forest, beginning with nutritious herbs and berry bushes. Forest management finely attuned to the specific ecological situation is needed in this respect. This can only be accomplished by qualified foresters with heart and feeling for nature, not by short-term profiteers. Bear core areas consisting of a mosaic of structured forests, shrubs and semi-natural grasslands should be at least 3500 km^2 and well interconnected by broad forested linkages. Isolated areas tend to be colonized mostly by males, which without an adequate number of females in a large enough area cannot establish a stable breeding population.

The Carpathians are becoming increasingly popular for tourism and recreation. Many people in many places exert a certain amount of stress on bears and vice versa. The problems experienced can be guessed as similar to those of North America, which are curtailed by allowing tourists only in certain zones in which bears are kept from habituation with the use of 'bear proof' containers and enforcement against littering.

Poaching of bears certainly occurs in Romania. Even when unintentional, according to ICAS's Wildlife Unit the trapping of bears in snares set for ungulates is increasing. Over the last two years 30 snarings were reported. The Wildlife Unit responds to emergencies whenever they can and are often successful in freeing a bear by sedation. However, sometimes a bear must be killed when it has suffered severe injuries. In one case a raged bear was shot after it snapped the steel snare and raged onto his rescuers.

Only surplus and nuisance bears may be legally hunted in Romania. However the surplus can be questionable and the reliability with respect to this issue is being debated. Moreover, it is not clear whether the hunting is truly selective, as it should be to maintain population stability in terms of proper age structure and sex ratio (Smith 1995). The killing of territorial females and males can have a disproportionate negative impact on the population and upset the status quo within bear society.

Protection status of the brown bear in Europe

The European brown bear – like the wolf - is listed as a 'strictly protected species' on Appendix II of the Bern Convention ratified by Romania in 1993 and published in the 'Monitorul Oficial' as Law 13/2/1993. It is also listed on Annexes II and IV of the EU Habitats Directive. The Annex II and IV listing implicates that EU member states are obliged to fully protect bears and their habitat throughout the country. Conservation measures are provided in the EU action plan for the brown bear (Swenson *et al.* 2000), to be adapted into an action plan for Romania. The Annex II listing also obliges EU member states to designate Special Areas of Conservation (SAC's) for bears as a part of Natura 2000. Several other resolutions for brown bear conservation also oblige the Romanian government to set aside special reserves, and forbid the EU to

sponsor any spatial developments detrimental to the species. According to EU legislation a bear may only be killed if there is an overriding reason of societal importance, for example in the interest of public safety or when unacceptable economic damage is the case. This has been taken into the Romanian hunting Law 103/96 adopted in 1996.

Bear killed after it was snared by poachers and upon rescue broke free to attack his liberators from ICAS Wildlife Service and the local hunting unit. Photo: Rogier Klaver.

Although the Romanian bear population should benefit from European conservation legislation, effective protection will largely depend on widespread public goodwill, and adequate protection and compensation against livestock depredation. Large-scale, productive and undisturbed remote habitats for bears should be set aside. The importance of the Romanian bear population as vital stock for the European bear population should be fully appreciated and fostered by the Romanian government. This includes taking effective measures to prevent the habituation of bears.

Further reading

Further reading on the biology, ecology and conservation management of the brown bear is recommended in Pasitschniak-Arts (1993), Herrero (1985), Servheen *et al.* (1998), Swenson *et al.* (2000), Kaczensky (2000), Kryštufek *et al.* (2003) and Dečak *et al.* (2005).

The Eurasian lynx (Râsul)

Population

Romania harbours probably more than a thousand Eurasian lynx (*Lynx lynx*), the official estimate of 1800 animals (2003) probably being too high, as knowledge of this reclusive species among hunting unit managers is variable.

'Photo trapped' Eurasian lynx in the forest steppe of Vashlovani Reserve, eastern Georgia. Photo courtesy of Noah's Ark Centre for the Recovery of Endangered Species (NACRES).

Habitat

The following habitat features indicate the likelihood of lynx occurrence:

- *Relief and snow cover* – Hill sides with a multitude of rock or cliff formations covering at least 20% of the area or greater for the provision of dens, hideouts and command views. Areas with snow cover higher than one meter are not suitable.

- *Forest cover* – In Romania the lynx lives predominantly in large, mature and structured forests with plenty of dense shrub, fallen trees, caverns, streams and grasslands. The forest can be deciduous, mixed or solely coniferous. Forest cover should be at least 60% of the area. At least 200 km^2 of undisturbed natural space should be available for a family of lynx.

- *Prey availability* – The lynx, like most other non-social cats, is an opportunistic but determined solo hunter. Roe deer ranks high on the list of prey species and should be present in a density greater than 25 animals per 10 km^2. There should also be an abundance of other middle-sized to small animals (e.g. hares, marmots and squirrels) and partridge-like birds. Red deer are also killed, but mostly as fawns or disabled adults.

- *Human activity and related factors* – Sheep, goats and poultry incidentally supplement the natural diet when encountered unprotected in a pen or freely near the forest edge. Like for the bear and wolf, an increase in road density in the mountains is detrimental, making remote vestiges of lynx habitat accessible to hunters and disturbing recreationists. Highways and other busy roads or human occupied areas present absolute barriers, wide disturbance zones and mortality sinks. Ecological forestry is good for the lynx, industrial forestry is bad.

Distribution

The Eurasian lynx once occurred almost throughout Europe and probably co-existed partially with the nowadays critically endangered Iberian lynx (*Lynx pardinus*) in the Pyrenees. This former range has shrunk drastically with separate populations nowadays in Fenno-Scandinavia, the Baltic States and in Central and Eastern Europe. The lynx was recently reintroduced in Central Europe (Breitenmoser *et al.* 2000). Small populations and pioneering individuals remain in eastern France (The Alps and the Jura Mountains), Switzerland, Austria, southern Germany and recently there are indications of lynx in southeast Belgium (Ardennes; pers. comm. H. Wijsman). The Carpathians are a vital stronghold for the species, with an estimated population of 2500 animals spread over the Czech Republic, Slovakia, Poland, Hungary, Yugoslavia, Ukraine and Romania. Most lynx are found in large forested areas with an abundance of ungulates (roe deer and red deer).

In Romania the bulk of the lynx population has retreated to the Carpathian highland forests, occurring up to the tree line in summer. It avoids areas with snow depth exceeding one meter. Its distribution is believed to be almost continuous across the range (figure A1.4). Some lynx live in woodland of the lowlands and there are reports of animals that were shot in more open areas near the Black Sea coast.

Aspects of lynx biology

The lynx is a reclusive, shy and alert animal, rarely encountered by people. Hence it is one of the least known carnivores in Romania. Monitoring is best done by way of snow tracking, killed prey, scats and photo trapping.

Lynx live a semi-solitary life, only joining during the mating season. Territories are demarcated using gland secretions, spraying, scrapes, tree

scratching and probably faeces. An established adult male shares his territory often with one or two females, but does not tolerate other males. The female territories usually do not overlap, but male territories may partially. Telemetry of lynx in the Romanian Carpathians indicates that male territories are maximally 200 km² and female territories 100 km². The lowest reported home range reported for the Carpathians is 20 km². Lynx density depends mainly on prey abundance and refuge. In the rest of Europe densities are usually not very high; on average one to three adults per 100 km² (ELOIS). The average density reported for the Romanian Carpathians is 3.9 animals/100 km².

Mating occurs between February and mid-April. A litter contains one to four, sometimes five, kittens (average is 2.46 kittens) that are sheltered for two-three months in a den. At ten-eleven months the young leave their mothers care, but do not reach sexual maturity until they are three years old. Young males are chased away by their father and then go in search of their own territory. It is believed that only about half of the lynx offspring reaches adulthood.

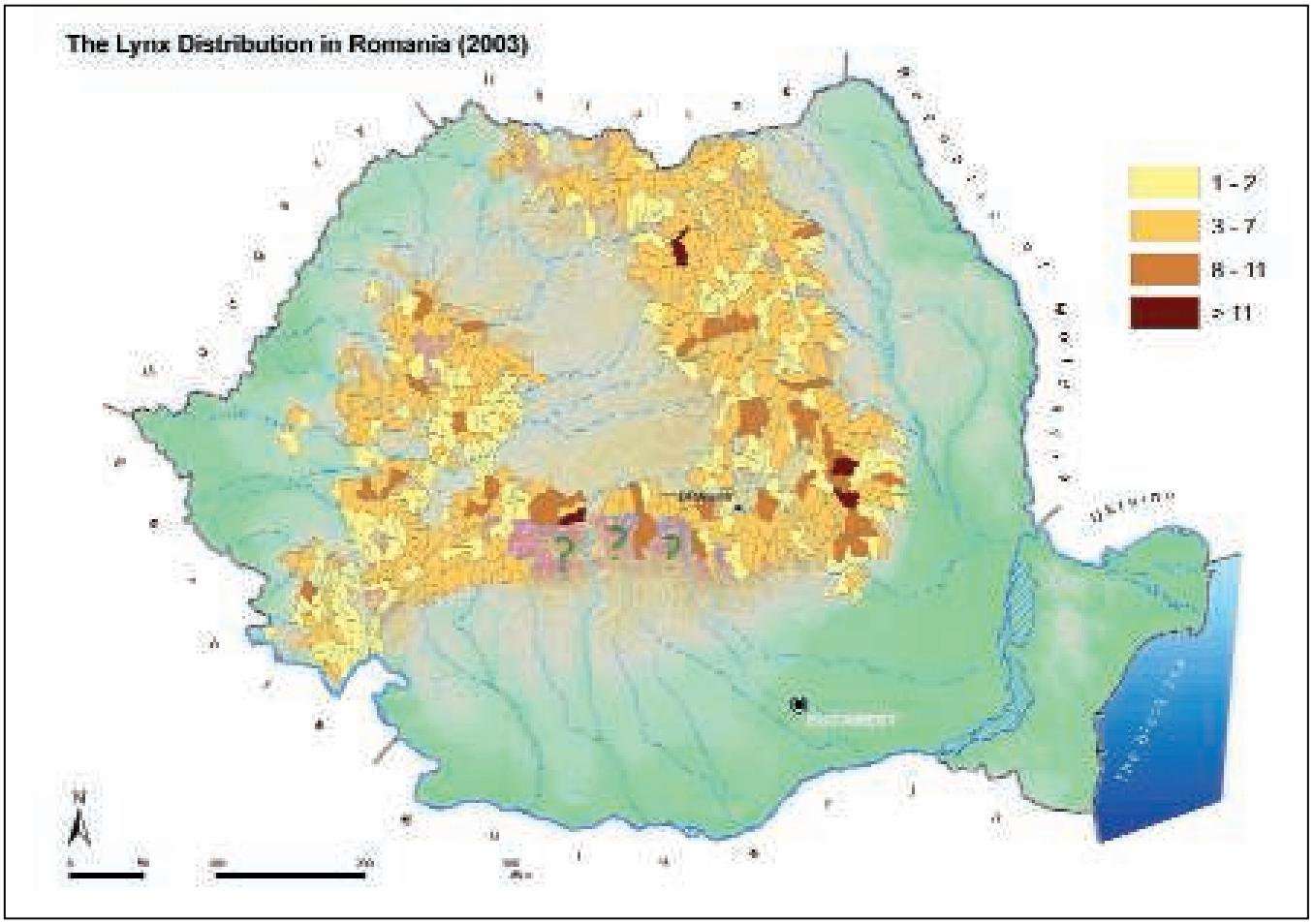


Figure A1.4
Lynx distribution in the Romanian Carpathians in 2003 as estimated by hunting unit managers. The green question marks indicate areas for which no data was provided. Source: Romanian Ministry of Agriculture, Forestry and Rural Development.

Pair of Eurasian lynx. Courtesy of Fleur van Vliet.

Food

The preferred prey of the lynx in the montane forests of Romania is ungulates, especially the abundant roe deer. Young or weak red deer and wild boar are preyed upon sporadically. Chamois can be depredated by lynx when they descend into the tree zone. Small to mid-sized rodents (hares, squirrels and marmots) and birds up to the size of a Capercaillie also feature highly on the prey list. Smaller carnivores like red fox, badger, marten and wild cat are incidentally killed and eaten (down-regulation). Foxes are killed most, especially in winter. Livestock and other domestic animals (dog and house cat) are only taken when natural prey is scarce. The lynx has excellent spatial memory, patrolling daily along familiar landscape elements and on wildlife trails in its territory, on average ten kilometres per round. It also uses certain strategy to catch prey. For instance one lynx in Piatra Craiului National Park is known to drive deer off a cliff after lunging at them from ambush. An adult lynx requires about 2 kg of meat a day, and when not disturbed will feed on a large kill from the size of a roe deer (20 kg) for several days

Relation with humans

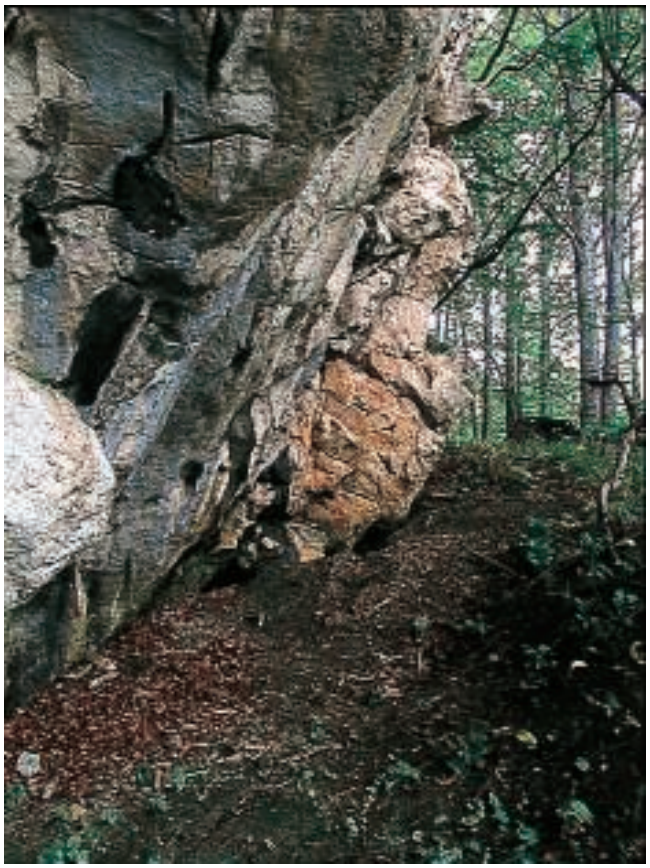
The Romanians view the lynx either with indifference, fascination or dislike. Unfortunately too many people still view the lynx as a ferocious and merciless killer. In the countryside the lynx is still persecuted by hunters regarding it as competitor. The lynx usually avoids human habitation but may venture close when prey is scarce or difficult to catch, like in winter with deep snow.

Threats and conservation

Like the other large carnivores Lynx need sizeable and undisturbed natural forests that are well connected and productive in terms of prey. It suffers greatly from transport infrastructure, urbanization, mass recreation, agricultural intensification and industrial forestry. Its only natural enemy is the wolf, although to what extent is not well researched. There are indications that in limited habitat areas the lynx is suppressed by wolves.

Busy roads are significant mortality sinks for the Iberian lynx in Spain (Ferreras *et al.* 2001). Information on the negative impact of roads on Eurasian Lynx is limited. From lynx mortalities gathered from across The Alps (Molinari-Jobin *et al.* 2003) 14.1% were attributed to traffic.

Despite its protection in Romania, the lynx can be legally hunted from September till March, and according to yearly set quota. For example in 2003 the quota was 271 but only 42 animals were reportedly killed. There is no information about poaching of lynx. It is not unlikely that some animals are shot or trapped illegally. On the level of mortality we can only draw information from lynx populations elsewhere in Europe. Breitenmoser *et al.* report in an unpublished paper that 71% (60 of 84) of reported lynx deaths in Switzerland can be attributed to human activities, and mainly persecution.



Lynx maternity den in a crevice underneath a rocky outcrop just outside Piatra Craiului national park. Photo: Erwin van Maanen

Protective status of the Eurasian lynx in Europe

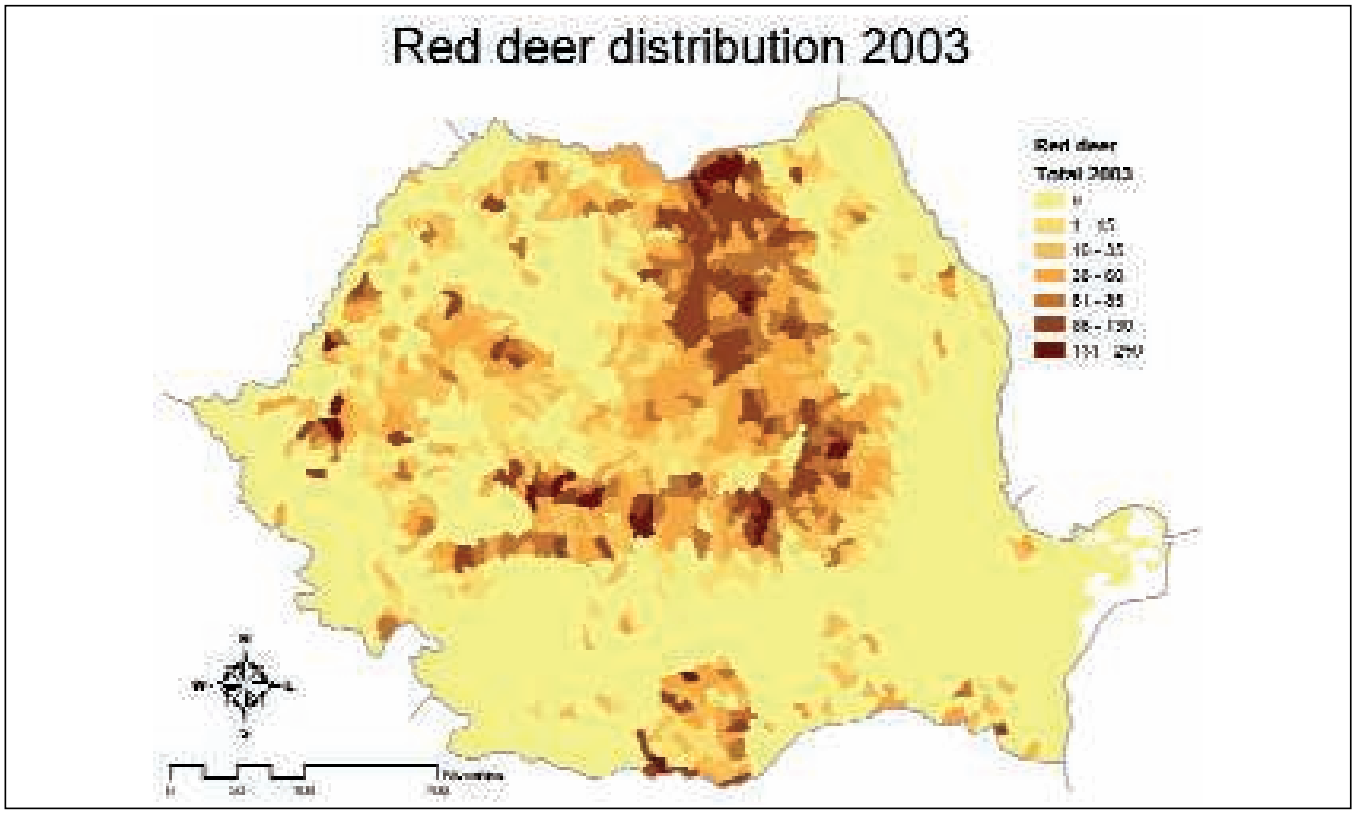
The Eurasian lynx is in the category 'Least Concerned' of the IUCN – World Conservation Union's 1996 Red List. It is listed as a game species on Appendix III of the Bern Convention (issue 19.09.1979), ratified by Romania in 1993 and published in the 'Monitorul Oficial' as Law 13/2/1993. However, hunting and trapping of lynx is only allowed by certain permitted means, and only to remove excess or nuisance animals from a vigorous population and within a limited hunting season. The lynx is listed as a 'non-priority species' on Annex II and IV of the EU Habitats Directive. This means that full protection of the lynx and its habitat is necessary, the conservation measures for which are provided in a special action plan (Breitenmoser *et al.* 2000). Annex II and IV listing also implicates that Special Areas of Conservation (SAC's) should be designated for the lynx as part of the Natura 2000 constellation and that protection is also valid throughout the country. A lynx may only be killed when public safety or communal interests are truly and significantly at stake.

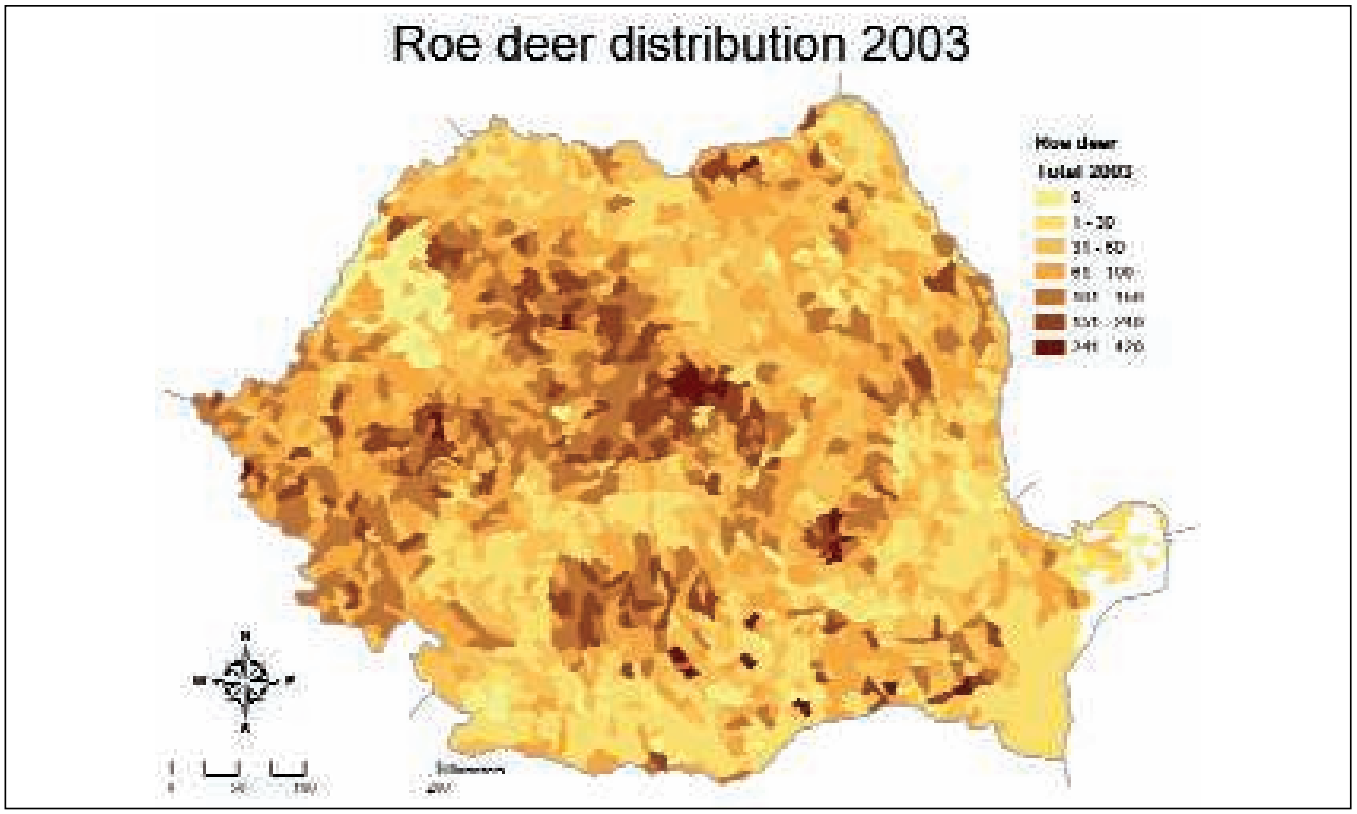
Although the Romanian lynx population should benefit from European conservation legislation, effective protection will largely depend on widespread public goodwill, image improvement and adequate protection and compensation against livestock depredation. Large-scale, prey-rich and undisturbed remote habitats for lynx should be set aside, mostly coinciding with habitat of the other two large carnivores in the Carpathians. The importance of the Romanian lynx population as vital stock for the European lynx population should be fully appreciated and fostered by the Romanian government.

Further reading

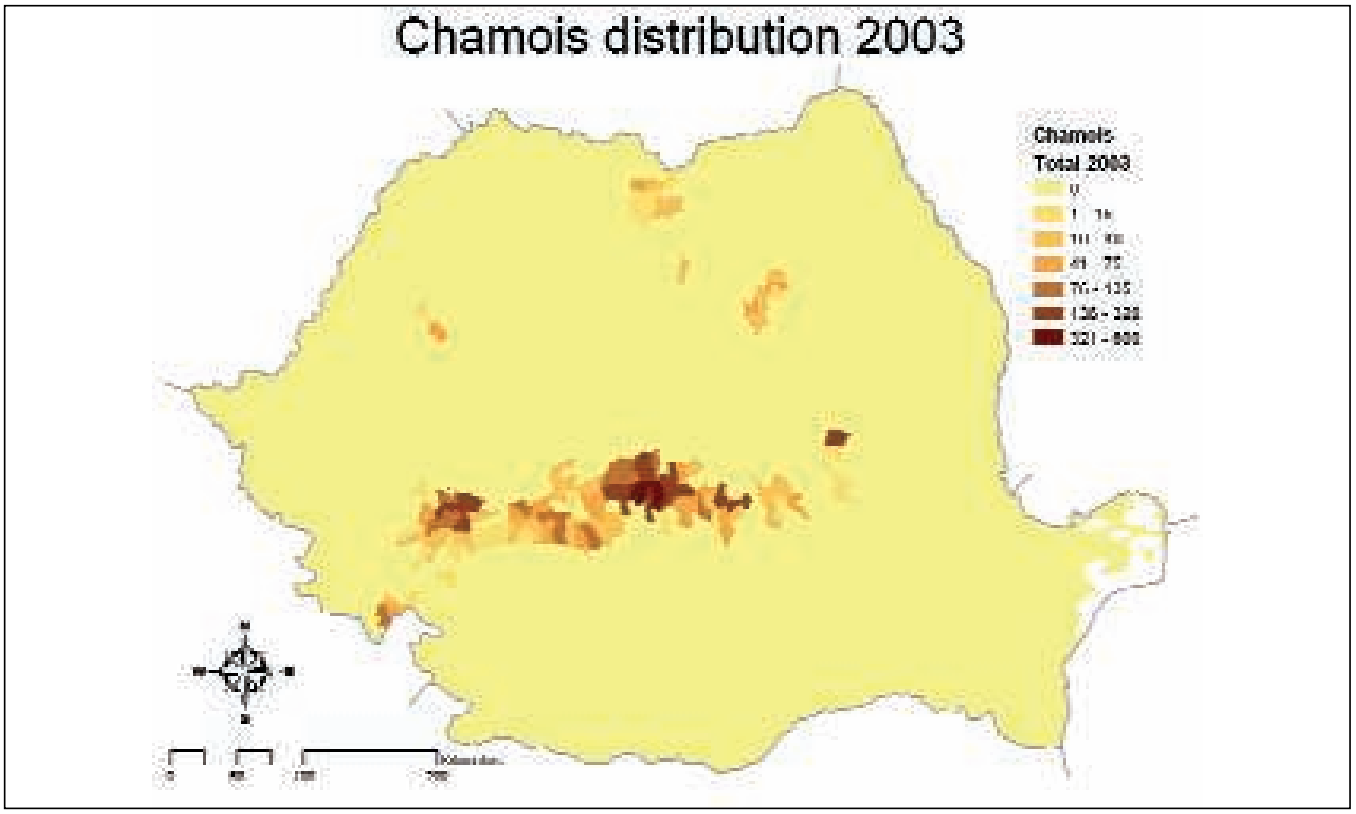
Further recommended reading on the biology, ecology and conservation management of the Eurasian lynx is Breitenmoser *et al.* (2000); Sunquist & Sunquist (2002); and the Eurasian Lynx Online Information System for Europe (ELOIS on internet).

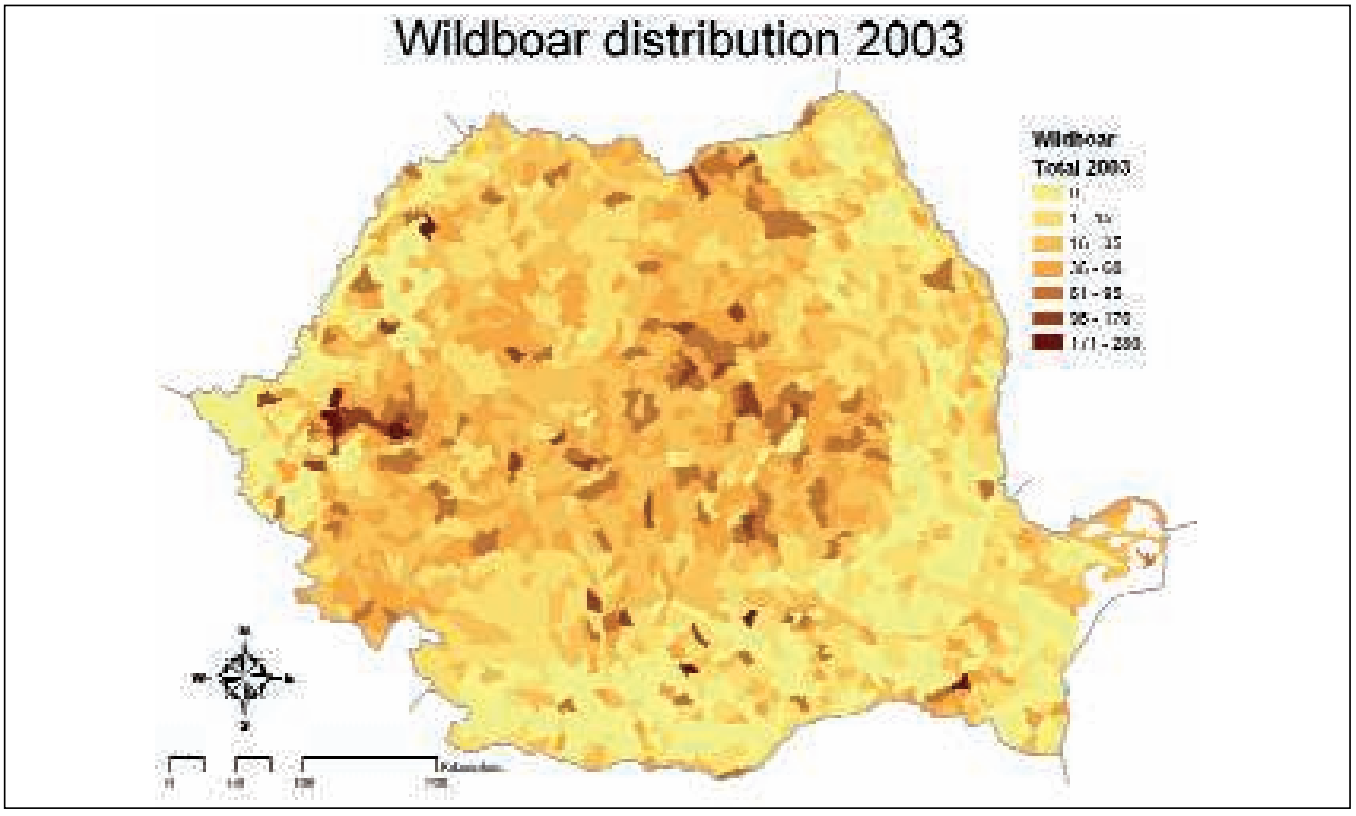
APPENDIX 2
Large herbivore distributions in Romania 2003





Source: Romanian Ministry of Agriculture, Forestry and Rural Development.


Chamois distribution 2003
Chamois
Total 2003


Wildboar distribution 2003
Wildboar
Total 2003

APPENDIX 3
Modelling with GIS and Marxan

Several landscape ecological models are available to determine ecological networks using simulated annealing. In this study the freely available model called Marxan (version 1.8.2)1 was used with permission from the developers (Ball & Possingham 2000) from the University of Queensland, Australia, in combination with CLUZ software, developed by the Durrell Institute of Conservation and Ecology of the University of Kent, UK. Marxan produces the best set of alternative conservation reserve networks on the basis of physical, ecological, social or cultural, and economic criteria or constraints. CLUZ (Conservation Land-Use Zoning) is an Arc View GIS component that links with Marxan2.

To select the most suitable set of conservation reserves the following criteria were set:

1. to ensure protection of a predetermined national population of target species in a coherent protected areas network according to their ecological requirements;

2. to ensure the best configurations for core areas attaining the highest surface areas with least boundary lengths (compaction), and;

3. to ensure that protected areas do not unnecessarily restrain economic developments within a region, so that the network maximizes opportunities for sustainable land use and does not impose a great deal of ecological restoration.

The model is based on the premise that viable populations of organisms can only be maintained in an interconnected reserve system. From the perspective of nature conservation one would ideally achieve the largest reserve system possible. However, in reality the extent of any reserve system is limited by social and economic constraints (Possingham *et al.* 2000). Building a reserve network is therefore not a process of accumulating as much natural land as possible, but to allocate conservation areas as cost efficiently as possible. For the relatively unspoiled Romanian Carpathians the reserve designer can in fact choose from a large number of conservation sites or planning units. We choose to devise a reserve system that protects at a reasonable limit of at least 60% of the existing large carnivore populations to envelop large enough areas also including many other known biodiversity values (Chapter 4).

Marxan requires an input of planning units covering the whole of Romania. These units should be smaller than the intended protected areas, but large enough to contain all the necessary data. A planning unit is preferably a shape with natural boundaries. In this study a grid system of 19945 squares (planning units) measuring 5 x 5 km^2 was used. Marxan's decision to include a particular planning unit as a conservation unit depends on the net cost exerted by economic demands and achievement of an ecologically optimal core area. Marxan combines the suitable planning units into a compact core area of least net cost.

The amount of planning units selected depends on set targets for conservation, in this case conserving a certain percentage of large carnivore populations. Marxan makes suitable combinations in 10000 iterations. This simulation is repeated 10 times to result in the best configuration. In theory the best configuration is the reserve system with the best coherence and compactness that can be designated in areas with least economic cost. For further explanation of the conceptual background and mathematical formulations of Marxan see Ball & Possingham *et al.* (2000) and McDonnell *et al.* (2002).

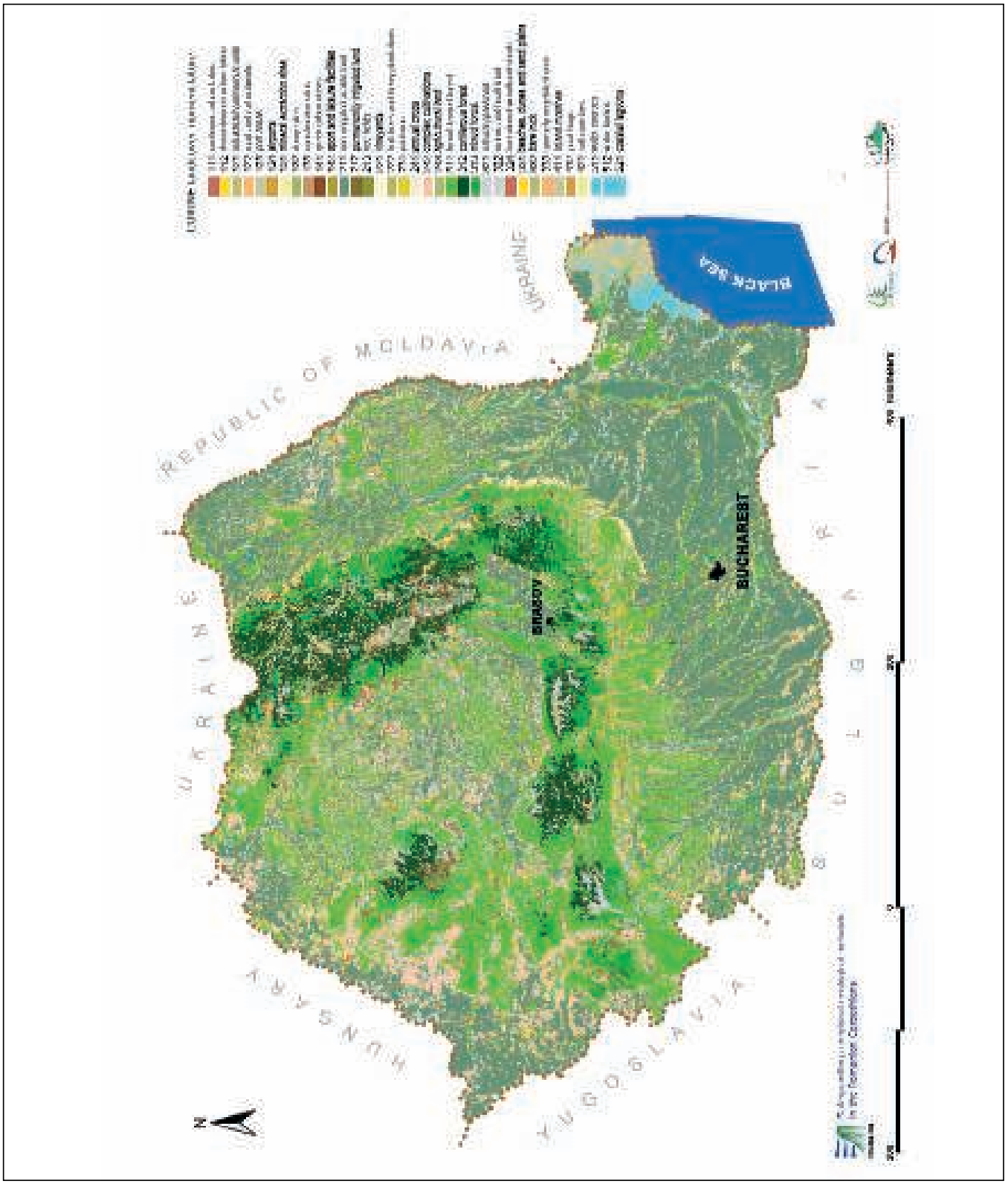


Figure A3.1
CORINE Land Cover map of Romania.

The net cost of a planning unit is determined by using the following variables:

Optimal purchase area (A) – Is a normative appraisal of the balance between economic cost and the ecological profit with respect to protected core area size (in hectares). In economic sense small cores containing the same amount of conservation objects as large cores are preferred. However one must also take into take into account that maintaining large protected areas with suitable habitat is essential for the effective conservation of large carnivores.

Unsuitable habitat (L) – The ecological network for large carnivores must be composed of suitable habitat. By including the best existing (prime) habitat and excluding lesser habitat the net cost is reduced. Habitat suitability was determined using CORINE Land Cover features (figure A3.1) and ecological requirements of large carnivores in Romania (Appendix 1). Each CORINE-class was given a suitability index for each carnivore, as follows: 0 = non-habitat, 1 = secondary habitat and 2 = primary habitat. These indexes were determined with Romanian wildlife managers. CORINE-classes such as cities and villages, intensive agricultural land, water bodies and bare land were considered unsuitable as habitat for large carnivores (Figure A3.1). Prime habitat for large carnivores included the CORINE-classes broad-leaved forest, coniferous forest, mixed forest, natural grassland and transitional woodland-shrub.

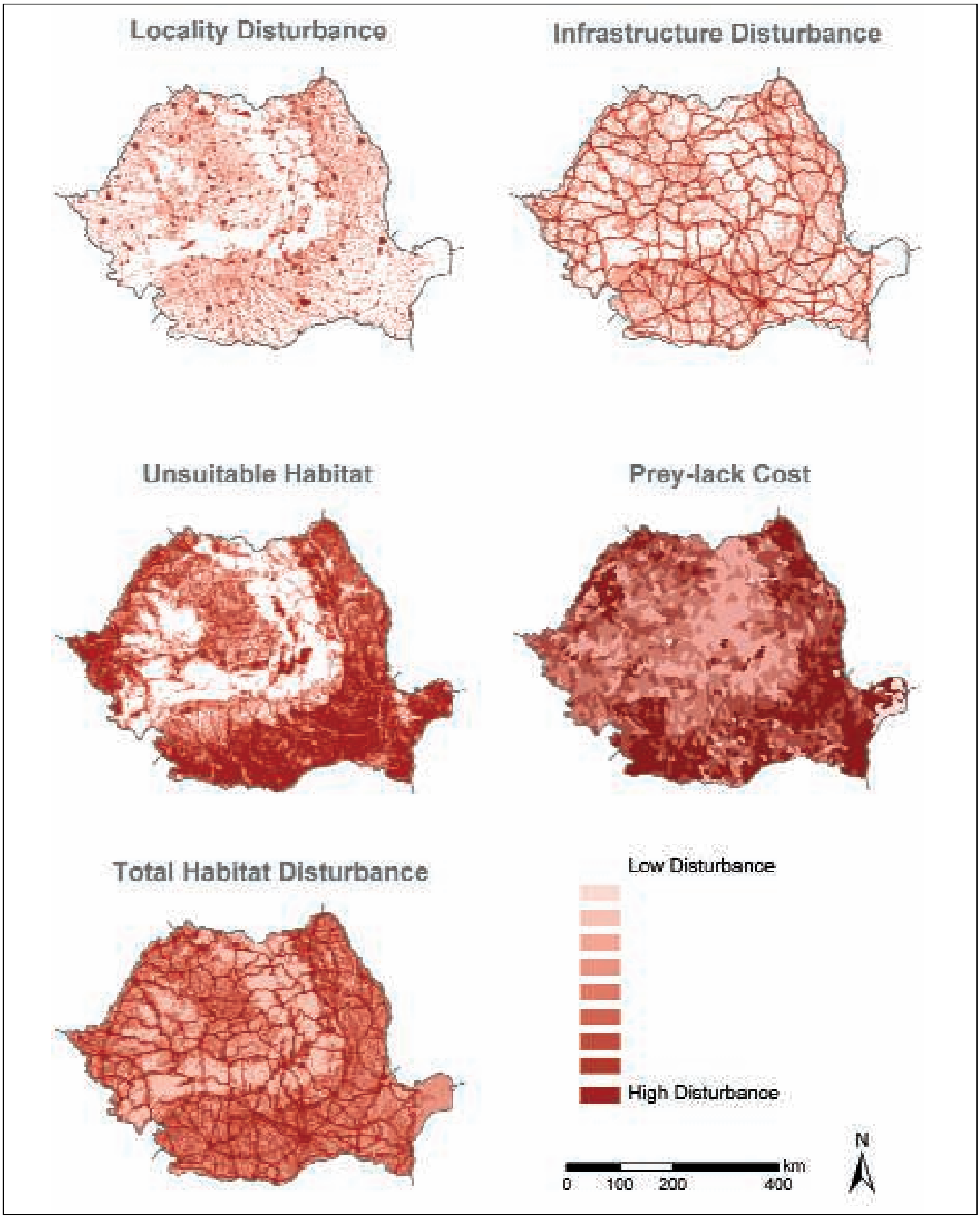
Extent of urbanization (U) – Protected areas should be allocated out of harms way of urbanization. Hence, areas with the greatest urban influence – calculated as a percentage of each planning unit - are least suitable as part of large carnivore habitat. Three classes of human settlements were used, namely: major cities, towns and villages. The widely dispersed rustic villages in the Romanian landscape were considered least expansive and threatening to wildlife at present. Major expanding cities are a great concern, as a source of disturbance in terms of noise, light, dangerous traffic, pollution and high human presence/interference. The model incorporated a buffer (disturbance zone) of 1500 meter around major cities, 1000 meter around smaller towns and no buffer around rustic villages. This net cost (locality cost) for urbanization is displayed in figure A3.2.

Transport infrastructure density (I) – major paved roads and railways fragment and disturb the natural landscape to an extent which depends on traffic volume. Areas with high road density and high traffic intensity are not suitable for large carnivores and herbivores. A disturbance zone was set for roads and railroads. Railways were given a disturbance zone of 500 meter, national roads or highways 1000 meter and country roads 500 meter. This resulted in net cost for transport infrastructure (figure A3.2).

Prey lack cost (P) – Ungulate densities provide a measure of habitat suitability and carrying capacity for large carnivores. The inverse of total ungulate density is a measure for prey lack cost (P). To prevent the modelling of an exceedingly great ecological network due to high populations of common roe deer and wild boar all over the countryside, more weight was given to planning units with sizeable red deer populations, red deer being also indicative of good forest quality and an important conservation target. Thus areas with the low densities of red deer were considered less suitable for large carnivores.

Total cost

The above costs combined and analysed by spatial annealing provides a measure of the overall habitat suitability of an area for the large carnivores combined, or conversely a measure of non-habitat


Locality Disturbance
Infrastructure Disturbance
Unsuitable Habitat
Prey-lack Cost
Total Habitat Disturbance
Low Disturbance
High Disturbance
0
100
200
400
km
N

(figure A3.2). The total cost was calculated using the following formula:

Total cost for planning unit x = Ax + Lx + 4Ux + 4Ix + 4Px

Where A = optimal purchase area (ha), L = unsuitable habitat cover, U = extent of urbanization, I = transport infrastructure density, P = prey lack cost.

Cost variables urbanization, transport infrastructure and the lack of prey were multiplied by a factor of four to emphasize their importance relative to the cost variables optimal purchase and unsuitable habitat.

The resulting 'total habitat disturbance' map in figure A3.2 shows that only in the Romanian Carpathians habitat conditions for large carnivores are optimal.

Figure A3.2
Marxan reveals the restrictions or 'costs' exerted by transport infrastructure, urbanization and rural settlements (locality disturbance), unsuitable habitat features (i.e. unsuitable CORINE Land Cover features) and lower availability of ungulates on large carnivore ranging across Romania. The restrictions combined forms a map of total habitat disturbance. The darkest red areas indicate areas least suited for large carnivores. White or whitish areas are most suited, actually revealing possible core areas. The map also reveals the large carnivore habitat sensitivities with respect to further sectoral developments.

Reserve configuration

The total habitat disturbance map is used by Marxan to configure all 19945 planning units into a system of reserves or core areas at least economic cost and with highest habitat suitability for large carnivores. To achieve the best configuration two more factors are included in the Marxan analysis, namely boundary length and target percentage for conservation. The boundary length of reserves should be as low as possible with respect to surface area. The target percentage is the percentage of the existing large carnivore populations conserved. Marxan calculated reserve systems for the following target percentages: 15%, 30%, 45%, 60% and 75%. Table A3.1 displays the portions of the exiting large carnivore populations protected under each target. The existing populations are derived from counts in hunting units in 2003.

The required home ranges for each large carnivore species were set as follows: for bear and wolf three planning units (=75 km^2) and six planning units (=150 km^2) for lynx. Note that these home ranges correspond to the current high densities (see also section 3.8).

Conservation targets for each of the three large carnivores incorporated into Marxan to model corresponding reserve systems (figure A3.2), based on totalled hunting unit counts in 2003.

Targets	15%	30%	45%	60%	75%	Estimated total number of existing animals in Romania (2003)
Bear	754	1509	2263	3017	3772	5029
Wolf	487	975	1462	1949	2437	3249
Lynx	227	454	681	908	1135	1513

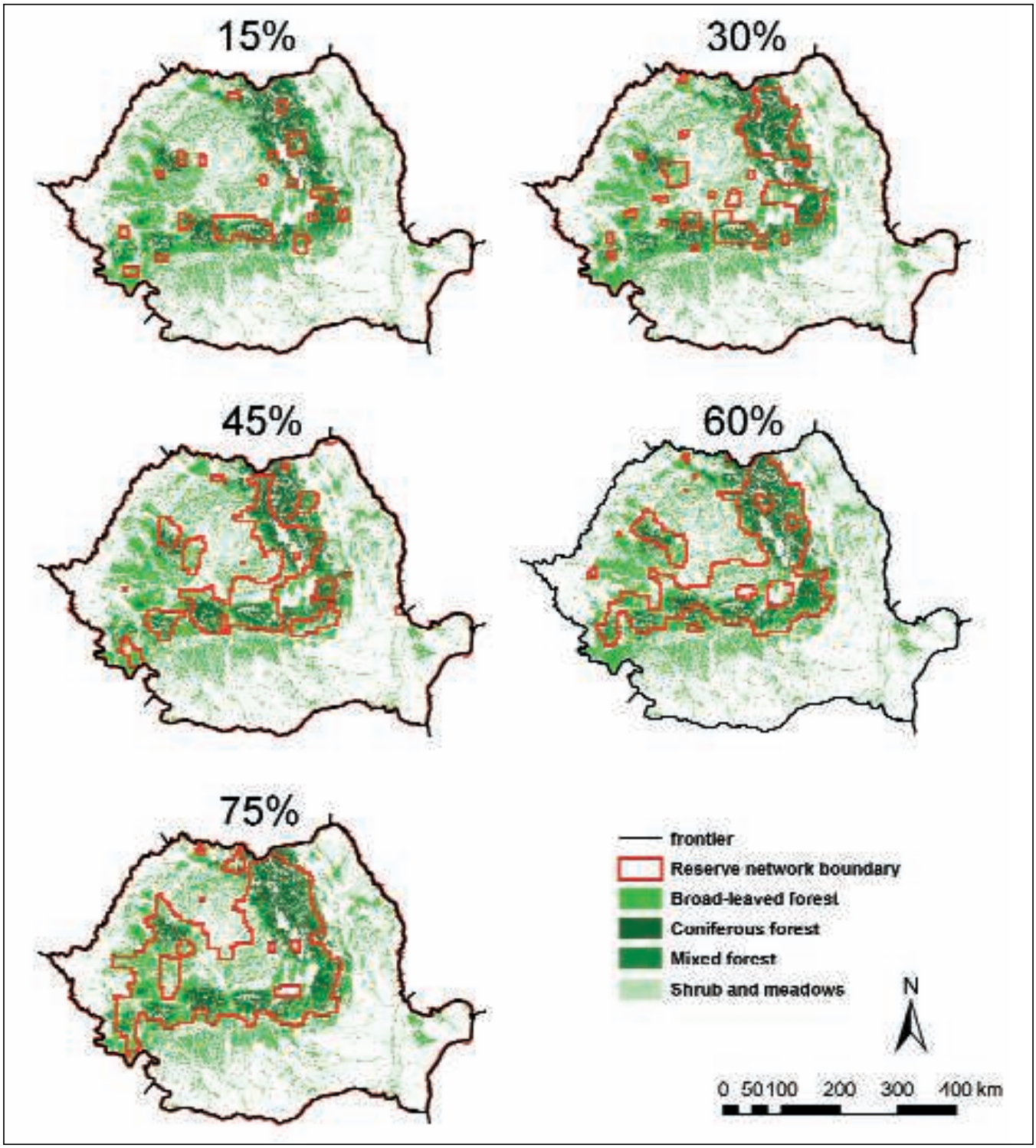


Figure A3.3
Results of the Marxan reserve delineation (red outline) for different large carnivore conservation targets (table A3.1). The target of 60% was used to model the objective delineation of the Romanian Carpathian Ecological Network based on optimal reserve configuration and least economic cost.

Figure A3.3 displays the best reserve solutions for the conservation targets in table A3.1, calculated by Marxan with five target percentages. This shows that conserving less than 30% of the existing large carnivore populations results in widely disconnected reserves, which are most probably not able to maintain viable populations should they become completely isolated. Conserving at least 60% of the current large carnivore populations is ecologically most meaningful.

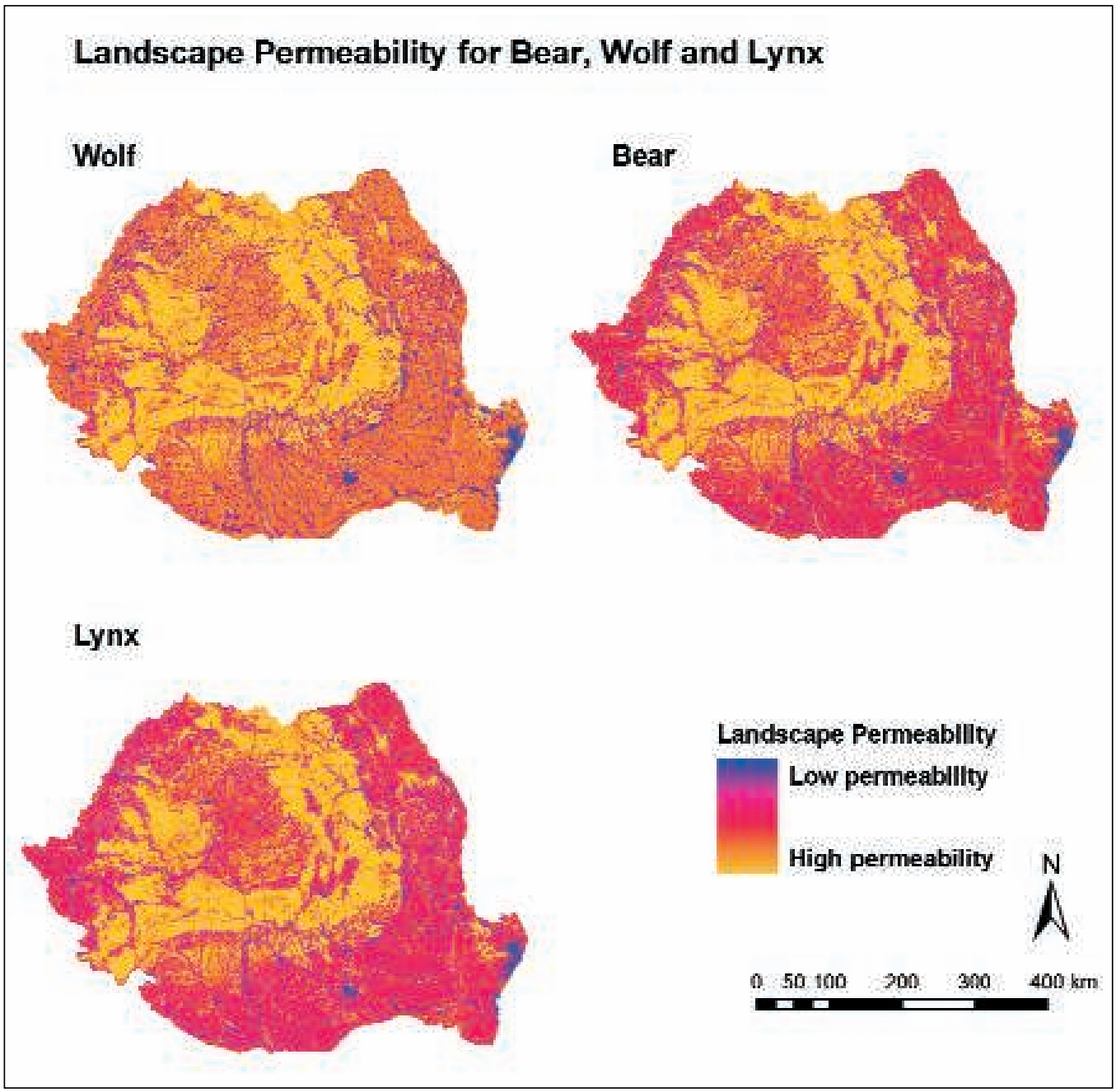


Figure A3.4
Permeability of the Romanian landscapes for lynx, bear and wolf.

Connectivity analysis

On its way from one area to another an animal may have to traverse different landscapes, each imposing a certain cost through non-habitat and various natural and anthropogenic barriers and disturbances. Landscape permeability for an animal is determined by its ability to move in it with relative ease (least energy expenditure), undisturbed and safe, and in finding certain sustenance and refuge. High landscape permeability is most important to animals with low mobility and specific habitat requirements; e.g. a wolf is more inclined to cross wide agricultural fields than the highly forest bound bear. Figure A3.4 shows the landscape permeability for each of three large carnivores in Romania.
The cumulative cost for each of the carnivore species to move from a particular location inside the reserve network modelled by Marxan (60% result) to any other location is shown in figure A3.5. Together with figure 3.4 this reveals the current high conductivity of the Romanian Carpathians and beyond for movements of large carnivores and other mammals.

For effective dispersal an animal ideally needs to travel the shortest, safest and least energetically demanding distance through a landscape. Thus the smallest divides with least human disturbances and most suitable habitat features present the best ecological linkages. Using least-cost-path analysis the best ecological linkages between two reserves can be modelled in the Romanian Carpathians, a task for the implementation phase in conjunction with detailed land-use planning and with verification by field survey.

Modelling values

Habitat suitability costs

Costs for habitat suitability were determined by calculating the area (in %) of suitable habitat present within each 5 x 5 km2 planning unit (grid cell).

Each land cover type (see figure A3.1) of the Corine landcover system for Romania was assigned a habitat suitability value for each of the three large carnivore species: unsuitable habitat = 0, secondary habitat = 1 and primary habitat = 2.

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