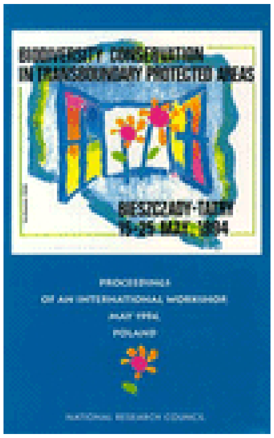


Biodiversity Conservation in Transboundary Protected Areas

Alicja Breymeyer and Reginald Noble, Editors; Office of Central Europe and Eurasia, National Research Council

ISBN: 0-309-58959-2, 288 pages, 6 x 9, (1996)

BIODIVERSITY CONSERVATION IN TRANSBOUNDARY PROTECTED AREAS

Proceedings of an International Workshop
Bieszczady and Tatra National Parks, Poland
May 15-25, 1994

Edited by
Alicja Breymeyer
Reginald Noble
with
Stephen Deets, Natalie Brand,
Kelly Robbins, Sharon Vandivere

Office for Central Europe and Eurasia
Office of International Affairs
National Research Council

National Academy Press
Washington, DC 1996

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competencies and with regard for appropriate balance.

This report has been reviewed by a group other than the authors according to procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

The National Academy of Sciences is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The National Academy of Engineering was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. William A. Wulf is interim president of the National Academy of Engineering.

The Institute of Medicine was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Kenneth I. Shine is president of the Institute of Medicine.

The National Research Council was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. William A. Wulf are chairman and interim vice chairman, respectively, of the National Research Council.

A limited number copies of this report are available from:
Office for Central Europe and Eurasia
National Research Council
2101 Constitution Avenue, NW
Washington, DC 20418

Additional copies are available for sale from:
National Academy Press
2101 Constitution Avenue, NW Box 285
Washington, DC 20055
Tel: 1-800-624-6242 or (202) 334-3313 (in the Washington Metropolitan Area).

Library of Congress Catalog Card Number: 96-69773

International Standard Book Number: 0-309-05576-8

Printed in the United States of America.

Contents

OVERVIEW

OVERVIEW

Reginald Noble and Alicja Breymeyer

INTRODUCTION

In the past few years, there has been considerable international concern about the rate of species loss on a global scale. The 1992 International Convention on Biodiversity (which was signed at the United Nations Conference on the Environment and Development in Rio de Janeiro, Brazil), the expanding Biosphere Reserve Program under the auspices of the United Nations Education, Scientific, and Cultural Organization (UNESCO), and many other projects highlight the priority that these worries are receiving. These international activities also recognize that neither pollution nor ecosystems respect political boundaries; cooperation on many different levels is required.

The National Academy of Sciences of the USA (NAS) and the Polish Academy of Sciences (PAN) began bilateral cooperation on environmental issues in 1986. These earlier efforts included a series of workshops and resulted in the publication of *Ecological Risks: Perspectives from Poland and the United States* (National Academy Press, 1990). In 1994, building on work both academies have completed in recent years and tapping into their strong ties with the scientific and ecological communities in Central Europe, the NAS and PAN agreed to organize a workshop on "Biodiversity Conservation in Transboundary Protected Areas." Dr. Stanley Krugman, Dr. Reginald Noble, and Dr. Alicja Breymeyer were called upon to assist with planning and to serve as workshop co-chairs.

The papers contained in this volume represent proceedings of this workshop. This workshop took place in Poland from May 16-24, 1994, with the first half of the meetings held at the Bieszczady Biosphere Reserve, while the second half took place at the Tatry Biosphere Reserve. By holding the meetings in two different biosphere reserves, the ten NAS participants were able to experience first hand some of the unique aspects of biodiversity conservation problems in Central and Eastern Europe, while at the same time a split venue made the meetings accessible to a larger number of European participants. In all, more than fifty Poles were in attendance along with ample representation by experts from the Republic of Belarus, the Czech Republic, Ukraine, and the Slovak Republic. These participants ranged broadly in background and included scientists, managers, NGO representatives, policy makers, GEF program managers, and representatives of funding organizations.

The purpose of the workshop was to explore opportunities to integrate science and management in transboundary protected areas in Central Europe for the conservation of biodiversity. More specific goals included:

- Clarification of current and future problems of wildlife management, particularly overgrazing;
- Clarification of current and future problems of tourism and recreational use of protected areas;
- Sharing of current Western theories and practices on forest management, including restoration ecology and landscape ecology; and
- Development of a network of scientists and managers to cooperate in biodiversity conservation in transboundary protected areas.

By publishing the proceedings of this workshop, it is hoped that the benefits of the workshop will be extended beyond the sphere of actual participants and that it will have a beneficial effect on the thinking and actions of the region's ministries of forestry and environment, interested U.S. government agencies, international organizations, and other relevant parties.

The many people who contributed to the success of this workshop and who worked so diligently on this publication are too numerous to name. However, we would like to express our thanks to the local hosts, Dr. Woj Wojciechowski (Director, Bieszczady National Park and Biosphere Reserve) and Dr. Wojciech Gasienica Byrcyn (Director, Tatry National Park and Biosphere Reserve), whose efforts were greatly appreciated by all who participated and who contributed to the collegial atmosphere which quickly developed during the workshop. In addition, Stephen Deets of the National Research Council and Bozena Grabinska, Andrzej Piotrowski, Violetta Narkiewicz, and Jolanta Wieckowska of the Institute of Geography of PAN provided invaluable assistance in the organization and execution of the workshop. Stephen Deets also supervised the final editing and production of this volume, and editorial assistance was provided by, among others, Natalie Brand, Kelly Robbins, and Sharon Vandivere of the National Research Council. Finally, financial support from the Ford Foundation, the Polish Academy of Sciences, and the Frank Press Fund of the National Research Council is gratefully acknowledged.

Highlights of each section along with relevant discussions during the workshop are summarized below.

GENERAL CONSIDERATIONS OF CONSERVATION OF PROTECTED AREAS

In order to lay the foundation for the rest of the book, it begins with a review of concepts of management and restoration of ecosystems. The themes in this first section were discussed throughout the workshop in Poland and appear repeatedly throughout this book. This is particularly clear in the paper on "Biological Diversity of Vegetational Landscapes: Problems with Evaluation" by Dr. Jerzy Solon. Dr. Solon touches on questions of the value of areas with species richness versus those with rare species, the effects of anthropogenic disturbance, and the trade-offs of different biodiversity management strategies. All of these issues are developed more fully in the sections below.

In the paper by Dr. Karen Holl, the difficulties of restoring degraded lands are detailed. First, it is usually questionable whether the original condition can or even should be recreated, although minimal structural and functional characteristics of the ecosystem must be restored. However, Dr. Holl emphasizes the importance of balancing social needs in order to successfully complete the project. The extent and costs of these technologies and approaches, which are still in a development phase, put a premium on goal-setting for both forest preservation and restoration.

Dr. Stanley Krugman provides some broad justifications for establishing protected areas, and he lays out six considerations for the design of protected areas. The critical elements which must be taken into account are purpose, size, shape, location, management strategy, and legal basis. In a presentation specifically on fragmented ecosystems (which is not included in this volume), Dr. Stephen Berwick built on these concepts. He stressed that the design of reserve systems should include informed acquisition, expansion, and restoration of relict systems, such as old-growth ecosystems existing in the North American Pacific Northwest coniferous forests, the once characteristic mixed lowland forests of Central Europe in Bialowieza in Poland and Belarus, and the beech groves of the Carpathian mountains. Currently many old-growth systems are vulnerable due to "edge-creep", as wind and light replace the forest and scrub and animals of farms invade.

The emerging tenets of conservation biology are being applied in the protection of fragmented coniferous forests of the American Northwest. The effects of edge creep, reduced carrying capacities of small fragments for large animals, the cascading effects of extinctions of linked species, and deleterious genetic changes in small inbred populations can result in populations so small that further extinctions are inevitable. General calculations of minimum viable populations of animals show the need to maintain populations of at least 500 individuals, and for a viable forest, there must be at least 50 hectare (ha) of old-growth character. However, large mobile animals require much more landscape. For example, a wolf pack may have a territory of 150,000 ha and therefore will require an intervening forest "matrix" similar to the original conditions of an old-growth landscape. A mature forest can provide such a matrix if harvesting methods of long-rotations, mixed species, and uneven ages occupy about one-third of the landscape. Some of the unusual, distinctive features of old forests cannot be duplicated in young, managed ecosystems, including a preponderance of predators based on a food chain dependent on decaying wood from the dead trees, which are usually removed in a sanitary forest operation. Since forest fragments, like other islands, maintain their characteristic array of plants and animals by balancing in-migrants with extinctions, the size, number, shape, and distance between islands becomes as much a matter of biology as land planning and acquisition. This reinforces some of the ideas raised by Dr. Holl on conservation and restoration being a political-social challenge as much as a scientific one.

While there is general agreement on the value of corridors for mobile animals, there are conflicting opinions about their utility for the genetic flow in many plant species. The most obvious example of landscape corridors are riparian ecosystems, the topic of the paper by Dr. Catherine Pringle. In addition, streams are an ideal landscape unit to focus on with regards to transboundary areas as streams and watersheds often cross political boundaries.

Dr. Pringle discusses the need for a conceptual basis for viewing rivers and streams within landscapes for the development of effective conservation strategies. Management within stream watersheds should be approached from an understanding of the natural connectivity and variability between stream properties, including the four major dimensions: longitudinal linkages along stream channels (e.g., upstream-down-stream); lateral linkages between a stream channel and its floodplain; vertical linkages between the stream channel and groundwater; and a temporal scale. Natural and human disturbances interact to determine physical and biological characteristics on all of these plains of reference.

Scientists, managers, and conservationists are broadening their view, and policies on river conservation are beginning to reflect these changes. An example of fledgling attempts at international cooperation on a large-scale can be seen in the on-going discussion on the Danube River and Delta, which drains 12 European nations. During the workshop, Dr. Kazimierz Drobowolski emphasized that the Bug and Odra are examples in Poland of major environmental problems requiring international cooperation.

During the discussion, there was agreement that conservation biology and restoration ecology need to be integrated into protected management plans, tested in "real world" situations, and continually modified to respond to the needs and constraints of specific cases. The paper by Drs. Boguslaw Bobek, Doreta Kabza, and Kajetan Merta on MAB Biosphere Reserves provides information on areas where these concepts are, or should be, applied. Arguing that the era of national parks is over and that they have fulfilled their historic mission, these authors address how biosphere reserves seek to overcome some of the continuing problems mentioned above of fragmented ecosystems and impacts of degraded areas surrounding the parks. UNESCO, under the MAB program, seeks to enhance the viability of strictly protected areas by the creation of buffer zones and transition zones which will balance ecological requirements with the economic needs of people living in these areas.

BIODIVERSITY CONSERVATION STRATEGIES IN THE PARTICIPATING COUNTRIES

The second section includes papers on the biodiversity strategies of the United States, Slovakia, Belarus, Ukraine, and Poland. The papers by Dr. Victor Perfenov and Michael Pikulik and by Dr. Zuzanna Guziova highlight some of the specific problems of biodiversity conservation in Central Europe.

Not surprisingly, there were some disagreements on the definition of biodiversity. A simple yet all encompassing definition is that biodiversity is the variety of life and its processes. This includes genetic, species, community, and ecosystem levels of organization. Despite some differences in meaning, the basic concept has already been used to develop programs and strategies for conservation. Although the approaches used varied widely, there was a remarkable convergence on the final goal: maintenance of species and habitat diversity and ecological processes. The programs and strategies were tailored to include not only biological but also economic and social factors. All countries have developed lists of threatened and endangered species and passed legislation to ensure their protection. The programs of each country differ primarily in the stage of implementation rather than in the broad concepts underlying them.

There are, however, limitations and controversies in applying the theoretical concepts of biodiversity. Some of these are the impossibility of measuring all levels of diversity at the same time, problems of interpreting indices of diversity, and the apparent lack of correlation between diversity and the potential value and/or stability of an ecosystem.

Current measures of biodiversity often have limited comparability and are hard to interpret. Much work needs to be done in developing meaningful measures for evaluating progress. In spite of this, when restricted to particular taxonomic groups and taking into account comparable scales, these measurements may be of some use. Measurements of total biodiversity serve as but one of several criteria for evaluation; other potential criteria include naturalness, uniqueness, vulnerability, ecological importance, the presence of "keystone species", and the potential utility for humans. The real questions are: What do we want to manage? Why do we want to manage it? and How can we do so? These questions give us insight into the kinds of measurements that are needed.

The invasion of alien or exotic species also pose special problems for conservation and evaluation of biodiversity in any given area. This occurs along both geographical and temporal scales. One problem with existing measures of biodiversity is that they may mask the significant replacement of native species by alien or exotic ones. Such species can seriously alter ecosystem structure and function. Questions that arise when trying to deal with this problem are: (1) Should we attempt to prevent or inhibit the invasion of alien or exotic species? (2) What methods can be used to prevent those invasions? and (3) Who should decide about these kinds of actions especially when a fast response is needed?

BIOSPHERE RESERVES AND NATURAL CONDITIONS IN CENTRAL EUROPEAN BORDER REGIONS

The nine papers in Section 3 provide important information on four transboundary biosphere reserves in Central Europe and on the natural conditions in south-eastern Poland. These case studies help ground the previous discussions of biodiversity conservation and include valuable background information for the papers in the second half of this volume.

During the workshop, the presentation of these case studies was accompanied by a discussion on "Science for Parks and Parks for Science." The value of information gained through scientific investigation for the management and protection of national parks has long been recognized—Science for Parks. Science for parks encompasses two types of research: research to characterize and gain understanding of park resources and research to develop and implement effective management practices. It has been only in recent years that the value of national parks and other protected areas for the purpose of gaining a better understanding of natural processes has been widely understood—Parks for Science. Parks for science is important for three purposes: to determine what resources are present in order to protect them, manage them, and detect changes in them; to understand the natural dynamics and processes of populations, ecosystems, and other park resources; and to assess the effects of specific threats and to devise and evaluate management practices. The establishment of a strong Parks for Science program, therefore, should strengthen, not diminish, the importance of management oriented research.

WILDLIFE AND TOURIST MANAGEMENT IN TRANSBOUNDARY RESERVES

The twin problems of managing animals and people are the focus of the fourth section. Wildlife management in Poland and the United States has focused traditionally on restoration, exploitation, and maintenance of viable populations of large vertebrates. Such management has involved human manipulation of populations and habitat, and it has emphasized "game" species almost exclusively. However, as the role of the wildlife manager in both countries has expanded to include the extant variety of terrestrial and aquatic fauna, our conceptualization of wildlife needs to be as inclusive as possible (e.g., all invertebrate and vertebrate life forms).

Classification and characteristics of protected areas in Poland and the United States differ. National parks in the United States are typically large, have no particular management relationship to surrounding land, and are protected from consumptive uses. U.S. parks are areas of "set aside in perpetuity" to protect unique geological, floral, and/or faunal features, and in which traditional wildlife management typically was not practiced. Polish parks, often called core areas, are protected from consumptive uses, but in contrast to U.S. parks, they are small and surrounded by larger transition and buffer zones of protection that can be managed for consumptive purposes. Forested ecosystems are of primary concern to park managers in Poland, and because of the consumptive uses around national parks, managers have to be directly concerned with elements of wildlife management, particularly for harvestable species, such as red deer (*Cervus elaphus*), and ungulates of international concern, such as the rare European bison (*Bison bonasus*).

General impacts of high-density populations of ungulates on other fauna and flora are outlined in these papers. Common themes and questions include: (1) Are ungulate densities too high and should they be reduced? (2) Polish national parks or core areas of strict protection are too small to adequately conserve large mammals, including large predators such as wolf (*Canis lupus*); (3) Park boundaries are typically political and have little correlation to animal movements and habits; (4) The practice of feeding large mammals, although traditional throughout Europe, is ill-advised and artificially increases local carrying capacity; and (5) Land use practices outside national parks (e.g., logging) can have a pronounced effect on large mammals. Conflicts between traditional forest management, including the harvest of both timber and wildlife, and nature protection, specifically conservation of biological diversity, are increasing in both countries.

There was agreement that more research is needed to evaluate effects of high-density ungulates on biodiversity. While considerable data exist on effects to flora, very little information is available on effects to sympatric fauna. There is an urgent need in transboundary protected areas in Poland to coordinate research efforts and unify research protocols and methodologies. Some panelists contended that human exploitation, primarily logging in transition and buffer zones surrounding national parks in Poland, was excessive and a deterrent to conservation of biodiversity. Others contended that enhanced wildlife management in transition and buffer zones is needed because of the potential economic gains to local communities; for example, $2.5 million (U.S.) was generated last year through the sale of hunting licenses in the area of Bieszczady National Park and Biosphere Reserve. Everyone agreed that national parks, whether small or large, cannot be conserved in isolation; they are directly affected by activities outside their boundaries.

Two resolutions related to wildlife management were presented and discussed, although they were not formally adopted by panel participants. First, core units of Polish protected areas (i.e., national parks) are too small to conserve viable populations of large mammals, particularly large carnivores. For example, the strictly protected forest in Bialowieza National Park is only 47 km^2, and the exploited forest is over 550 km^2. Second, there is a need for fundamental change among forest managers on issues of biodiversity; currently, emphasis in Poland is narrowly focused on exploitation of wood fiber.

The papers on managing wildlife are followed by three on managing people. The paper by Dr. Gregorz Rakowski examines the potential effects of increased tourism in the cross-border protected areas in eastern Poland. While recognizing mass tourism could cause a serious damage to the nature in the protected areas (some of which is detailed in the paper by Dr. Marek Peska), proper management could reduce the possible negative impacts. The development of various forms of eco- and agrotourism in these areas should be promoted. The nature and landscape values of Poland's border regions as well as the geographical situation of the country are the good basis for international ecotourism development. Eco- and agrotourism development could be a chance to improve the economic situation of local communities, although the increase of ecological education and financial support for local communities would be needed for these plans to succeed. Dr. Thomas Heberlein approaches tourism from a different perspective. In order to better understand the needs and behavior of park visitors as well as local communities, he advocates that they should be studied like other wildlife. Effective management of tourists requires knowledge based on scientific procedures, including observation and surveys in conjunction with representative sampling and experimental design.

MONITORING AND MEASURING THE DIVERSITY OF LIFE IN BORDER AREAS

As all ecosystems are affected to varying degrees by anthropogenic physical and chemical stresses, assessing their overall effect on biological diversity and ecosystem processes necessarily requires monitoring over a network of sites distributed throughout the range of the effects. In addition to documenting the diversity of life in these border areas, the papers in section five illustrate the variety of monitoring programs

All of the monitoring programs addressed here concentrate on biological diversity, and the participants strongly recommend that biodiversity monitoring be a cornerstone of any environmental information network. However, no single monitoring strategy can effectively provide all of the important scientific and management information that is needed to address biodiversity issues at a single reserve, much less over an international landscape. In practice, different programs choose quite different monitoring designs depending upon the processes of most importance to their designers. Sampling on a grid provides an unbiased sample with even spatial coverage (i.e., efficient mapping), but with relatively limited effectiveness in detecting rare species. For example, a decade of intensive grid sampling at the Sequoia-Kings Canyon National Park (a Biosphere Reserve in the United States) has only detected two thirds of the plant species known to be in the park, partially because the grid points, by chance, have not yet intersected wetlands and other limited habitat types. A stratified design samples each habitat type with more equal effort. This is efficient in producing statistically interpretable estimates of the density of rare species, but is subject to anomalies due to oversampling rare habitat types relative to their frequency and by the need to stratify into somewhat arbitrary categories. For broad scale changes (e.g., climatic warming), spatial shifts along a gradient may be more consistent and predictable responses to stress than are local changes in species abundance.

Intuitive searching by an experienced systematist or naturalist consistently detects more rare species than the other methods, but at the expense of unrepeatability (precluding its sole use for monitoring), biased samples, and unknowable sampling properties. This is the approach in Dr. Bohdan Prots' study of the flora of the Ukrainian Carpathians. The wide scale of the investigation permits historical and geographic explanations of biodiversity patterns. For example, one clear contributor to the high diversity of the study sites is that they lie at the boundary of distinct biogeographic regions. Wide taxonomic coverage revealed abnormal structures associated with stress responses that would probably have been missed in a single-species investigation. Naturally, detections from searching cannot be unbiased with respect to landscape feature as a whole, leading to the strongest inferences for historical biogeography, and limited capabilities to detect ecological and population changes.

In some case, the impact on a "indicator" species may be chosen as a surrogate for correlated effects in the environment. An indicator could be of concern because it is already especially rare, known to be sensitive to a particular stress, or "charismatic". If policy is to be formulated on the basis of a single species, a high priority is to understand, on a mechanistic basis, the behavior and population dynamics of that species. Dr. Milan Kodrik's report on an experimental analysis addressed primarily toward a single stress—atmospheric deposition—and its effects on a single species closely approximates an indicator study. The analysis starts with soil chemistry, continues through its effects on root growth, and proceeds to the effects on tree demography and forest canopy structure. With a single major stress, it is practical to investigate ecologically realistic experimental field plots and to calibrate the stress effects to size and age. As a result, the indicator study developed confidence in population projections that are difficult in a community-level study and impossible with a biogeographic survey. However the combination of labor intensity and ability to conduct such large-scale consumptive sampling makes this study essentially unreplicable, and the results will certainly be used to estimate root relations far outside the original study site.

Dr. Reginald Noble reported on a probability based regional forest health monitoring approach that is being implemented in the United States. This approach employs an interpenetrating design that utilizes a grid system from which sites may be randomly selected for monitoring a variety of indicators. These indicators range from crown condition and foliar chemistry to root pathology and soils characterization. This protocol, though it does not conform to any of the models described above, incorporates features of each. With U.S. assistance, this model has been recently undertaken in the Baltic Republics and discussions are now underway for expanding the region to include Belarus, Poland, and Ukraine.

This range of strategies illustrates the dilemma faced in coordinating monitoring programs. If different parameters are measured, or if the data differ greatly in their reliability or completeness, statistical comparisons of ecological impacts becomes nearly impossible. However, if all programs only follow specified protocols, both opportunities to address severe localized problems and scientific innovation may be preempted. As monitoring programs will, and should, continue to be somewhat idiosyncratic in order to best address the most important local information needs, coordination may be stimulated by the improvements in information technology. Dr. James Quinn reported on Euro MAB's Biosphere Reserve Inventory and Monitoring (BRIM) program, which is designed to facilitate standardization and communication of biodiversity and other environmental information among Biosphere Reserves. The initiative has already produced a database of sites, facilities, scientific contacts, and available data types (ACCESS) and is working on an annotated directory of permanent vegetation plots. The MAB Fauna and MAB Flora databases are designed to speed and standardize the reporting of species occurrences in reserves, and has already been extensively tested in Central Europe.

Cross-boundary data are not useful for landscape analyses unless they are easily accessible to the widely separated investigators. Biodiversity data for about 20 Central European Biosphere Reserves is now disseminated over Internet. Newly available environmental information now permits more efficient and reliable habitat characterizations. Locations can be determined and mapped from downloaded remote-sensing imagery, and it has become much more practical to describe sites according to site-specific environmental attributes rather than artificial classifications. This will, for example, allow investigators to characterize vegetation *post hoc*, in the way most appropriate for a particular analysis, as an alternative to having to live with one of many competing classification schemes applied *a priori*. High resolution mapped attributes allow robust spatial statistics, allowing predicted biodiversity (or other) patterns to be described probabilistically with known confidence limits rather than stated categorically. While using these tools in Biosphere Reserves will require training and infrastructural support, it also opens the way to effective international monitoring in a way not previously possible.

I

GENERAL ISSUES OF CONSERVATION OF PROTECTED AREAS

THE BIOLOGICAL DIVERSITY OF VEGETATIONAL LANDSCAPES: PROBLEMS WITH EVALUATION

Jerzy Solon
Institute of Geography and Spatial Organization
Polish Academy of Sciences

INTRODUCTION

In light of the drastic changes taking place in land use, the over-exploitation of resources on a global scale, and the far-reaching climatic changes now being predicted, one of the basic tasks facing scientists and decision-makers is elaborating directions of economic development that preserve to the greatest possible extent the existing richness of living forms and their assemblages. The central concept in the management of nature understood in this way is the concept of biological diversity or biodiversity.

Biodiversity in the widest sense is measured either by estimating richness (number of types of living organisms) in an area, or by one or more indices combining richness and relative abundance within an area. In some cases, instead of measuring diversity in an area, diversity within a typological unit of higher rank is measured (Wilson 1988).

It therefore appears that three separate approaches to the analysis of biodiversity may be taken. These are: (a) the biogeographic approach, which concentrates on actions on the global scale and on the identification of the areas which are richest from the point of view of the number of taxa (Grehan 1993; Platnick 1992), (b) the taxonomic approach, which operates by way of cladistic diagrams concerning the differentiation within systematic units (Williams et al. 1991), and (c) the ecological or ecological-landscape approaches, which focus on the determination of biodiversity on local and regional scales as well as the identification of the mechanisms of dependence between the number of species and the surrounding processes and conditions (Lubchenco 1991).

Where the first two approaches are concerned, one of the central issues in the maintenance of biological diversity is the relative importance for diversity of different areas, taxa, or ecosystems. However, this importance can be assessed in different, if related, ways. The first and most obvious way makes reference to "intrinsic" diversity and thus deems an area with higher diversity to be of greater importance than one with lower diversity. The second way involves attempts to assess the contribution made by any given area to the overall diversity of a given geographic region. It is possible from this perspective that an area with lower intrinsic diversity may actually be more important than others with higher diversity (World Conservation … 1992).

The overwhelming majority of the work done has been concerned with the analysis of biodiversity in the global, biogeographical interpretation, or else within one ecosystem type. Far rarer are works treating biodiversity at the level of the landscape or region (Baker 1990).

The aim of this article is to present some of the relationships between aspects of diversity at different landscape levels and to highlight some of the misunderstandings and difficulties in interpretation which are connected with these approaches. The examples cited here are mainly derived from different regions of Poland and concern only the vegetation cover.

LEVELS OF DIVERSITY

In general, there are three classes of objects whose diversity is measured. These are genotypes, species, and communities (Gliwicz 1992). Each class can be related to either typological or spatial sequence and referenced to different areas (Table 1).

Many different factors are involved in determining both the biodiversity of species within communities and the typological diversity of ecosystems within landscapes or regions. The most important of these factors are the ones connected with location (in terms of geography, the history of an area and the differentiation of the abiotic environment) as well as biocoenotic factors (ecosystem type, type of usage, degree of anthropogenic transformation, reaction to stress and disturbance, etc.). Furthermore, relative diversity is very often dependent upon the scale of measurement: 1 m^2 of xerothermic grassland has more species than 1 m^2 of tropical forest, but the relationship is reversed if the area considered is increased to 1 km^2 (Wilson 1988; World Conservation … 1992; O'Brien 1993; Huntley 1993; Solon 1993).

The diversity of vegetation cover within the landscape is a very complex phenomenon. Schematically, this may divided into three groups of phenomena (Table 1). The first group includes floristic diversity (species, growth forms, ecological groups, etc.). The second group includes synthetic characteristics which are the fundamental formal (numerical) descriptions of landscape diversity. In this interpretation, diversity signifies the physiognomic, ecological, and, above all, syntaxonomic differentiation of phytocoenoses in a given area. An important element in this group of characteristics is patchiness, or the overall number of patches (phytocoenoses). It is accepted that the greater the number of patches the greater the diversity (Baker 1989).

TABLE 1 Compilation of the Most Often Defined Aspects of Diversity at Different Organizational Levels of Animate Nature

OBJECT OF DIVERSITY	MEASURE	OBJECTS IN WHICH DIVERSITY IS DEFINED	REFERENCE AREA
Species level			
a) SPECIES	a) NUMBER	a) ECOSYSTEM	a) WHOLE AREA
b) OTHER TAXA (genera etc)	b) PROPORTION	b) ECOSYSTEM TYPE (1 m2, 1 km2 etc.)	b) UNIT OF AREA
c) OTHER GROUPINGS OF SPECIES (growth forms, size classes, trophic levels, habitat requirement classes, range types, etc.)	c) REGION (ecological, administrative, etc.)	c) NON-AREAL MEASURE	
	d) HIGHER-RANK TYPOLOGICAL CATEGORIES		
Landscape level, aspects independent of location			
a) ECOSYSTEMS	a) NUMBER	a) LANDSCAPE	a) WHOLE AREA
b) TYPES OF ECOSYSTEMS	b) PROPORTION	b) REGION (etc.)	b) UNIT OF AREA
Landscape level, aspects dependent on location			
a) ECOSYSTEMS	a) CONTRAST	a) LANDSCAPE	a) WHOLE AREA
b) TYPES OF ECOSYSTEMS	b) NUMBER OF BOUNDARIES	b) REGION (etc.)	
	c) SHAPE INDEX		

The third group of characteristics influencing landscape diversity involves the spatial organization of phytocoenoses, the differentiation in their shapes and sizes, the degree of complexity of boundaries, and the number of neighboring patches, as well as the physiognomic, syntaxonomic, and usage contrasts between these patches.

In contrast to the features of the second group (synthetic characteristics), whose values may be determined on the basis of statistical data, determinations of the features from the third group require detailed analysis of the spatial relations between the different communities. They may therefore be referred to as a group of analytical components of the overall diversity of the landscape (Solon 1995).

There are two main factors which influence different aspects of vegetational diversity at the landscape level at the local scale. The first is the differentiation and spatial arrangement of habitats, which could be expressed in terms of potential vegetation; and the second is the land use structure and other anthropogenic activities. So, landscape diversity must be viewed as resulting from the superimposition of two different vegetation patterns: (a) patterns related to the distribution of communities along gradients of limiting factors, and (b) patterns resulting from portions of the landscape being under different human influence and in different stages of recovery following disturbance. The relative contribution of these two kinds of pattern to overall landscape diversity is variable (Baker 1989, Solon 1990).

The different aspects of the biological diversity of vegetation in the landscape are to a significant extent independent of one another and are clearly not additive. They also react in various ways to the different anthropogenic factors. This is particularly clear when comparisons are made between the biodiversity of objects belonging to different levels of organization in nature, different trophic levels or different systematic groups.

In light of the aforementioned considerations, the well-known statement from Whittaker (1977) that "a system made up of one herbivorous species and one predator species is more diverse than a system made up of two herbivores" does not represent a true assessment of the different systems. Evaluated jointly in this statement are the number of species and trophic levels, i.e., two different aspects of diversity which should be looked at separately. Using this method of evaluation, it may be asked which system is the more diverse: one containing ten herbivorous species, or one with two herbivores and one predator? An unequivocal answer cannot be given to questions formulated in this way.

In relation to taxonomic diversity, Prendergarst et al. (1993) give data for Great Britain which show that there is often a lack of coincidence between species-rich areas for different taxa and also that many rare species are absent from the areas with the highest species diversity.

THE INFLUENCE OF ANTHROPOGENIC ACTIVITIES ON DIVERSITY WITHIN VEGETATIONAL LANDSCAPES

It has been observed many times that conditions of moderately intensive anthropogenic activity sustain a greater spatial diversity of vegetation in the landscape than areas in which there is no such activity (Suffling 1988; Huston 1979). This is an analogous relationship to the change in the species richness described earlier for phytocoenoses. In the 1970s, Grime (1979) drew up a model in which the number of species, life strategies, total standing crops, and level of disturbance were all linked together. It was suggested in the model that moderate intensities of stress and/or disturbance increased species richness by reducing the vigour of potential dominants and thus allowing subsidiary species to coexist alongside them. However, the model went on to suggest that species richness declines once stresses and/or disturbances rise to extreme levels and as there arise conditions to which only a very small number of species are sufficiently well-adapted to survive (Grime 1979; Reader, Taylor, and Larson 1991).

In the conditions of Central Poland, the greatest values of indices for the diversity of phytocoenoses are noted in vegetational landscapes with average or moderately high levels of anthropogenic disturbance. This is particularly clear in the well-developed suburban zones. On the other hand, clearly lower values for indices of diversity are noted for both intensively-used agricultural landscapes and landscapes subject to low pressures from man and characterised by a significant proportion of near-natural communities (Fig. 1) (Solon 1995).

The actual level of diversity within different landscapes is also greatly dependent upon the history of the spatial system (Law & Morton 1993). Solon (1994) analysed the role of successive increases and decreases of anthropogenic

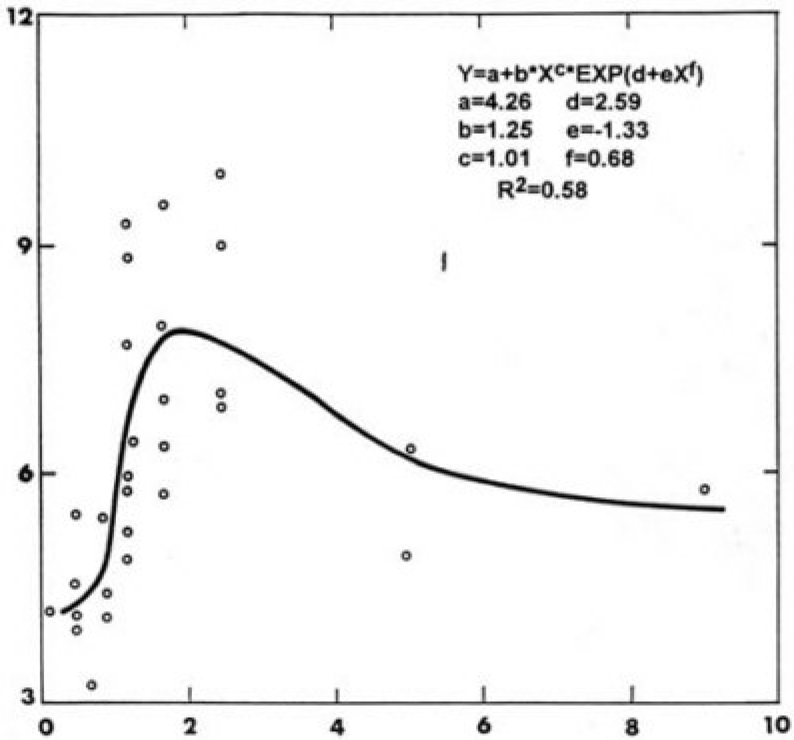


FIGURE 1 Relationships between the Anthropogenic Disturbance and Vegetation Diversity According to Maxwell Distribution Model for 29 Vegetation Microlandscapes in the vicinity of Wigry Lake. X axis - 0.1 × (number of houses); Y axis - actual vegetation diversity according to modified Shannon's formula 10 × [1-H(E)/H(E, P)] (after Solon 1995).

activity and was able to demonstrate that vegetational micro-landscapes presently characterised by the same level of anthropogenic disturbance have a vegetation cover of distinctly greater actual diversity if they had been subject to increasing pressure within the last thirty years. In contrast, micro-landscapes in which anthropogenic activities had experienced systematic decline had actual vegetational diversity that was lower.

In addition, a clear lack of an unequivocal relationship between different variables is observed within the analytical components of the total diversity of a vegetational landscape. It was concluded from detailed studies in the area of Lake Wigry (Table 2) that there were only weak and usually statistically-insignificant correlations between five characteristics of phytocoenoses (habitat type, degree of anthropogenic deformation, mean patch size, number of neighboring patches, and an index of shape). The type of habitat and the degree of anthropogenic deformation were found to have a significant influence on the mean sizes of patches of plant communities (correlation coefficient 0.43). However, this linkage is rather complicated. In general, the higher the level of anthropogenic deformation of the vegetation, the smaller the sizes of the different patches. However, at the same level of deformation, the patches of relatively the smallest size are those occurring in wet areas, while the largest ones are those in dry areas (Solon, in print).

The shape index of phytocoenoses is clearly, though weakly, correlated with both the level of deformation and the number of neighbors. The higher the level of anthropogenic deformation of a given phytocoenosis, the lower the value of the shape index. This indicates, in other words, that patches have more regular shapes and are closer to squares. On the other hand, patches enclosed by a greater number

TABLE 2 Changes in the Vegetation Cover of Meadows in the Valley of the River Nida near Mlodzawy

Vegetation (Solon 1993)	1961r.		1985r.
Number of community types	14		13
Number of types common to both periods	6		6
Number of separate patches	21		17
Index of typological similarity*		0.44	
Local flora (Roo-Zielinska 1993)	1961r.		1985r.
Number of specie	374		361
Number of species common to both periods	323		323
Index of typological similarity*		0.88	

* Index of typological similarity calculated in accordance with the formula 2c/(a+b); where c = number of types common to both periods; a = number of types in the first period; b = number of types in the second period

of other communities are characterised by very irregular and most often elongated boundaries. In contrast, there is no significant correlation between the size of a patch and the shape index.

A separate issue is the independence of changes in biological diversity under the influence of anthropogenic activity taking place at various levels of organization. For example, drainage work carried out at the beginning of the 1960s led to changes in land use in the Nida Valley around Pinczow. This in turn led to changes in the actual vegetation and local flora (Table 3, Fig. 2). There were slight declines in both the number of inventoried plant communities and the overall species richness. Nevertheless, the changes in the vegetation were considerably greater than those in the flora, and it was therefore necessary to conclude that, beyond the changes in the inventory of communities, there had been fundamental changes in their distributions (Roo-Zielinska 1993; Solon 1993).

The results give a clear indication that the influence of anthropogenic activity on changes in components of the overall diversity of vegetational landscapes is multitracked and often leading in different directions. On the one hand, there may often be a rise in overall diversity (by way of an increase in the number of types of vegetation patch and/or the number of patches), but on the other hand there may be a reduction in the diversity (as a consequence of the simplification of the structure by which communities neighbour one another and a decline

TABLE 3 Correlations between Selected Surface Characteristics of Plant Communities in the Environs of Lake Wigry (Solon 1995)

VARIABLES	2	3	4	5
1	0.61^{***}			
2				-0.26^{*}
3			0.52^{***}	
4				0.28^{*}
5				
6		0.43^{**}		

Significance level: ***0.001; **0.01; *0.05.
1-habitat type
2-anthropogenic deformation
3-patch size
4-number of neighboring patches
5-shape index
6-habitat and deformation together

in the shape index). It would therefore seem that the current state of knowledge makes it difficult to anticipate the quantitative character of topological changes in components of diversity under the influence of changes in anthropogenic activity.

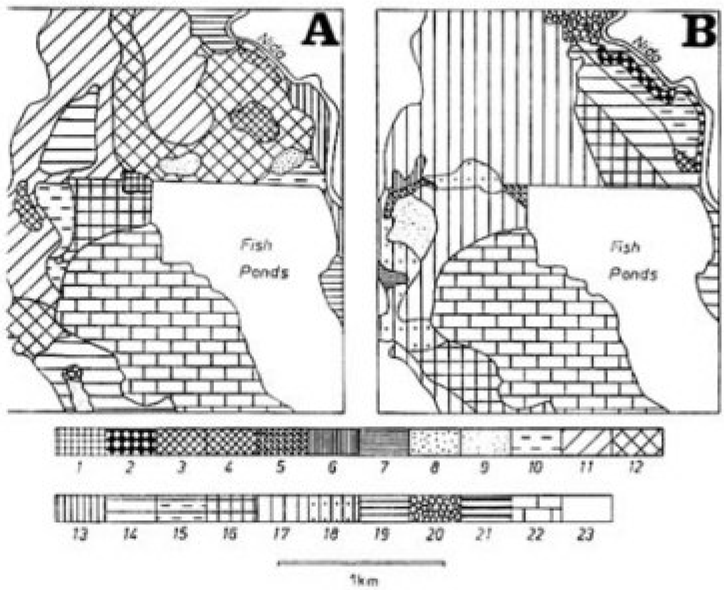


FIGURE 2 Actual Vegetation of the Fragment of Nida Valley (after Solon 1993). A) in 1961, B) in 1985. 1) Caricetum ripariae; 2) Caricetum gracilis phragmitetosum; 3) Caricetum gracilis typicum; 4) Caricetum gracilis caricetosum nigrae; 5) Phragmitetum; 6) Caricetum paniculatae; 7) Caricetum acutiformis; 8) Carici-Agrostietum; 9) Caricion davallianae; 10) community intermediate between Caricion Molinion and Calthion; 13) Epilobio-Juncetum; 14) CirsioPolygonetum var. davallianae and Calthion; 11) Molinion; 12) community intermediate between with Lathyrus palustris; 15) Cirsio-Polygonetum var. with Cerastium arvense; 16) community intermediate between Cirsio- Polygonetum and Cirsium canum-Cirsium rivulare community; 17) Cirsium canum-Cirsium rivulare community, var. with Carex nigra; 18) Cirsium canum-Cirsium rivulare community, typical variant; 19) Arrhenatheretum; 20) Diantho-Armerietum; 21) Salici-Populetum; 22) Ribo-Alnetum; 23) other communities.

CONCLUSIONS

In many cases, and particularly in cultural landscapes which, after Naveh (1988), can be characterised as heterogenic, small-grained, and metastable agricultural landscapes, it is impossible to preserve all aspects of diversity simultaneously. More than once this has led to serious conflicts in planning protective measures. These conflicts may be of different types, including those between the tendencies to renaturalize or conserve nature, those involving the protection of the diversity in one group at the expense of another, or those between the protection of diversity in one place and the reduction of diversity over considerably greater areas. Actions giving rise to increases in typological diversity in spatial units may, in extreme cases, lead to structural and functional chaos in the vegetation of a given landscape system.

One of the causes of such conflicts is the lack of an appropriate conceptual apparatus for the formal description, comparison, and evaluation of different structural and functional aspects of biological systems at the landscape level, which jointly make up its biodiversity.

A second cause is the joint treatment of different elements (aspects) of diversity, with no consideration given to their origins, ecological character, or qualitative variability.

The third and final cause is the identification of the diversity of ecosystems with their value. This often leads to great misunderstandings in the evaluation of the quality of landscape units.

In spite of the aforementioned limitations, there is a widespread tendency to treat biodiversity as an absolute and superior value, as the most important index in the planning of all activities related to nature conservation and the management of the environment. In the view of Bowman (1993) "… the word 'biodiversity' suffers the problem of reification, the treatment of an abstract idea as if it were a thing."

An approach based on the evaluation and protection of diversity cannot replace other traditional framework concepts on which nature conservation has been based. In reality, diversity and the threats to it should rather be one of many criteria aiding decision-making.

REFERENCES

Baker W.L., 1989, A Review of Models of Landscape Change, Landscape Ecology 2, 111-133.

Baker W.L. 1990, Species Richness of Colorado Riparian Vegetation, Journal of Vegetation Science 1: 119-124.

Bowman D.M. 1993, Biodiversity: Much More than Biological Inventory, Biodiversity Letters 1.6: 163-163.

Gliwicz J. 1992, Roznorodnosc Biologiczna: Nowa Koncepcja Ochrony Przyrody (Biological Diversity: A New Concept of Nature Conservation), Wiad. Ekol. 38.4: 211-219.

Grehan J.R. 1993, Conservation Biogeography and the Biodiversity Crisis: A Global Problem in Space/Time, Biodiversity Letters 1.5: 134 -140.

Grime J.P. 1979, Plant Strategies and Vegetation Processes, J. Wiley & Sons, 222 pp.

Huntley B. 1993, Species-richness in North-Temperate Zone Forests, Journal of Biogeography 20: 163-180.

Huston M. 1979, A General Hypothesis of Species Diversity, Am. Naturalist 113: 81-101.

Law R., Morton R.D. 1993, Alternative Permanent States of Ecological Communities, Ecology 74 (5): 1347-1361.

Lubchenco J., Olson A.M., Brubaker L.B., Carpenter S.R., Holland M.M., Hubbell S.P., Levin S.A., MacMahon J.A., Matson P.A., Melillo J.M., Mooney H.A., Peterson C.H., Pulliam H.R., Real L.A., Regal P.J., Risser P.G. 1991, The Sustainable Biosphere Initiative: An Ecological Research Agenda, Ecology 72, 2, 371-412.

Naveh Z. 1988, Biocybernetic Perspectives of Landscape Ecology and Management, Proc. of the First Symposium of the Canadian Society for Landscape Ecology and Management: 23-34, Polyscience Publications Inc.

O'Brien E.M. 1993, Climatic Gradients in Woody Plant Species Richness: Towards an Explanation Based on an Analysis of Southern Africa's Woody Flora, Journal of Biogeography 20:181-198.

Platnick N.I. 1992, Patterns of biodiversity, (in:) Eldredge N. (ed.), Systematics, Ecology and the Biodiversity Crisis, 15-24, Columbia University Press, New York.

Prendergast J.R., Quinn R.M., Lawton J.H., Eversham, B.C., Gibbons, D.W. 1993, Rare Species, The Coincidence of Diversity Hotspots and Conservation Strategies, Nature 365:335-337.

Reader R.J., Taylor K.C., Larson D.W. 1991, Does Intermediate Disturbance Increase Species Richness within Deciduous Forest Understory?, Modern Ecology. Basic and Applied Aspects, 363-373, Elsevier.

Roo-Zielinska E. 1993, The Current State and Changes in the Meadow Flora in the Nida Valley, S Poland, Fragm. Flor. Geobot. 38.2:581-592.

Solon J. 1990, The Spatial Distribution of Vegetation Units as a Result of Habitat and Synanthropization Pattern, Ekologia (CSFR) 9.4:383-393.

Solon J. 1993, Changes in the Vegetation Landscape in the Pinczow Environs (S Poland), Phytocoenologia 21.4:387-409.

Solon J. 1994, Vegetation Differentiation and its Changes in the Warsaw Suburban Zone - A General Review, Memorabilia Zoologica 49:99-113.

Solon J. 1995, Anthropogenic Disturbance and Vegetation Diversity in Agricultural Landscapes, Landscape and Urban Planning 31:171-180.

Suffling R. 1988, Catastrophic Disturbance and Landscape Diversity: Implications of Fire Control and Climate Change in Subarctic Forests, Proc. of the First Symposium of the Canadian Society for Landscape Ecology and Management: 111-120, Polyscience Publications Inc.

Whittaker R.H. 1977, Evolution of Species Diversity in Land Communities, Evol. Biol. 6: 1-67.

Williams P.H., Humphries C.J. & Vane-Wright R.I. 1991, Measuring Biodiversity: Taxonomic Relatedness for Conservation Priorities, Aust. Syst. Bot. 4:665-679.

Wilson E.O. (red.) 1988, Biodiversity, National Acad. Press, Washington D.C.

World Conservation Monitoring Centre 1992, Global Biodiversity: Status of the Earth's Living Resources (edited by B. Groombridge), Chapman & Hall, London, xx + 594pp.

RESTORATION ECOLOGY: SOME NEW PERSPECTIVES

Karen D. Holl
Stanford University

INTRODUCTION

Clearly, the ideal method of preserving biodiversity and concomitant ecosystem services is the preservation of minimally disturbed ecosystems. However, the impact of humanity on the environment has progressed at an unprecedented rate and scale in recent decades. Myers (1993) estimates that nearly 50% of tropical forests worldwide have been destroyed. While the clearing of tropical forests has received much notice, similarly staggering figures can be cited for the degradation of nearly any type of ecosystem in any region worldwide. For example, approximately half the forested area in Central Europe has been damaged by air pollution (Godzik and Sienkiewicz 1990). The current state of the global environment precludes the possibility of simply protecting minimally disturbed areas in an effort to conserve global biodiversity. Restoration of damaged ecosystems is a necessary additional strategy to further conservation efforts. This paper outlines an interdisciplinary approach to restoring damaged ecosystems that maximizes both ecological and human benefits.

AN INTERDISCIPLINARY APPROACH

Bradshaw (1987) has suggested that restoration of damaged ecosystems is the "acid test" of our understanding of natural processes. An understanding and recognition of basic ecological principles in project design are essential if there is to be any hope of restoring disturbed ecosystems. Not surprisingly, most restoration projects have demonstrated the limited extent of our understanding of ecosystem processes. At the same time, such efforts have and will continue to increase our knowledge of ecosystem functioning in less disturbed systems.

Poor understanding of ecosystem processes is only one of the myriad ecological and social challenges to restoring damaged ecosystems. A few of the numerous ecological problems include mitigation of minimal soil nutrients, competition of native with invading non-native species, lack of reference systems as a source of floral and faunal propagules, and residual toxicity of soil or water. Lack of funding, restrictive legislation, and conflicting needs of landowners also commonly encumber restoration efforts. Confronting such challenges and meeting the needs of numerous constituent groups necessitate an interdisciplinary decision-making approach. Such an approach is foreign to most people, who are trained in highly specialized disciplines. Basic understanding of natural sciences, economics, sociology, and law, and, more importantly, the ability to communicate with people of different backgrounds are absolutely essential to the success of restoration efforts.

The need for interdisciplinary cooperation is best illustrated by an example: the Roanoke Regional Landfill in western Virginia. A research project to investigate the use of native herbaceous species for restoring the landfill instead of the aggressive, non-native species currently used was initiated at the interest of a local councilman, the director of a regional historic theme park, and researchers at Virginia Polytechnic Institute and State University. While such a strategy would have ecological and aesthetic benefits, the board overseeing landfill closure and the landfill operators were hesitant to adopt innovative restoration procedures because of the extra effort and cost and fear of not complying with landfill closure regulations. Researchers were confronted with strict regulations regarding plant rooting depth, although research suggests that roots do not penetrate landfill liners (Dobson and Moffat 1993), and with problems of methane emission, soil compaction, and variable soil nutrient levels. Clearly, each group involved had its own interests and concerns. After a great deal of negotiations, some of the native species that showed promising results in the pilot study are being included in the final closure plan.

While restoration efforts will be confronted by different obstacles, meeting the needs of a number of parties is a common theme. It is particularly important to recognize the need for an interdisciplinary approach to conservation in transboundary protected areas. In such areas, not only will cooperation between a number of groups in a single country be necessary, but also between different countries that may have different governing systems and financial resources and in which parks have varied levels of protection from human activity.

PROJECT DEVELOPMENT

Goal Setting

Restoration projects can be loosely divided into a number of different stages, although there is clearly a great deal of overlap (Fig. 1). Goals must be clearly defined from the outset; otherwise, conflict throughout the project is inevitable. Most importantly, a mutually desirable endpoint for the ecosystem must

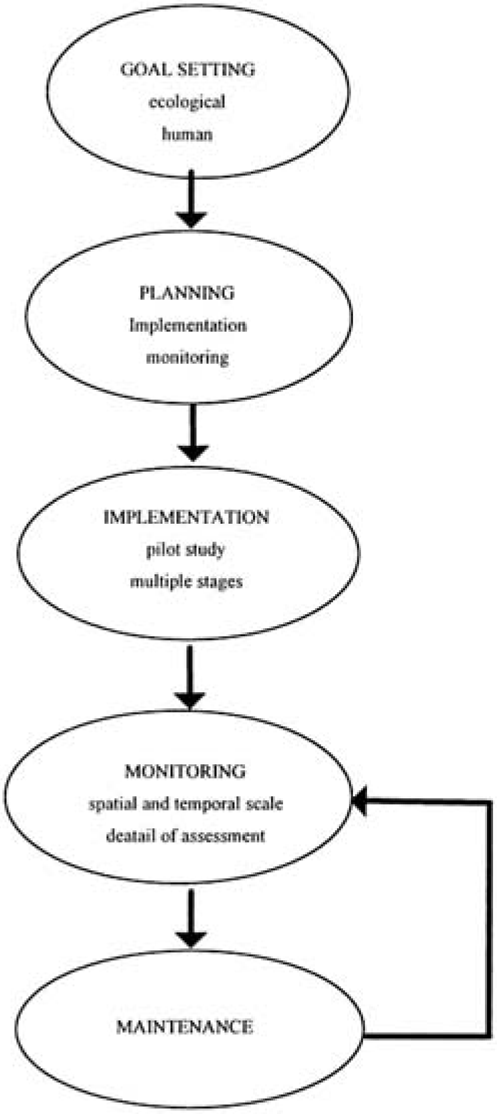


FIGURE 1 Stages in Restoration. (SOURCE: NRC 1992).

be agreed upon. Generally, three types of endpoints are considered for rehabilitation of disturbed ecosystems.

The first option is restoration of both predisturbance structure and function (Bradshaw 1984). It is highly debatable whether this goal is feasible due to the lack of reference systems, impossibility of recreating disturbance regimes, and continued stresses; however, some restoration efforts have resulted in ecosystems quite similar to those present prior to disturbance. For instance, prairie restoration efforts in the midwestern United States have succeeded in re-establishing much of the native flora (e.g., Howell and Jordan 1989; Mlot 1990; Trager 1990). Also, restored seagrass beds in a number of areas worldwide closely approximate the predisturbance ecosystems (Thorhaug 1990).

Although restoration to predisturbance condition is the most desirable endpoint for conservation of biodiversity, due to ecological and financial constraints, the goal of most large-scale restoration projects, especially in highly disturbed areas, is to restore certain structural or functional components of the predisturbance ecosystem. More often emphasis is on restoring certain functional characteristics. For example, mine reclamation legislation in the United State requires a certain percentage of ground cover and that maintenance of water quality be attained in order to secure bond release, while there are no strict requirements on the vegetational species used. Although fewer projects are focused on restoring individual species, there have been extensive efforts aimed at restoring threatened or endangered species (e.g., Harris and Feeney 1989; Short et al. 1992).

A third option for highly disturbed ecosystems is creation of an alternative type of ecosystem that is considered of higher value to nearby communities. While this option may seem ecologically less desirable, it may result in greater overall benefits to the entire landscape. For example, while wetlands are not common in the Appalachian region of the United States, they are increasingly being created on surface-mined areas to treat acid mine drainage, control runoff, and provide habitat for certain species, thereby facilitating conservation of the surrounding forest.

Clearly, after selecting a general endpoint for restoration, more specific goals must be determined, such as the actual structural and functional characteristics to be restored or the time scale in which a project will be completed. Other additional goals might include involving the community in the restoration project or furthering knowledge of certain ecosystem processes. Regardless, these goals must be agreed upon by all groups in order to facilitate subsequent stages of the project.

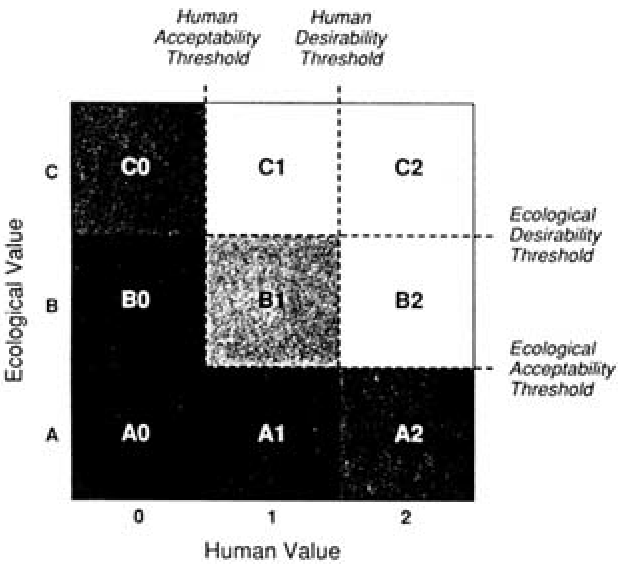
In all cases, selecting goals requires balancing ecological and human values (Fig. 2). As an example, for the landfill restoration project discussed previously, the ecologically most desirable endpoint would be to restore the predisturbance community by planting seedlings and covering the area with forest topsoil. However, the increased cost of these procedures would likely make this option unacceptable to humans. Such needs are not always in conflict, though. For instance, installing a proper gas venting system would minimize risks to both humans and the flora and fauna. While Figure 2 illustrates human and ecological needs in two dimensions, it is important to recognize that the values of different groups involved, such as legislators, managers, and nearby communities, will usually vary greatly; likewise, it may not be clear what is the most ecologically desirable endpoint. Options must be weighed from the perspective of all parties affected by the outcome. Considerations include the costs and benefits of different options, the magnitude of disturbance and feasibility of recovery, and the effect of the endpoint of the ecosystem in consideration on other nearby systems. Usually, the solution falls in the B1 box (Fig. 2); the proposal is acceptable from a number of different perspectives, but is not necessarily the most desirable option for any single party.

Planning

The nature of the planning process will vary widely depending on the scale of the project, the severity of disturbance, and the type of ecosystem. However, it is necessary at the planning stage that specific procedures for ameliorating existing stresses, rehabilitating damaged areas, and monitoring the success of these procedures be detailed. For terrestrial systems, examples of factors to be considered include the type of plant species to be used (e.g., native vs non-native, annual vs perennial, early- vs late-successional), the method of revegetating (e.g., seeds, seedlings, or cuttings), and necessary soil amelioration (e.g., mulching or fertilizing). For aquatic systems decisions must be made about methods of stabilizing stream channels (e.g., planting vs structural methods) and reducing nutrient levels in lakes (e.g., source reduction, precipitation, or aeration), among many others. The suitability of introducing faunal species must be considered for all systems.

These decisions will be constrained by many factors, the most common of which are cost and availability of materials. For instance, seeds are only available commercially for a small percentage of plant species and there is usually little genetic variability. Collection of seeds from a nearby source would be ideal, but is extremely time consuming and often results in low germination rates. Because of the large number of options for restoration, a pilot project is advisable and can save a great deal of time and money. If a pilot project is not possible, a careful review of other similar projects may facilitate decision-making.

It is important that a detailed time schedule for both implementation and monitoring be outlined. The time of year of planting has a large impact on vegetational establishment as does the order of planting of different species. Most restoration projects consist of a single or a few closely spaced treatments. However, a basic understanding of ecological succession would suggest that a longer term management plan is a more realistic approach.



Cell	Ecological Value	Human Value
A0	Unacceptable	Unacceptable
A1	Unacceptable	Acceptable
A2	Unacceptable	Desirable
B0	Acceptable	Unacceptable
B1	Acceptable	Acceptable
B2	Acceptable	Desirable
C0	Desirable	Unacceptable
C1	Desirable	Acceptable
C2	Desirable	Desirable

FIGURE 2 Project Assessment Matrix. (SOURCE: NRC 1992).

Implementation

Implementation is not discussed in detail here as this stage is specific to the goals and plans decided upon for each individual project. While thorough goal setting and planning will facilitate implementation, unforeseen problems will always arise. Therefore, some flexibility in plans is essential. It is important to reemphasize that implementation is a multi-stage process that will overlap with monitoring and maintenance. In other words, ecosystem restoration is a dynamic process that requires time.

Monitoring

Monitoring is often not included in an effort to minimize costs, but it is an essential component of any project to ensure that problems are corrected and to facilitate future work. Monitoring protocols must be outlined and criteria for success determined during the planning phase of the project, not after implementation. Traditionally, the success of restoration projects has been monitored using only a few criteria, over small spatial scales, and for a short period of time (Fig. 3), which precludes evaluating the role of restoration in conservation efforts.

Generally, only a few criteria are considered in measuring restoration success, such as vegetative biomass, soil or water nutrient levels, and soil erosion; in very few cases are floral and faunal community composition monitored. A variety of both functional and structural criteria should be considered in judging restoration success. Westman (1991) lists a number of such measures, including genetic diversity, pattern of local and regional distribution, and natality/mortality rates. Pielou (1986) suggests a simple way to quantify relative community diversity and compare restored and reference community composition.

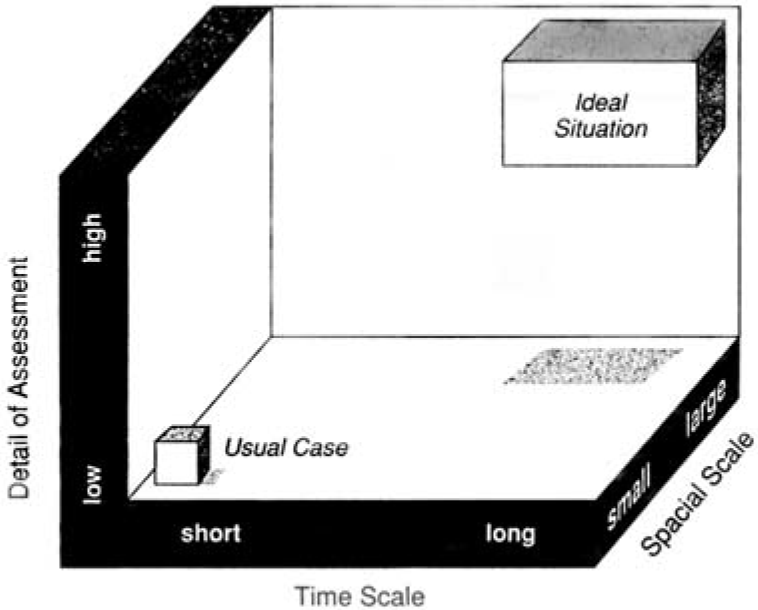


FIGURE 3 Planning and Monitoring Ecosystem Restoration. (SOURCE: NRC 1992)

Success of ecosystem restoration is normally evaluated after only a few years, even though recovery from natural disturbance in most ecosystems requires a much longer time. As a result, most restoration projects are aimed at achieving short-term goals, which may inhibit long-term ecosystem restoration. For example, aggressive, non-native, herbaceous species are often planted on reclaimed mined sites in the southeastern United State in an effort to minimize erosion and achieve 5-year cover requirements. However, these species have been shown to inhibit the long-term development of the vegetational communities (Brenner et al. 1984; Burger and Torbert 1990; Hughes et al. 1992). Clearly, short-term needs must be met, but more consideration must be given to maximizing long-term goals.

Ecosystem restoration must also be planned and monitored at larger spatial scales. Human actions often affect ecosystems over large areas. For instance, surface mining causes increased nutrient levels in entire watersheds (e.g., Matter and Ney 1981; Dick et al. 1986). Logging may cause changes in temperature and species composition far into the remnant patches of forest. Likewise, recovery of reclaimed areas is dependent on the composition of the surrounding landscape (e.g., Wolfe 1990; Nepstad et al. 1991; Anderson 1993). Therefore, it is essential that the surrounding landscape, and not just the area being restored, be considered in the planning and monitoring stages.

Maintenance

Ideally, maintenance will be minimal if the project has been well planned and implemented over an extended period of time. Problems observed during routine monitoring will dictate the need for further maintenance and changes in the original monitoring plan. One component of continuing any restoration program should be efforts to disseminate results. The failure of many groups involved in restoration to make their results widely available to others in the field has handicapped restoration ecology in general, and mistakes are therefore needlessly repeated.

EDUCATION

Education and community involvement are essential components of all stages of any restoration project for a number of reasons. Most importantly, one must remember that restoration of ecosystems is only an academic exercise unless the behaviors that resulted in the original disturbance are altered. In order to affect such a change, it is necessary that the general public understand the relationship between its actions and the resulting ecosystem degradation in order to modify behavior. For example, a large-scale tropical dry forest restoration program has been initiated in recent years in northwestern Costa Rica (Janzen 1988). A major obstacle to restoration in this area is the fires that spread rapidly through deforested areas. These fires are normally started by landowners to "clean" their land. The government has initiated a widespread publicity campaign to inform people of the problems caused by burning. Similarly, citizens of developed countries need to be better educated about the effects of automobile emissions on flora and fauna. Education does not insure changes in behavior, but it is a necessary first step.

Community involvement at early stages is necessary to address the needs and concerns of nearby communities, and community involvement throughout the process will help develop a sense of pride and respect for the restored area, giving incentive to further its protection. Berger (1987) cites numerous examples of individuals and communities that have been the driving force behind restoration efforts.

Finally, restoration projects provide excellent models for educating students at all levels and the general public about both ecosystem functioning and interdisciplinary decision-making. For example, high school students have been intimately involved in the landfill restoration project discussed previously. Not only have they tested many scientific hypotheses, such as the effect of temperature on plant establishment and the ability of different plant species to control erosion, they have also talked to local government officials, attended landfill board meetings, and visited the location of a landfill currently under construction. Interdisciplinary education is necessary to prepare our future leaders for the challenges they will face.

RESEARCH NEEDS

Much work in restoration ecology has been initiated in recent years, and restoration ecologists are constantly being confronted with new challenges. For this reason, research in all areas of restoration ecology is desperately needed. Currently, areas of pressing urgency include competition between native and invading non-native species, an obstacle to restoration in many ecosystems (e.g., Wingate 1985; Towns et al. 1990; Mills et al. 1992); the effect of landscape structure on restoration; and quantification of ecosystem services provided by restored areas in order to communicate the benefits of restoration to the general public.

As ecosystem restoration is increasingly cited as one strategy to preserve biodiversity (e.g., Jordan et al. 1988; Cairns 1988), it is essential that there be more study of the long-term effects of ecosystem restoration on regional conservation. Most research has consisted of one-time sampling of single sites. The few larger scale studies in regional conservation suggest that, as would be expected, restored areas favor generalist species (e.g., Engelmann and Weaks 1985; Holl 1994; Selser and Schramm 1990) and tend to host more homogeneous floral and faunal communities than reference systems (e.g., Allen and MacMahon 1985, Holl 1994). While study of the impact of restoration on conservation of species diversity is lacking, the role of restoration in the conservation of genetic diversity has not been addressed at all.

CONCLUSION

This discussion has not presented an optimistic outlook toward the possibility of restoring damaged ecosystems. Restoration efforts face many ecological and socio-economic obstacles. However, these challenges can also be viewed as opportunities. The growing number of restoration projects initiated in the past few years will serve to further our understanding of ecosystem processes and provide valuable models for interdisciplinary decision-making. If we act quickly, restoration of degraded ecosystems in combination with lifestyle changes provides an opportunity to improve the state of the global environment.

REFERENCES

Allen, M. F. and J. A. MacMahon. 1985. Impact of Disturbance on Cold Desert Fungi: Comparative Microscale Dispersion Patterns. Pedobiologia 28: 215-224.

Anderson, A. N. 1993. Ants as Indicators of Restoration Success at a Uranium Mine in Tropical Australia. Restoration Ecology 1: 156-167.

Berger, J. J. 1987. Restoring the Earth. New York: Anchor Press.

Bradshaw, A. D. 1984. Land Restoration Now and in the Future. Proceedings of the Royal Society of London B 223: 1-23.

Bradshaw, A. D. 1987. Restoration: An Acid Test for Ecology. Pages 23-29 in: W. R. Jordan III, M. E. Gilpin, and J. D. Aber (eds.) Restoration Ecology. Cambridge: Cambridge University Press.

Brenner, F. J., M. Werner, and J. Pike. 1984. Ecosystem Development and Natural Succession in Surface Coal mine Reclamation. Minerals and Environment 6: 10-22.

Burger, J. A. and J. L. Torbert. 1990. Mined Land Reclamation for Wood Production in the Appalachian region. Pages 159-163 in: J. Skousen, J. Sencindiver, and D. Samuel Dave (eds.) Proceedings of the 1990 Mining and Reclamation Conference and Exhibition Vol. 1. Morgantown: West Virginia University.

Cairns, J., Jr. 1988. Increasing Diversity by Restoring Damaged Ecosystems. Pages 333-343 in: Wilson, E. O. (ed.) Biodiversity. Washington, D.C.: National Academy Press.

Dick, W. A, J. V. Bonta, and F. Haghiri. 1986. Chemical Quality of Suspended Sediment from Watersheds Subject to Surface Coal mining. Journal of Environmental Quality 15: 289-293.

Dobson, M. C. and A. J. Moffat. 1993. The Potential for Woodland Establishment on Landfill Sites. London: Department of the Environment.

Engelmann, M. H. and T. E. Weaks. 1985. An Analysis of the Effects of Stripmining Disturbance on Bryophyte Species Diversity. Bryologist 88: 344-349.

Godzik, S. and J Sienkiewicz. 1990. Air pollution and Forest Health in Central Europe: Poland, Czechoslovakia, and the German Democratic Republic. Pages 155-170 in: W. Grodzinski, E. B. Cowling, and A. I. Breymeyer (eds.) Ecological Risks: Perspectives from Poland and the United States. Washington, D.C.: National Academy Press.

Harris, R. D. and L. Feeney. 1989. Restoration Habitat for Burrowing Owls (Athene cuniccularia). Pages 251-260 in: H. G. Hughes and T. M. Bonnicksen (eds.) Restoration '89: The New Management Challenge, First Annual Meeting of the Society for Ecological Restoration. Oakland, California: Society for Ecological Restoration.

Holl, K. D. 1994. Vegetational and Lepidopteran Conservation in Rehabilitated Ecosystems. Ph.D. Dissertation. Blacksburg: Virginia Tech.

Howell, E. A. and W. R. Jordan III. 1989. Tallgrass Prairie Restoration in the North American Midwest. Pages 395-414 in: I. F. Spellerberg, F. B. Goldsmith, and M. G. Morris (eds.) The Scientific Management of Temperate Communities for Conservation. Oxford: Blackwell Scientific Publications.

Hughes, H. G., G. L. Storm, and B. E. Washburn. 1992. Establishment of Native Hardwoods on Mined Lands Revegetated under Current Regulations. Pages 601-606 in: Proceedings of the 9th Annual Meeting of the American Society for Surface Mining and Reclamation . Princeton, WV: American Society of Surface Mining and Reclamation.

Janzen, D. H. 1988. Guanacaste National Park: Tropical Ecological and Biocultural Restoration. Pages 143-192 in: J. Cairns Jr. (ed.) Rehabilitating Damaged Ecosystems. Boca Raton, FL: CRC Press.

Jordan, W. R., III, R. L. Peters, II, and E. B. Allen. 1988. Ecological Restoration as a Strategy for Conserving Biological Diversity. Environmental Management 12: 55-72.

Matter, W. J. and J. J. Ney. 1981. The Impact of Surface Mine Reclamation on Headwater Streams in Southwest Virginia. Hydrobiologia 78: 63-71.

Mills, E., C. Secor, J. Leach, and J. Carlton. 1992. Biological Pollution: A Constraint on Great Lakes Restoration. Page 144 in: Proceedings and Abstracts of the 54th Midwest Fish and Wildlife Conference.

Mlot, C. 1990. Restoring the Prarie. BioScience 40: 804-809.

Myers, N. 1993. Tropical Forests: The Main Deforestation Fronts. Environmental Conservation 20: 916.

National Research Council. 1992. Restoration of Aquatic Ecosystems. Washington, D.C.: National Academy Press.

Nepstad, D. C., C. Uhl, and E. A. S. Serrao. 1991. Recuperation of a Degraded Amazonian Landscape: Forest Recovery and Agricultural Restoration. Ambio. 20: 248-255.

Pielou, E. C. 1986. Assessing the Diversity and Composition of Restored Vegetation. Canadian Journal of Botany 64: 1344-1348.

Selser, E. J. and P. Schramm. 1990. Comparative Species Diversity and Distribution of Butterflies in Remnant and Restored Tallgrass Prairie Sites. Pages 63-66 in: D. Smith and C. A. Jacobs (eds.) Proceedings of the Twelfth North American Prairie Conference. Cedar Falls, IA: University of Northern Iowa.

Short, J., S. D. Bradshaw, J. Giles, R. I. T. Prince, and G. R. Wilson. 1992. Reintroduction of Macropods (Marsupialia: macropodoidea) in Australia: A Review. Biological Conservation 62: 189-204.

Thorhaug, A. 1990. Restoration of Mangroves and Seagrass: Economic Benefits or Fisheries and Mariculture. Pages 265-281 in: J. J. Berger (ed.) Environmental Restoration, Science and Strategies for Restoring the Earth. Washington D.C.: Island Press.

Towns, D. R., Daugherty, C. H., and I. A. E. Atkinson (eds.) 1990 Ecological Restoration of New Zealand Islands. Conservation Sciences Publication No. 2. Wellington: Department of Conservation.

Trager, J. A. 1990. Restored Prairies Colonized by Native Prairie Ants (Missouri, Illinois). Restoration and Management Notes 8: 104-105.

Westman, W. E. 1991. Ecological Restoration Projects: Measuring their Performance. Environmental Professional 13: 207-215.

Wingate, D. B. 1985. The Restoration of Nonsuch Island as a Living Museum of Bermuda's Precolonial Terrestrial Biome. Pages 225-238 in: P. J. Moors (ed.) Conservation of Island Birds. Cambridge: International Council for Bird Preservation.

Wolfe, R. W. 1990. Seed Dispersal and Wetland Restoration. Pages 51-95 in: Accelerating Natural Processes for Wetland Restoration after Phosphate Mining. Bartow, Florida: Florida Institute of Phosphate Research.

DESIGN OF PROTECTED AREAS

Stanley L. Krugman
Forestry Specialist

INTRODUCTION

There are any number of different definitions for protected areas commonly based on their purpose and objectives. But generally, by protected area one means the maintenance of a specific natural landscape, forest, water area, and, more recently, a specific biological resource in a condition virtually unmodified by human activity. This, of course, is an ideal state, but one seldom obtained. This is especially true in Europe, where human activities have been underway for thousands of years. The temperate zone forests which once covered most of Europe in some form has supported an ever growing human population and as a result, these forests have become highly fragmented, greatly reduced in size, and, to some extent, reduced in biological richness. Even so there is still an urgent need to protect, maintain, and even restore that biological resource that remains. In many locations this is still possible and feasible.

JUSTIFICATION

There are essentially four principal reasons for establishing and maintaining protected areas: first, protected area management currently is the only scientifically, technically, and economically feasible means of conserving existing natural biological diversity. This form of nature protection, when done correctly, will maintain the natural evolutionary processes. By preserving the integrity of the biological resource of plant and animal species, protected areas are essential for the current and future replenishment of surrounding abandoned and degraded areas. Ecological restoration has in recent years become a serious science which is now being applied in a number of countries to restore once wild lands. In addition, by preventing the often irreversible loss of a sizable proportion of a region's biological resource, the current high rate of extinction is reduced. This is of direct importance to the economic welfare of modern agriculture and forestry, since there is an urgent need to maintain as broad a genetic base as possible to maintain productivity under changing environmental conditions.

A second value for many protected areas is that they provide an array of essential environmental and social services to society. Many protected areas, by their large size, location, and not being greatly disturbed, minimize flooding, landslides, reduce erosion, and commonly contribute to improved water quality. These values are often overlooked and undervalued by society. Yet such services will become even more important in the future as population pressure on the landscape increases and more of the natural systems are utilized.

A third value for having protected areas, which is receiving more attention, is their contribution to the protection and maintenance of cultural values. In recent years a number of additional protected areas have been established and enlarged to include historical areas and religious relics as well as the biological resource.

A fourth value for having protected areas is their contribution to biological research. Many protected areas are excellent outdoor laboratories for the study of natural biological and ecological research issues. With the current interest in ecological management, protected systems are invaluable in the study of natural ecological processes. As such, protected areas are essential as natural benchmarks to compare the ability of managed areas to maintain sustainable biological productivity.

CATEGORIES

Currently in Europe there are 1,552 National Protected Systems covering an area of 33,340,000 ha, representing 7.1 percent of the land area. In the United States there are 970 National Protected Systems covering an area of 98,349 ha, representing 10.7 percent of the land area. While in Poland there are 78 National Protected Areas covering 2,230,000 ha or 7.3 percent of the land area. Neither the number of protected areas nor their coverage are really important. What is important is how representative they are in protecting the natural resources and how ecologically sustainable they are over time.

The title of protected area often can be misleading. There are a variety of categories from those that are strictly protected to multiple use areas in which a degree of protection is provided for selected resources. Strictly protected areas, such as Research Natural Areas in the United States and the Zapoveddniks in Russia, are among the most protected areas. In the United States Research Natural Areas range from 20-30 ha to 6,000 ha in size. In Russia the Zapovedniks are much larger, but still represent less than 2 percent of the ecosystem area in need of protection in terms of the wilderness concept. In the traditional Zapovednik, only the buffer zone is exposed to any human use. In the Research Natural Areas program, only none-manipulative research is allowed. There is no use by the public.

Among other forms of protected areas are the National Parks, Wilderness Areas, Biosphere Reserves, certain forms of scientific reserves such as Botanical Areas, Genetic Management Areas, and Biodiversity Management Areas, Protected Landscapes and Multiple Use Management Areas. The protection of the resource is highly varied and often of marginal value to the maintenance of natural biodiversity. This certainly is very true for some of the National Parks world wide, where human use pressure has severely impacted the biological resources. There are, of course, some exceptions to this statement. There are some National Parks that in fact have identified the preservation of the biological resource as a high priority. But such National Parks are rare. All too often the proposed and even established protected areas are too small in size to adequately sustain the priority resource over time. This is a real danger that now must be faced as protected area management is expanded in scope world wide.

The choice of the category of protected area clearly depends upon the goals and objectives identified for priority management. It is for these reasons that several relatively new types of protected areas have been established in the last 30 years. There is a recognized need to protect (conserve) selected plant species as well as individual species populations, especially those of importance to agriculture and forestry. In Turkey, for example, an array of selected populations of wild relatives of important agricultural and forestry crops are being preserved in what are called Gene Management Zones (Genetic Management Areas). Some of the Gene Management Zones may contain only one priority species, but most of the Protected Areas do contain a number of different species. These Protected Areas will be managed solely to maintain the natural genetic integrity of the targeted species.

In the United States, somewhat similar areas have been established to conserve targeted forest tree species. Because of the complexity of the reproductive biology of forest trees, a broader ecosystem approach has been taken to conserve forest trees. There is a need to protect (manage) often large forested areas in such a manner that natural biological process can function. A number of associated woody and non-woody species are also conserved in this type of protected area. Depending on the species, a Genetic Management Area can be more than 1000 ha or as few as 3 to 5 ha. in size. Such forest genetic reserves are urgently needed within major forest areas of intense utilization to maintain a reliable and varied genetic reservoir for future genetic improvement, to provide standards for progress in breeding and tree improvement, and to perpetuate populations suitable for mass seed production for commercial forestry production.

CRITICAL ELEMENTS

In designing a protected area there are six major elements that must be clearly considered and these include: purpose, size, shape, location, management strategy, and legal basis.

Purpose

The optimal size, management, and shape will depend in part on the purpose of the protected area. To strictly conserve a biological resource both the location and size will depend largely on the reproductive characteristics of the organisms involved. This is commonly expressed as maintaining the minimum viable population of the target organisms. In simple terms it is the smallest numbers of a species that can be expected to persist for a specific period of time. Often this is not fully known so commonly an attempt is made to maintain the minimum viable habitat, which is an area that is large enough to sustain a minimum viable population and has all the habitat characteristics necessary for the species to be protected. Habitat characteristics for many species often are known to a greater degree than species characteristics.

For National Parks and related multi-purpose areas for which biological protection is often secondary to other uses, such as recreation, the ideal system would be to have an area large enough to maintain the largest animal or the seasonal territories and migration routes of the largest local herbivores. In theory such a size most likely will conserve most of the ecological components and still provide an array of other uses if properly managed.

Size

Obviously the size of a proposed protected area should be sufficient to maintain the genetic structure of the species and their biological diversity. The reduction in area size and habitat diversity are frequently the most common cause of loss of biodiversity. In the temperate forests, such as in Europe, forest fragmentation has resulted in the rapid reduction and loss of sustainability of natural biodiversity. Forest fragmentation accelerates this process by increasing edge effects, reducing carrying capacity, and causing loss of habitat elements, which result in genetic loss and secondary extinction.

Other factors that must be considered in determining the appropriate size for a protected area include: rate of birth, mortality, mobility, and the degree of unplanned human intervention. In highly developed regions, consideration must be given to the degree of natural or man made habitat disturbances over time. The area should be sufficiently large to permit migration and eventual ecological restoration if required in the future.

In an ideal world the protected area should be as large as possible. It is far better to have one very large area rather than a series of small areas. Accepting the fact that forest ecosystems are dynamic, it is best to contain as many of the habitats in a large area. This would avoid the faults of forest fragmentation. The larger area permits a greater number of ecological relationships to fully function and this fact contributes greatly to sustainability.

Shape

For very large areas the type of shape is not as important as it is for smaller areas. As noted earlier, there is a need to reduce the edge effects. There is some experience and limited experimental data that would support a more circular shape. The final shape is also determined by the location of the centers of endemisms. However the shape is often determined by the area that is available and proposed management options. If possible, the boundaries of the protected area should follow the natural surficial contours and features of the area, including local rivers, mountains, and watersheds, as well as containing complete ecosystems.

Location

An all too common failure for many protected areas is in their biologically hostile location. Often protected areas become small isolated islands within highly managed or disturbed ecosystems. Under such conditions the normal activities that maintain the biological resource can not properly function, which will eventually lead to the deterioration of the protected area. Investments in a poor location for conservation of biodiversity is a poor investment indeed. It is most desirable to seek areas of low human population densities and low future growth rates. Areas of low economic demand for forest and agricultural products and other resources as oil and coal should be considered.

Management

There is a common belief among some biologists that protected areas require no management. This is a serious mistake. To maintain protected areas requires carefully developed management plans carried out by a well trained professional staff with an adequate budget working on site. Management plans are necessary to provide a workable guide for the allocation of the limited financing and technical staff that would be available. Plans are needed to control the introduction of exotics plants and animals, which decreases natural species and genetic diversity. Management plans are often needed to restore, through ecological restoration, damaged or incomplete elements of the ecosystem. By means of ecological restoration, individual associations can be rebuild to ensure that critical habitats are sustainable.

Legal Consideration

To maintain their function over time, protected areas must have a solid legal foundation. Protected areas must be part of an overall national legal framework and be an accepted activity of both the national and local society. When possible protected areas should be officially designated by the government. To strengthen these goals, protected area management planning should be also incorporated into both national and regional planning activities. With the current high interest in the protection of nature, the time is now appropriate to further strengthen the legal status of existing protected areas. As is always the case, the success of this effort will depend upon how well the protected area program fits into the overall national framework. Thus this activity will depend on an individual country's legal and policy requirements.

CONCLUSION

This has been a review of the major elements related to the design and establishment of protected areas. Local biological and physical conditions will determine the specific technical details for the establishment and maintenance of a given protected area. Today there is, however, sufficient scientific and technical information available to ensure that protected area programs have a sound foundation. There is also adequate field experience to supplement the scientific base, so there is no longer a justification for the delays in protecting the world's remaining natural biological resources.

REFERENCES

Botkin, D.B. and L.M. Talbot. 1992. Biological Diversity and Forests, pp. 47-74. In: Managing the World's Forests, N.P. Sharma ed. Hunt Publishing Co. Dubuque, Iowa.

Braatz, S., G. Davis, S. Shen and C. Rees. 1992. Conserving Biological Diversity. A Strategy for Protected Areas in the Asia-Pacific Region. World Bank Tech. Paper No. 193: 69 pp.

Decker, D.J., M.E. Krasny, G.R. Goff, C.R. Smith and D.W. Gross. 1991. Challenges in the Conservation of Biological Resources. A Practitioner's Guide. Westview Press, Inc. Boulder, Colo. 402 pp.

Harris, L.D. 1984. The Fragmented Forest. University of Chicago Press, London. 211 pp.

Krugman, S.L. 1979. Biosphere Reserves-Strategies for Conservation and Management of Forest Gene Pool Resources, pp. 123-127. In: Selection, Management and Utilization of Biosphere Reserves, J.F. Franklin and S.L. Krugman, eds. U.S. Dept. Of Agri., Forest Service Tech. Report PNW-82.

Krugman, S.L. 1984. Policies, Strategies and Means for Genetic Conservation in Forestry in Plant Genetic Resources, C.W. Yeatman, D. Kafton and G. Wilkeseds. Westview Press, Colo., pp. 71-78

Ledig, F.T. 1986. Conservation Strategies for Forest Gene Resources. For. Ecol. Manage. 14: 77-90.

Ledig, F.T. 1988. The Conservation of Diversity in Forest Trees. BioScience 38: 471-479.

National Research Council. 1991. Managing Global Genetic Resources - Forest Trees. Washington D.C.: National Academy Press. 229 pp.

Riggs, L.A. 1990. Conserving Genetic Resources On-site in Forest Ecosystems. For. Ecol. Manage. 35: 45-68.

Wilson, E.O. 1992. Diversity of Life. Belknap Press of Harvard University, Cambridge Ma. 424 pp.

STREAMS AS INTEGRATORS OF ECOLOGICAL AND SOCIO-ECONOMIC PROCESSES

Catherine M. Pringle
University of Georgia

"We all live downstream."
Unknown

INTRODUCTION

Since streams and rivers integrate processes occurring in the terrestrial and atmospheric environment, their consideration is integral to biodiversity conservation at a landscape level. Streams and associated riparian forests provide crucial habitat for a diversity of terrestrial species, and their protection is key to maintaining regional biodiversity (Naiman et al. 1993). Streams have been likened to blueprints of the terrestrial environment, reflecting the interaction of many different factors, including hydrologic modifications, changes in land use, point-source and non-point source pollutants, groundwater contamination, acid rain and deposition, introduction and proliferation of exotic species, and climate change (Pringle et al. 1993a).

Streams and rivers are not just reflections of the terrestrial environment that they drain (i.e., their immediate catchment or watershed), they also integrate processes occurring in other drainages as well. A case in point are the drainages within the transboundary protected area of Tatra Park in Poland and Slovakia, which are affected by industrial emissions (H_2SO_4 and NO_x) from other countries in Europe.

CONCEPTUAL APPROACHES FOR AQUATIC CONSERVATION

Emerging conservation strategies for streams and their drainage areas are being developed around the following basic questions (e.g., Boon 1992): (1) What are we trying to conserve? (2) What priority should be given to the conservation of flora and fauna? and (3) How are we to assess the conservation potential of rivers?

Streams as Four-Dimensional Environments

In order to address these questions we need a conceptual basis for viewing the stream. One approach is to see rivers as four dimensional environments involving processes that connect upstream-downstream, channel-groundwater, and channel-floodplain (riparian zones), and these dimensions differ temporally (Stanford and Ward 1993). The vertical dimension of river interactions (channel-groundwater) includes not only hydrological and chemical effects of groundwater on stream flow, but effects of the river itself on groundwater quality and quantity. Lateral connections between a river and its valley and floodplain are often overlooked by developers and, in many industrialized nations, floodplains have been so severely damaged that their prior significance cannot even be assessed. Natural and human disturbances interact to determine the probable biophysical state of the catchment ecosystem and biodiversity on all of these different planes of reference (i.e., longitudinal, lateral, vertical, and temporal). Clearly, management within catchment basins should be approached from an understanding of the natural connectivity and variability of structural and functional properties of riverine ecosystems.

Streams as Integrators of Ecological Properties and Socio-Economic Processes in the Landscape

Opportunities for sustaining humans and their environmental systems can be enhanced by examining how socio-economic/ecological processes are integrated at the landscape level (Lee et al. 1992). For instance, market processes and human institutions affect landscape properties, and landscape processes in turn affect the production of goods and services valued by human society (Lee et al. 1992). In southern Georgia in the United States, the advent of the center pivot irrigation system has resulted in higher crop yields. Regional implementation of this irrigation system was also accompanied by extensive removal of streamside riparian vegetation to facilitate movement of the center pivot in a large circular arc across the landscape. The loss of buffering capacity of streamside vegetation is resulting in extensive erosion in many areas and the direct input of nutrients and pesticides from agricultural runoff. Current studies are attempting to quantify these inputs.

Achieving a balance between human needs and environmental sustainability is the most important challenge facing environmental managers (Lubchenco et al. 1991). Given the increasing rate of anthropogenic alteration of local, regional, and global ecological properties of our environment (e.g., Turner et al. 1993), scientists involved in developing management/conservation strategies for aquatic ecosystems must understand underlying socio-economic factors.

Regional Differences in the History of Human Effects on Rivers

Flowing water systems are a legacy of historical processes operating within the landscape (e.g., Decamps et al. 1988). The relative intensity and duration of interactions between humans and the watersheds in which they live has been greater in some areas of the world relative to others. Different geographic areas are affected by a diverse array of environmental problems that reflect both ecological properties and socio-economic processes. As stated by Boon (1992), populations grow, nations industrialize, global water demand increases, and thus the effects of man on rivers change in diversity extent and permanence. The historical sequence of river development in Europe (Petts 1987) from past to present includes: subsistence fishery, commercial fishery, recreational fishing, floodplain reclamation, navigation, pollution, dams, and now conservation. Some of these human activities that are potentially damaging to river systems have decreased in intensity or remained stable depending on the geographic area. In Britain for instance, construction of large dams passed through several decades of rapid growth, but now appears to be leveling off (Boon 1992). In rapidly developing countries (e.g., Brazil and India), pollutants that "gradually" might have appeared in North American and European rivers over a century or more are rapidly building up in the compressed time frame of a few decades (Boon 1992). In Poland, where 60% of all lakes are severely polluted (Postel 1992), there has been a relatively long history of heavy human settlement in the landscape with a consequently longer period for cultural eutrophication to occur.

Key sociopolitical landmarks in the history of Central Europe have had a profound effect on the level of environmental degradation. As is the case for many Central European countries in transition, intensive development/ industrialization during the Soviet Era resulted in the degradation of aquatic systems at a level of magnitude greater than what much of the western world has experienced. The post-World War II Era was characterized by a lack of science-based policy and environmental management.

In Poland, high quality drinking water has dropped from 32% to less than 5% during the last twenty years. Over half of Poland's river water is too contaminated even for industrial use (Postel 1992). Pollution in surface waters is increasing due to contamination by industry and municipal sewage discharges as well as by agricultural sources. Shortages of acceptable quality water also limit economic activity within Poland. Drainage projects have led to lowered groundwater tables and excessive drying of considerable areas of land, and increasing needs for water have led to further stresses on water supply. The area of excessively dried land in Poland amounts to approximately 4 million hectares. Increased drying of the central region of Poland is also associated with high degrees of deforestation, particularly in those area where forest cover is below 15% (Ryszkowski 1990). It has been noted that water quality problems in Poland resemble those that were familiar to the United States over two decades ago, before the U.S. undertook massive water cleanup and sewage treatment programs (e.g., Hillbricht-Ilkowska 1990; Cooper 1990; Gromiec 1990).

EMERGING CONSERVATION STRATEGIES FOR AQUATIC SYSTEMS

Regional differences in emerging conservation and management strategies reflect the history of human effects on the environment and current socio-economic conditions. Szaro (1996, this volume), for example, relates the historical progression of national conservation strategies in the United States.

A feature of recent policy developments in river conservation in the western world is a broadening of views by scientists, managers, and conservationists. All of these different groups are expanding their perspective from a reductionist perspective to a landscape perspective. Reductionist science is now moving away from a stream segment approach to looking at the entire basin. River management policy makers are realizing that "everyone lives downstream," that downstream events/processes can affect areas upstream, and that events/processes in different catchments frequently affect upstream areas. Reductionist conservationists are now looking beyond the channel, and conservation organizations have moved away from their preoccupation with streams based solely on recreation and aesthetics.

Broader-based training for aquatic resource managers that encompasses an understanding of ecosystem connectivity and landscape linkages is becoming increasingly adopted within the United States, with strong proponents in both aquatic science and conservation biology (Doppelt 1993). In the United States, implementation of this broader-based thinking at the management level is being catalyzed by recent collaboration between conservation groups and aquatic scientists (Dewberry and Pringle 1994). Conservation groups have expanded their perspectives from addressing local issues at the scale of 'river reach' to recognizing the need for protection and restoration strategies that consider whole drainage basins or landscapes. Concurrently, scientists are expanding their focus from site-specific studies to drainage level studies and to the still larger landscape scale (e.g., Stanford and Ward 1993). Since successful development of a predictive science of ecological management must consider socio-economic and political realities, scientists can benefit from the broader perspective that conservation groups bring to the problem. With agreement among both scientists and conservation groups on the extent of the degradation of the North American river systems, there is common ground for addressing the needed changes in national policy (e.g., Coyle 1993; Doppelt et al. 1993; Anderson 1993; Brouha 1993; Pringle and Aumen 1993; Richter 1993; Woody 1993; Duff 1993).

Most countries in Central and Eastern Europe are moving to a full market economy. The dominant processes in this transitional period are economic openness, privatization, and restructuring. Despite many positive aspects, there is a concern that these processes may bring about negative effects for the natural environment (i.e., in the rush to achieve privatization, Central and Eastern

European countries might encourage unsustainable development: Is the model of the western consumer lifestyle a good option for sustainability?). The questions arise: How can this period of transition be used as an opportunity to carry out sustainable restructuring in an environmentally healthy manner? How can Central and Eastern European countries in transition benefit from emerging western conservation strategies? Projects such as the Green Lungs of Poland (GLP) and the Green Lungs of Europe (GLE) are addressing these questions by attempting to create a macro-regional network of protected regions (throughout Poland and Europe) that are rich in biodiversity.

As in the United States and Britain, increased collaboration between scientists and non-government organizations involved in conservation issues could be a powerful force in the development of environmental reforms in countries in transition in Central and Eastern Europe. While Polish scientists are well aware of the serious magnitude of the problems that face aquatic systems in their country, not only must the economic resources be developed to implement necessary changes, but internal public support must be developed for environmental remediation and environmentally sound legislation. As pointed out by the GLP, society's participation in the process of decision-making constitutes a challenge for nationals of countries who, for half a century, had no experience with such forms of governance and state functioning. However, as the magnitude and severity of regional environmental pollution in Central and Eastern Europe challenge conservation and management strategies developed in the West, scientists and NGOs in Central and Eastern Europe may devise drastic solutions for which public support will be difficult to obtain.

INTERNATIONAL COOPERATION

To effectively address the serious environmental problems affecting the planet, massive collaboration clearly must be achieved on both local and regional levels. There is an urgent need for regional watershed-level management that transcends political boundaries. Cooperative arrangements between Central European nations in managing their transboundary protected areas can serve as a model for development of more complex international networks.

The Danube River is a dramatic example of the mismatch between the scale of ecological processes and the jurisdictional boundaries of management authority. It has a drainage area that spans at least 12 different nations covering 70% of Central Europe with a population of over 80 million people. Domestic and industrial wastes and the lack of primary sewage treatment in many large cities and towns throughout the drainage basin, in combination with severe economic problems, are among many formidable obstacles impeding the development of effective management and restoration strategies for the Danube River, its delta, and the receiving waters of the Black Sea (Pringle et al. 1993b). In the long run, only strong local and international cooperation will improve the environmental situation of the Danube Delta. The environmental security for the entire Danube Basin depends on the health of the river and its Delta.

In conclusion, as increasing friction occurs between nations over water as a rare resource (Postel 1993), countries will increasingly find themselves in the situation of those in Central and Eastern Europe, which are developing conservation strategies which shift to conform to changing political boundaries and socio-economic conditions. It would behoove the international conservation community to closely observe and learn from this process and to facilitate it when possible.

REFERENCES

Anderson, H. M. 1993. Conserving America's Freshwater Ecosystems: The Wilderness Society's Approach. Journal of the North American Benthological Society 12: 194-196.

Boon, P. J. 1992. Essential Elements in the Case for River Conservation, pp. 11-33. In: P. J. Boon, P. Calow and G. E. Petts. River Conservation and Management. John Wiley and Sons, Ltd., NY.

Brouha, P. 1993. The Emerging Science-Based Advocacy Role of the American Fisheries Society. Journal of the North American Benthological Society 12: 215-218.

Cohn, J. P. 1992. Central and Eastern Europe Aim to Protect their Ecological Backbone. BioScience 42: 810-814.

Cooper, W. E. 1990. Aquatic Research and Water Quality Trends in the United States and Poland, pp. 297-314. In: W. Grodzinski, E. B. Cowling and A. I. Breymeyer (eds.) Ecological Risks: Perspectives from Poland and the United States. National Academy Press, Washington, DC.

Coyle, K. J. The New Advocacy for Aquatic Species Conservation. Journal of the North American Benthological Society 12: 185-188.

Decamps, H., M. Fortune, F. Gazelle, and G. Pautou. 1988. Historical Influence of Man on the Riparian Dynamics of a Fluvial Landscape. Landscape Ecology 1: 163-173.

Dewberry, T. C. and C. Pringle. 1994. Lotic Conservation and Science: Moving Towards Common Ground to Protect our Stream Resources. Journal of the North American Benthological Society (in press).

Doppelt, R. 1993. The Vital Role of the Scientific Community in New River Conservation Strategies. Journal of the North American Benthological Society 12: 189-193.

Doppelt, B. M. Scurlock, C. Frissel, and J. Karr. 1993. Entering the Watershed. Island Press, Washington D.C.

Duff, D. A. 1993. Conservation Partnerships for Coldwater Fisheries Habitat. Journal of the North American Benthological Society 12: 206-210.

Gromiec, M. J. 1990. River Water Quality Assessment and Management in Poland. pp. 315-332. In: W. Grodzinski, E. B. Cowling and A. I. Breymeyer (eds.) Ecological Risks: Perspectives from Poland and the United States. National Academy Press, Washington, D.C.

Hillbricht-Ilkowska, A. 1992. Assessment of Trophic Impact on the Lake Environment in Poland: A Proposal and Case Study. pp. 283-296. In: W. Grodzinski, E. B. Cowling and A. I. Breymeyer (eds.) Ecological Risks: Perspectives from Poland and the United States. National Academy Press, Washington, D.C.

Kajak, Z. 1992. The River Vistula and its Floodplain Valley (Poland): Its Ecology and Importance for Conservation. pp. 35-50. In: P. J. Boon, P. Calow, and G. E. Petts (eds.) River Conservation and Management. John Wiley and Sons, NY.

Lee, R. G., R. Flamm, M. G. Turner, C. Bledsoe, P. Chandler, C. DeFerrari, R. Gottfried, R. J. Naiman, N. Schumaker, and D. Wear. 1992. Integrating Sustainable Development and Environmental

Vitality: A Landscape Approach. pp 499-521. In: R. J. Naiman (editor) Watershed Management: Balancing Sustainability and Environmental Change. Springer-Verlag, NY.

Lubchenco, J., A. M. Olson, L. B. Brubaker, S. R. Carpenter, M. M. Holland, S. P. Hubbell, S. A. Levin, J. A. MacMahon, P. A. Matson, J. M. Melillo, H. A. Mooney, C. H. Peterson, H. R. Pulliam, L. A. Real, P. J. Regal, and P. G. Risser. 1991. The Sustainable Biosphere Initiative: An Ecological Research Agenda. Ecology 72: 371-412.

Naiman, R. J., H. Decamps, and M. Pollack. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. Ecological Applications 3: 209-212.

Petts, G. E. 1987. Ecological Management of Regulated Rivers; A European Perspective," Regulated Rivers: Research and Management 1: 358-363.

Postel, S. 1992. Last oasis: Facing Water Scarcity. The Worldwatch Environmental Alert Series. W. W. Norton and Company, NY.

Pringle, C. M., and N. G. Aumen 1993. Current Efforts in Freshwater Conservation. Journal of the North American Benthological Society 12: 174-176.

Pringle, C. M., C. F. Rabeni, A. Benke and N. G. Aumen. 1993a. The Role of Aquatic Science in Freshwater Conservation: Cooperation between the North American Benthological Society and Organizations for Conservation and Resource Management. Journal of the North American Benthological Society 12: 177-184.

Pringle, C. M., G. Vellidis, F. Heliotis, D. Bandacu, and S. Cristofor. 1993b. Environmental Problems in the Danube Delta. American Scientist 81: 350-361.

Richter, B. D. 1993. Ecosystem level Conservation at the Nature Conservancy: Growing Needs for Applied Research in Conservation Biology. Journal of the North American Benthological Society 12: 197-200.

Ryzkowski, L. 1990. Ecological Guidelines for Management of Rural Areas in Poland . pp. 249-264. In: W. Grodzinski, E. B. Cowling and A. I. Breymeyer (eds.) Ecological Risks: Perspectives from Poland and the United States. National Academy Press, Washington, D.C.

Stanford, J. A. and J. V. Ward. 1993. An Ecosystem Perspective of Alluvial Rivers: Connectivity and the Hyporheic Corridor. Journal of the North American Benthological Society 12: 48-60.

Tomialojcia, L. (ed.) 1993. Nature and Environment Conservation in the Lowland River Valleys of Poland. Instytutu Ochrony Przyrody (PAN).

Turner, B. L. W. C. Clark, R. W. Kates, J. F. Richards, J. T. Mathews, and W. B. Meyer (eds). 1993. The Earth as Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 years. Cambridge University Press, NY, 713 p.

Woody, T. 1993. Grassroots in Action: The Sierra Club's Role in the Campaign to Restore the Kissimmee River. Journal of the North American Benthological Society 12: 201-205.

Wrobel, S. (Ed.) 1989. Zanieczyszczenia atmosfery a degradacja wod, Materialy sympozjum, Zaklad Ochrony Przyrody i Zasobow Naturalnych, Krakow.

PRESENT STATUS AND PERSPECTIVES OF MAB BIOSPHERE RESERVES

Boguslaw Bobek, Beata Kabza, Dorota Merta
and Kajetan Perzanowski

Jagiellonian University

For the protection of valuable natural habitats, the concept of the Biosphere Reserve is rapidly developing. According to the authors of this paper, this development can be attributed to the fact that National Parks (until recently the basic structure protecting valuable natural habitats) have now fulfilled their historic mission and have exhausted the possible future options in nature conservancy as a result of various barriers to their development.

It is only in the last ten years or so that people have started to realize that natural ecosystems protected in National Parks are reduced to small islands isolated in an environment altered by man (Harris 1984, Verner et al. 1980, Gilbert and Dodds 1987). For example, recent studies on the home ranges and territories of large ungulates and predators have shown that only a few National Parks encompass a full-year's home range (Harestad and Bunnel 1979, Hemker 1984, Sweanor and Sandergreen 1991). Even such a large park as Yellowstone does not cover the whole home range of the local elk population, which has its winter range in the neighborhood of the park (Boyce and Hayden-Wing 1979). Furthermore, it is very rare for a park to overlap with the ranges of rare and protected populations of mammals and birds (Seitz and Loeschke 1991).

In light of this, it is clear that to assure the proper development of wildlife populations, it is necessary to make mutual contact possible by creating "ecological corridors" (Forman and Gordon 1986, Noss and Harris 1986). Some more realistically-thinking ecologists have realized that there are few if any future possibilities for the creation of new large protected areas by the extension of already existing ones or by establishing new units. Both cases entail large and unavoidable expenses from the state budget, as well as conflicts with local inhabitants, who, through democratic structures, may effectively influence political and economic decisions to protect their own economic or cultural interests.

Such a recognition has stimulated conceptual work on a new model of large protected areas. This "multiple use module" (Harris 1984) encompasses fragments of natural ecosystems, which should become the central "core" area, as well as ecosystems exploited or altered by man, which could play the role of buffer zones. Buffer zones are gradually becoming more and more frequent around National

Parks (Dasmann 1981), and good examples of such projects exist in Florida and southern Ohio (Noss 1987).

The creation of a model of large protected areas has also become the task of the United Nations Educational, Scientific, and Cultural Organization (UNESCO) under the Man and Biosphere (MAB) program. From the beginning it was quite clear that effective nature protection over substantial areas would not be possible if the cooperation of local inhabitants were not assured. This cooperation could be achieved by the demonstration of the sustainable use of natural resources around the core area, i.e., buffer and transition zones. For example, in Africa the well-developed network of National Parks does not prevent densities of protected and threatened species from depending on cooperation with people inhabiting surrounding areas (Parker and Graham 1989). Unfortunately, such truths are often forgotten by enthusiasts of new or extended National Parks, who in effect aim at creating fictional systems of nature conservancy that exist only on paper. It is therefore important that the principles of Biosphere Reserves should be clearly explained in non-technical terms to local inhabitants, who are often against the very idea of nature conservancy due to a mistaken association of biospheres with the system of restrictions and prohibitions typical of national parks.

It is generally agreed that the overall goals of establishing and maintaining a Biosphere Reserve are:

- The preservation of natural or little disturbed ecosystems in the core area;
- The conservation or restoration of ecosystems in the buffer zone; and
- The rational and sustainable use of resources, mostly in the transition zone.

Fulfilling the above tasks should be the duty of a specially-created administration of a Biosphere Reserve, together with scientific and educational teams. The growing necessity for the preservation of existing biodiversity and the need to slow down the deterioration of natural habitats requires research oriented towards practical aspects of resource management (UNESCO 1984, 1987). Therefore, the research team in a Biosphere Reserve should formulate specific tasks to be executed by the administration. Some tasks will differ for each Biosphere Reserves, but those common to all or most are:

- The creation of a workplan for landscape management (tourist trails, roads, constructions, etc.) to minimize human pressure on the core area;
- Management of the transition zone, with the implementation of modern methods, techniques, and models allowing for the sustainable use of natural resources by local people;
- The education of local people and the restructuring of employment to reduce the unemployment rate in the transition zone to a minimum;

- The coordination of economic development by attracting job creating enterprises and by marketing local products, as well as the coordination of scientific research; and
- The launching of research projects important for all three zones of a Biosphere Reserve and the monitoring of pollution, endangered species, and fragile ecosystems.

At present, there are over 300 Biosphere Reserves around the world, and the number is still growing. However, analysis of the data on these reserves evokes doubts as to whether all fulfill the requirements laid down for this new conservation unit. According to UNESCO, people are an integral part of a Biosphere Reserve, with various forms of natural resource management being included in long-term plans for land use and with the resulting landscape patterns conserved and considered essential features of the Reserve. The direct involvement of local communities in the management of natural resources is crucial if society is to accept the requirements imposed by nature conservancy and if there is to be further successful development of a reserve. To ensure that this social acceptance is obtained, a Biosphere Reserve should evolve as economic and demographic changes proceed in the region, albeit with its protective functions maintained at the same time (von Droste and Gregg 1985; Kabza 1994).

A Biosphere Reserve should consist of three major zones: a centrally-located core area should usually offer strict protection to the most valuable and/or endangered habitats; a buffer zone should support most of the research projects, as well as the development and testing of new management approaches, educational programs, etc.; and finally the transition zone should typically serve as an area in which to integrate nature conservation with the sustainable use of natural resources (UNESCO 1987; Breymeyer 1994). Basically, a Biosphere Reserve should be beneficial to local communities in that it improves their social and economic status (Bobek et al. 1994). One of the essential functions of a Biosphere Reserve is also to provide educational and training opportunities for scientists, students, managers, and local people in both ecology and environment protection (UNESCO 1984).

Described above are the theoretical requirements for Biosphere Reserves. However, according to the environmental database on the scientific infrastructure of 175 Biosphere Reserves in 32 countries (Access 1993), research topics and the structure of management in most Biosphere Reserves do not differ fundamentally from those in National Parks. The reason is simply that as many as 107 (61%) of the Reserves are managed by National Park Administrations or similar services whose main function is the preservation and conservation of natural ecosystems. Research projects potentially beneficial to local communities are only carried out 62 biosphere reserves (35.4%), and only 17 biosphere reserves (about 10%) declare the existence of projects which could create a sustainable economy for the people inhabiting the transition zone. Quite surprising also is the number of biosphere reserves which consist of a core area only (Kabza 1994).

Thus, the rapid increase in the number of biosphere reserves around the world will not ensure credibility will unless programs meeting the requirements and needs of local people are introduced. The prevailing impression to date is that most biosphere reserves exist only formally or follow programs typical for National Parks. This is also the result of a the lack of legal status for biosphere reserves in most countries. Leaving the management of biosphere reserves to National Park Administrations has caused a loss of identity, with the created structures being neither National Parks nor Biosphere Reserves. It is not uncommon for the administration of the National Park managing the Biosphere Reserve to come to understand that the status of a biosphere reserve allows for the exploitation of natural resources through logging, the building of ski lifts, hunting etc. (Michalowski 1994). But the undertaking of such activities by them leads only to competition with local people, bringing them more losses than gains. One of the biosphere reserves of southern Poland may serve as on example here. The administration decided to buy a number of saddled horses for visitors to rent, along with a guide, in order to see the Park (the core area of the biosphere reserve) from horseback. At the same time, however, local stud owners living in the transition zone are only allowed to guide tourists around the Park after paying high fees and are therefore effectively eliminated from the tourist business in the area.

It would seems also that the very idea of biosphere reserves should be more widely and more effectively conveyed by the mass media. The majority of society is under-informed, associating biosphere reserves with structures protecting valuable natural areas, but at the same time regarding them as areas with more restrictions than National Parks. In countries where the name "Biosphere Reserves" has been translated badly, many local people even associate them with the Indian Reservations in North America.

CONCLUSIONS

- Conferring the status of Biosphere Reserve upon a certain area should take place in those countries in which there is an established legal basis upon which they can function.
- These countries having Biosphere Reserves without established legal status for them should be required by UNESCO to pass appropriate legislation and should have their nominations withdrawn if such a legal status for Biosphere Reserves is not enacted after a reasonable period of time.
- National Parks should become only core areas of biosphere reserves. Suggested are revisions of Park boundaries to allow them to meet the criteria required for the core area. A rigorous principle of removal or restraint upon nominations should be applied to National Parks which do not care for the sustainable development of the surrounding regions and for the basic needs of the local population (Batisse 1992).

- The future administration of Biosphere Reserves should include representatives of local communities and the important government institutions (like State Forest Administrations, branches of local government, etc.) involved within them. To improve the effectiveness of a biosphere reserve, its design should, if possible, recognize not only the most valuable natural habitats but also administrative boundaries.
- It is necessary to review the administration of Biosphere Reserves in accordance with the basic rule that every biosphere reserve has to carry out scientific and training projects oriented not only to nature conservation but also recognizing the needs of local people regarding the achievement of a sustainable economy.

A serious problem for the effective operation of a Biosphere Reserve is the proper selection of its managerial staff. The multi-functional character of Biosphere Reserves requires a specific approach to the management of the area and involves such tasks for the staff as the development of educational and training programs for local communities, the creation of a sustainable economy within the transition zone, involvement in exchange programs, and research projects. So far, existing information on management and scientific activity is available for core areas only, and generally there is a total lack of publications on the role, tasks, perspectives and designs of biosphere reserves (MAB 1993, Gregg 1984).

Biosphere Reserves have a great chance to become a dominant structure in nature conservancy in the 21st century, but they may also end up in the lumber-room of history as another potentially good idea which did not achieve its full potential in practice.

REFERENCES

ACCESS. 1993. MAB. A Directory of Contacts, Environmental databases, and Scientific Infrastructure of 175 Biosphere Reserves of 175 Countries. Dept. of State Publ. 10059.

Battisse 1982. The Biosphere Reserve - A Tool for Environmental Conservation and Management. Env. Cons. 9,2: 101-111.

Bobek B., Kabza B., Merta D., and Perzanowski K. 1994. The Concept of the Eastern Carpathians Biosphere Reserve - Present Status and Perspectives. J.Wildl. Res. 1: 000-000 (in print).

Boyce M.S. and Hayden-Wing L.S.(eds.) 1979. North American Elk: Ecology, Behavior and Management. Univ. of Wyoming, Laramie.

Breymeyer A.(ed.) 1994. Rezerwaty Biosfery w Polsce. Polski Narodowy Komitet MAB. 156 pp.

Dasmann R.F. 1981. Wildlife Biology. 2nd ed. John Wiley and Sons. New York.

Forman R.T.T., and Gordon M. 1986. Landscape Ecology. John Wiley and Sons. New York.

Fritz S. H., and Mech L.D. 1981. Dynamics, Movements and Feeding Ecology of a Newly Protected Wolf population in Northwestern Minnesota. Wildl. Monographs 80: 1-79.

Gilbert F.F., and D.G. Dodds. 1987. The Philosophy and Practice of Wildlife Management. Robert E. Krieger Publ. Co., Malabar, Florida.

Gregg W.P. (jr.). 1984. The International Network of Biosphere Reserves: A New Dimension in Global Conservation. In: The Biosphere: Problems and Solutions. T.N. Veziroglu (ed.). Amsterdam.

Harestad A.S. and Bunnel F.L. 1979. Home Range and Body Weight-A Reevaluation. Ecology, 60: 389-402.

Harris L.D. 1984. The Fragmented Forests. Univ.Chicago Press. Chicago and London.

Hemker T.P., Linzey F.G., and Ackerman B.B. 1984. Population Characteristic and Movement Patterns of Cougars in Southern Utah . J.Wildl.Manage. 48: 1275-1284.

Kabza B. 1994. Biosphere Reserves in Poland: Expectation, Realisation and Projection. J.Wildl. Res. 1: 000-000 (in print).

MAB. 1993. Euro MAB IV. Conf. Rep. Zakopane.

Michalowski W. 1994. The International Biosphere Reserve "Eastern Carpathians"-The Chance or the Threat for Bieszczady Mountains. J.Wildl. Res. 1: 000-000 (in print).

Noss R.F. 1987. Protecting Natural Areas in Fragmented Landscapes. Nat. Areas. J. 7: 1-13.

Noss R.F., and Harris L.D. 1986. Nodes, Networks and MUMs: Preserving Diversity at All Scales. Env. Manage. 10: 299-309.

Parker I.S.C., and Graham A.D. 1989. Men, Elephants and Competition. Symp. Zool. Soc. London 61: 241-252.

Seitz A., and Loeschke (eds.). 1991. Species Conservation: A Population Biological Approach.Birkhauser Vlg. Basel.

Sweanor P.Y., and Sandergren F. 1991. Migration Pattern of a Moose Population in Relation to Calf Recruitment. Proc. 18th IUGB Congr. Vol. 1: 631-634.

UNESCO. 1984. Action Plan for Biosphere Reserves. Nature and resources 20, 412 pp.

UNESCO. 1987. A Practical Guide to MAB. 40 pp.

Verner J., Morrison M.L., and Ralph C.J. (eds.). 1980. Wildlife 2000Modeling Habitat Relationship of Terrestial Vertebrates. Univ. of Wisconsin Press.

Von Droste B., and W.P. Gregg (jr.). 1985. Biosphere Reserves: Demonstrating the Value of Conservation in Sustaining Society. Parks 10,3: 2-5.

II

BIODIVERSITY CONSERVATION IN THE PARTICIPATING COUNTRIES

BIODIVERSITY CONSERVATION IN THE UNITED STATES

Robert C. Szaro and William T. Sexton
U.S. Forest Service

INTRODUCTION

One of today's most pressing environmental issues is the conservation of biodiversity (Szaro and Johnston 1994). The challenge is for nations, government agencies, organizations, and individuals to protect and enhance biodiversity while continuing to meet people's needs for natural resources. This challenge exists from local to global scales. If not met, future generations will live in a biologically impoverished world and perhaps one that is less capable of producing desired resources as well. Conserving biodiversity involves restoring, protecting, conserving, or enhancing the variety of life in an area so that the abundances and distributions of species and communities provide for continued existence and normal ecological functioning, including adaptation and extinction (Szaro 1994a). This does not mean all things must occur in all areas, but that all things must be cared for at some appropriate geographic scale.

THE HISTORICAL PERSPECTIVE

The United States has a long history of and commitment to environmental protection, with some of the World's most comprehensive and advanced programs for controlling pollution, protecting public lands, and enforcing environmental laws. The growth of this commitment reflects the settlement of the United States.

Prior to European immigration, several million native Americans lived in what is now the United States, harvesting fish and wildlife, planting, irrigating, clearing land with fire, and collecting vegetation for a wide variety of uses (West 1992). They had communities, roads in some cases, domesticated animals and a wide range of cultures, beliefs, and languages. Relative to the present, the total number of people was low. They had very limited technology with which to modify their environment, primarily fire. As today, these people depended on and used natural resources.

The early colonists who settled in the United States from the 1600's to 1800 had quite a different view of their landscape. In relation to Europe, the land was enormous and covered throughout with dense forests. Forests and other wildlands were viewed as an enemy. The landscape was covered with a foreboding wilderness filled with dangers. Those who ventured into this wilderness, fought back nature, and created civilization, were considered folk heroes and pioneers. It is quite clear from the literature, art, and records available that public perception was dominated by the view that forests were endless and constituted a barrier to survival, settlement, and growth. It was considered a laudable undertaking to clear and burn forests. Resources were viewed as limitless, and human impact on the landscape was deemed progress.

In the 1800's the focus in the United States was on expansion, settlement, and economic profits derived from resource exploitation and land disposal (West 1992). By the middle of the century railroads had spanned the country. Travel by river boats, wagons, horse, and foot travel had accessed the furtherest reaches of the American landscape. Huge amounts of land had been cleared for towns, farming, and ranching. Widespread land abuse by speculators and large companies was common. Damage to lakes and streams, loss of vast acres of forest, and disappearing wildlife were common. By the 1850's nearly 180 million acres of government territory were transferred to railroads in exchange for laying track in unsettled areas. The land disposal interests of the federal government was epitomized by the passage in 1862 of the Homestead Act. The general public attitude was still that resources were limitless and should be exploited for economic growth. Wilderness the enemy was replaced by wilderness the economic opportunity. The census of 1890 declared the closing of the American frontier. In the view of the United States government, the country was finally settled.

The period of the late 1800's and early 1900's has frequently been called the "Golden Age of Conservation" in the United States (West 1992). Public attention and government action focused on the widespread abuses that had occurred in the previous era. As a result of public debate over these issues, a new set of social, cultural, and economic values evolved across American society. This resulted in a variety of conservation oriented efforts, including in 1872 the establishment of Yellowstone National Park, the first in the world; the establishment of the Forest Reserves in 1891, putting in place most of the federal forest land that exists today; and the establishment of the National Park Service in 1916. A few examples of resource legislation that were associated with changing social and political views include: The Game and Wild Birds Preservation and Disposition Act of 1900; The American Antiquities Act of 1906 protecting cultural resources; The Alaska Game Preservation Act of 1908; and the Migratory Bird Act of 1918. Clearly American society had established a new and quite different set of values related to public lands and resource management, and it adopted a new paradigm of what constituted a reasonable, prudent approach to land management. This conservation paradigm was embodied by the concept of wise use.

The parallel with our present situation is quite striking. The age of conservation was ushered in with great controversy surrounding public lands and resources, whether there should be a public domain, where should it be, how much should there be of it, and what should it be used for. The major issues of that time still sound very familiar; Alaska, migratory birds, planting trees, the effect of catastrophic wildfires, the role and mission of the Park Service and Forest Service, concern for our cultural heritage, and the long-term sustainability of natural resources.

From the 1940's through the mid 1980's, the American view and interest in public domain natural resources shifted to efficient production in the context of national needs and economic growth. Beginning with World War II, public lands were "expected" to provide critical elements for the war effort. Wood, minerals, and red meat were a significant part of the national effort and played a major role in economic development following the war. Land management agency programs and budgets were built around market valued outputs and products. In the minds of many, "multiple use" became synonymous with commodity production of wood fiber, metals, and grazing, with a secondary concern for other values.

There were however, some very strong signals during the latter part of this period that signaled yet another change in our society's view of the environment. These included: The Wilderness Act of 1964; The National Environmental Policy Act of 1969; The Endangered Species Act of 1972; The Renewable Resources Planning Act of 1974; The National Forest Management Act of 1976; the first Earth Day in 1971; and Rachel Carson's 1972 book *Silent Spring*. And on top of the social and legislative activity there was an enormous amount of litigation in the 1970's and 80's related to environmental interests. Like the turn of the last century, our time experienced a great deal of social and political debate about the future of our nations natural resources.

By the mid 1980's perspectives on resource management and the conservation of biodiversity in the United States shifted dramatically to one of increasing concern. This mirrored changing global concern for conserving biodiversity with its profound implications for how we manage natural resources (Crow 1989). At the roots of this concern were a recognition of accelerating losses of species, increasing rates of deforestation and soil erosion, and shifting global climate due to the cumulative impacts of human activities. The United States and the World focused on environmental issues. In the United States, Edward O. Wilson led the charge by bringing national attention to biodiversity. His leadership led to a National Forum on Biodiversity that was held in Washington, D.C. in September 1986 (Wilson and Peter 1988). Biodiversity became the central issue for global conservation. Efforts to develop the framework Convention on Biological Diversity were launched by the United Nations Environment Programme (UNEP) in May 1989 when the Governing Council of the UNEP unanimously adopted a resolution introduced by the United States to begin negotiations on an international convention to conserve biological diversity. This was one of several parallel efforts leading up to the United Nations Conference on the Environment and Development (UNCED) that was held in June of 1992 at Rio de Janeiro, Brazil that included the negotiations for conventions on climate change and biological diversity, principles on global deforestation, and various declarations, initiatives, and agendas for UNCED itself (including AGENDA 21). The meeting had a tremendously ambitious goal: to make environmental concerns a central issue in international relations (Raeburn, 1992).

THE CURRENT CONSERVATION FRAMEWORK

With this historical background, it is easy to see that the United States has a long history of environmental protection, with some of the World's most comprehensive and advanced programs for controlling pollution, protecting public lands and enforcing environmental laws. The first 100 years of conservation tradition has resulted in an evolving framework to help manage and conserve biological resources in the United States for the use and enjoyment of present and future generations that consists of:

- Reducing habitat loss by using land and water more productively and efficiently, implementing programs to reduce wetland conversion, and purchasing sensitive and threatened areas.
- Establishing specially protected areas or habitats on about 10% of the U.S. land mass, about 225 million acres including wilderness, research natural areas, and special botanical areas.
- Special consideration of plant and animal communities in the remaining 20% of the U.S. land mass owned by the U.S. government, about 450 million acres.
- Restoring degraded habitat and controlling non-native species on public and private lands, and creating man-made habitats.
- Laws and policies to conserve individual, or groups of, fish, wildlife, and plant species.
- Statutes, regulations, and policies, which by reducing pollution of soil, water and air, help reduce stress on biodiversity.
- Ex-situ measures to conserve species and preserve germplasm in zoos, botanical gardens, and other off-site locations.
- State and local government programs, sometimes in partnerships with the U.S. government.
- Involvement of private parties and landowners, on their own, and in cooperation with public authorities.
- International programs to conserve biodiversity including improving the productivity of agriculture and forestry in developing nations, regulating ocean fisheries within a 200 mile limit, and supporting CITES and bans on whaling.
- Cooperative programs with Canada, Mexico and Central American nations to conserve habitats for migratory species that spend part of their lifecycles in the United States.

- Broad basic and applied research programs focused on the management and conservation of biological resources.

DEVELOPING AN ECOLOGICAL APPROACH

Clearly every effort should be made to conserve biodiversity (Szaro and Shapiro 1990; Szaro 1994a, b). The conservation of biodiversity encompasses genetic diversity of species populations, richness of species in biological communities, processes whereby species interact with one another and with physical attributes within ecological systems, and the abundance of species, communities, and ecosystems at large geographic scales (Harrington et al, 1990). Current programs to protect, maintain, and enhance populations of particular species contribute to the welfare of components of biodiversity, but they can only deal with a relatively small portion of the ever expanding list of threatened and endangered species (Miller 1994; Reid et al. 1992).

It is easy to understand why threatened and endangered species have received the focus of attention. Many are large, easily observable, and oftentimes aesthetically pleasing. This has resulted in most efforts at restoration and rehabilitation being directed towards endangered as well as harvested species (Bridgewater et al. 1994). Yet, threatened and endangered species represent only one aspect of a larger issue: conservation of the full variety of life, from genetic variation in species populations to the richness of ecosystems in the biosphere (Salwasser 1990). The best way to minimize species loss is to maintain the integrity of ecosystem function. The important questions therefore concern the kinds of biodiversity that are significant to ecosystem functioning. To best focus our efforts we need to establish how much (or how little) redundancy there is in the biological composition of ecosystems. Functional groups with little or no redundancy warrant priority conservation effort (Walker 1992). It is axiomatic that conservation of biodiversity cannot succeed through "crisis management" of an ever expanding number of endangered species. The best time to restore or sustain a species or ecosystem is when it is still common. And for certain species and biological communities, the pressing concern is perpetuation or enhancement of the genetic variation that provides for long-term productivity, resistance to stress, and adaptability to change. A biologically diverse forest holds a greater variety of potential resource options for a longer period of time than a less diverse forest. It is more likely to be able to respond to environmental stresses and adapt to a rapidly changing climate. And it may be far less costly in the long run to sustain a rich variety of species and biological communities operating under largely natural ecological processes than to resort to the heroic efforts now being employed to recover California condors (Gymnogyps californianus), peregrine falcons (Falco pereginus), and grizzly bears (Ursus horribilis). Resource managers know from experience that access to resources is greater and less costly when forests and rangelands are sufficiently healthy and diverse.

However, endangered species are fundamental indicators of environmental disturbance. Since extinction is a process, not a simple event, the recognition that a species is endangered is little more than a snapshot of a moving vehicle. Attempts at therapy most often address symptoms rather than causes. We have failed to communicate successfully why rehabilitation and restoration beyond the narrow focus of the endangered and harvested are essential. The environmental variables which affect the health and welfare of all the flora and fauna also affect people: water and air quality, recycling of organic and inorganic substances, microclimate, etc. Loss of biodiversity means loss of ecological services and options for the future. The cost of replacing ecological services, already great, will increase to staggering proportions. The real and potential wealth represented by conserved biodiversity cannot be replaced (Bridgewater et al. 1994).

The tough choices posed in the spotted owl (Strix occidentalis) case in the Pacific Northwest of the United States typify many future issues as the conservation of forest biodiversity becomes a higher social priority (Thomas et al. 1990). Regardless of the eventual outcome of this issue, there is an important lesson to be learned: Conserving biodiversity will not be cheap or non-controversial. Federal land management agencies in the United States have increasingly come under fire over management decisions that appear to decrease biodiversity. The dispute over the spotted owl and old-growth forests is the most visible example of how tough it is to blend the conservation of biodiversity with other uses and values of public resources. It illustrates the reality of "no free lunch" in resource allocations. Even though parks, reserves, set-asides, and easements are critical components in the mix for the conservation of biodiversity they will become more difficult to come by and ultimately will require an expansion beyond the "reserve mentality" (Brussard et al. 1992). Multiple-use of public lands is deeply ingrained. Somehow we have to come up with management prescriptions for our public lands that will allow both consumptive and non-consumptive uses but will do so in such a way that no net loss of native species will occur.

For example, a strategy to maximize species diversity at the local level does not necessarily add to regional diversity. In fact, oftentimes in our hast to "enhance" habitats for wildlife we have emphasized "edge" preferring species at the expense of "area" sensitive ones and consequently may have even decreased regional diversity. It is important to realize that principles that apply at smaller scales of time and space do not necessarily apply to longer time periods and larger spatial scales (Crow 1989). Long-term maintenance of species and their genetic variation will require cooperative efforts across entire landscapes (Miller 1994). This is consistent with the growing scientific sentiment that biodiversity should be dealt with at the scale of habitats or ecosystems rather than species (Hunter et al. 1988). If context is ignored in conservation decisions and the surrounding landscape changes radically in pattern and structure, patch content too will be altered by edge effects and other external influences (Noss 1994). For example, landscape connectivity is a direct consequence of the abundance of suitable habitat, its spatial patterning in the landscape, and the organism's scale of resource utilization (Pearson et al. 1994). Moreover, the scale and scope of conservation has been too restricted and steps must be taken to incorporate the benefits of biodiversity and the use of biological resources into local, regional, national, and international economies (Miller 1994, WRI/IUCN/UNEP 1992). The maintenance of biodiversity requires attention to a wider array of components in determining management options as well as the management of larger landscape units.

SUSTAINING THE ENVIRONMENT INTO THE NEXT CENTURY

The demands and expectations placed on biological resources are high and widely varied, calling for new approaches that go beyond merely reacting to resource crises and concerns (Szaro 1993a; Szaro and Salwasser 1991). New approaches must incorporate fundamental shifts in the scale and scope of conservation practice (Miller 1994). These include the shift of focus from the more traditional single species and stand level management approach to management of communities and ecosystems (Reynolds et al. 1992).

The United States is moving forward with an ecosystem management approach, one that is scientifically sound, ecologically based and totally integrated. Common sense dictates that this approach, one that considers the sum of the parts rather than each resource in isolation, is the proper and practical way to head. It uses as its foundation principles derived from conservation biology theory for conserving biodiversity and maintaining ecological systems (Soulé and Wilcox 1980; Soulé 1986, 1987; Salwasser et al. 1994). These principles include:

- Recover and conserve formally listed threatened or endangered species.
- Provide for viable populations of native plant and animals species.
- Maintain a viable network of native biological communities and ecosystems.
- Maintain structural diversity.
- Sustain genetic diversity.
- Produce and conserve resources needed by people.
- Protect ecosystem integrity soils, waters, biota and ecological processes.
- Restore and renew degraded ecosystems.

Ecosystem management responds to a significant shift in social values, scientific understanding and land management interests from that of the past. Ecosystem management is an identifying name tag for a new and evolving approach to land management. For practical purposes it is generally synonymous with sustainable development, sustainable management, sustainable forestry and a number of other terms being used to identify an ecological approach to land and resource management. Ecosystem management is a goal-driven approach to restoring and sustaining healthy ecosystems and their functions and values. It is based on a collaboratively developed vision of desired future ecosystem conditions that integrates ecological, economic, and social factors affecting a management unit defined by ecological, not political boundaries. Its goal is to restore and maintain the health, sustainability, and biodiversity of ecosystems while supporting communities and their economic base.

There are four basic operating tenets that provide an "umbrella" for an ecosystem management approach. Under this umbrella are a number of components which are all driven or related in some degree to participation, collaboration, using the best science, and following an ecological approach. These tenets are:

- Partnerships: Sharing responsibility for land management is fundamental. Ecosystems cross boundaries, making the need for cooperation, coordination, and partnerships a must for managing the entire ecosystem.
- Participation: Get people involved in all aspects of public resource decision-making so that managers will know their needs and views. It is essential to use a highly participatory process, from beginning to end, before deciding on a course of action by involving all those interested in formulating alternatives, evaluating those alternatives, and describing the process used to select one. The focus should be on desired end results, future ecological and social conditions, and the land use classes and management actions that will best attain them.
- Scientific Knowledge: Use the best scientific information and most appropriate technologies available to understand the range of choices of actions and the consequences of each. Integrate information and technology, such as ecological classifications, inventories, data management systems, and predictive models, and use them routinely in landscapescale analyses and conservation strategies. This includes strengthening teamwork between researchers and resource managers to improve the scientific basis of ecosystem management (See Soulé and Kohm 1989; Solbrig 1991; Szaro 1994b).
- Ecological Approach: In the simplest terms, this means looking at many factors across a broad landscape, using several scales, addressing linkages between landscape elements and ecological processes, and a number of other activities. The science of ecology will be applied to multiple-use management, recognizing that people are part of the ecosystems we manage. Landscapes should be used as the basic unit for planning and managing ecosystems to meet specific objectives, both desired future ecological conditions and desired economic and social goals, while reconciling conflicts between competing uses and values.

Evolving from these four principles are a set of methods and tools that compose the basic elements of any ecosystem management approach. The following represent key elements of such an approach:

- Address activities and information across several geographic scales. For aquatic information, use a range of nested watersheds; for terrestrial information use, the levels described in Ecoregions of the United States.
- Select scales/boundaries appropriate for highly mobile species.
- Adopt means to deal with the complexity that comes with using multiple scales and multiple boundaries across scales for organizing and using information necessary for sound analyses.
- Conduct information collection, analyses, and planning across administrative and jurisdiction borders to coincide with useful ecological boundaries.
- Address biotic information across levels of biological organization (cell, organism, population, community, ecosystem, landscape, biome, biosphere).
- Develop and use methods to recognize and address patterns and change over time and space for key elements at multiple scales.
- Define major disturbance factors and their range of historic variation.
- Develop common approaches to ecological classification.
- Develop, seek out, utilize, and transfer the very best available scientific knowledge.
- Conduct analyses over large geographic areas that encompass smaller project areas.
- Cooperatively develop desired conditions.
- Address effects at the project level and at least at one scale above and below.
- Develop approaches to share information across many borders, including integrated resource inventories and information provided for national uses.
- Develop decision support technologies and methods to support the complexities of ecosystem management. Build recognition of uncertainty into those processes, including the fact that most questions will probably never be answered and major mistakes can take a long time to heal.
- Integrate information and technology, such as ecological classifications, inventories, data management systems, and predictive models, and use them routinely in landscapescale analyses and conservation strategies.
- Develop information about a variety of species habitat needs.
- Develop information about ecological processes, including the carbon cycle, nutrient cycle, hydrologic cycle, succession, biological diversity, population dynamics.

- Develop knowledge of linkages within and between systems and processes.
- Work within the scope of natural processes that shape landscape and ecosystem conditions.
- Develop knowledge about the human dimensions of ecosystem management.
- Use highly participatory process from basic data collection through monitoring and involve all the publics that want to be included.
- Seek and form as many partnerships as possible with federal, state, local, and other organizations in doing ecosystem management.
- Use an adaptive management process as an integral part of monitoring and evaluation.
- Focus on end results, desired future ecological and social conditions, and the land use classes and management actions that will best attain them.
- Develop, monitor, and evaluate vital signs of ecosystem health.

These are some of the key tools and methods that must be in place to support ecosystem management. There should be independent and unique decisions on individual projects and plans, but there should be a general approach towards an ecosystem management process. Many of the tools and methods noted require sharing and cooperation across administrative boundaries. Much of the information needed at each unit to conduct ecosystem management, especially information at the higher geographic scales, is useful to many units and many other organizations also interested in ecosystem management.

CONCLUSION

The global focus on issues related to the conservation of biodiversity will continue to increase, and it will highlight serious and complex problems not likely to be easily resolved. A broad understanding of the significance of managing of biological resources currently exists in the United States across the social and political spectrum. In fact, most areas of the United States and levels of government have experienced first hand the difficulty of understanding and managing species or ecosystems that have been put in jeopardy.

The national paradigm of acceptable land management in the United States and provisions for associated values have changed dramatically over the last 200 years. Social, cultural, economic, and environmental views and values have continued to adjust based on perceptions of scarcity, national security and development, scientific understanding, and the desired condition for the country's health and well being. This has required dramatically different responses from all levels of government, economic sectors, educational systems, and non-governmental organizations.

The current framework for conservation of biodiversity has evolved as a mix of related individual laws and regulations over the last 125 years. The majority of these were put in place within the last 30 years, with a variety of relationships to federal, state or private lands. Specific direction for conservation of biodiversity resources in the United States remains primarily aimed at federal lands and agencies. Designation of a particular species as Threatened or Endangered creates responsibilities and constraints for all ownerships, public and private. Improving scientific awareness and shifting societal values and priorities have resulted in a new approach to managing lands and resources. This approach is focused on looking at large systems and landscapes, as opposed to the individual component parts. The term used to describe this philosophy and approach on public lands in the United States is ecosystem management. The fundamental focus of ecosystem management is on the maintenance of biodiversity.

Public lands and resources will continue to be a focal point for diversive opinions, interests, and values. Ecosystem management will not remove controversy. It is an approach that is based on using the very best information in a very professional manner to determine the "sustainable" decision space. The selection of alternatives will continue to be a mix of resource, social, cultural, and political interests. The key is to apply ecosystem management in a manner that provides the very best information upon which to examine sustainable options and make decisions.

Old management paradigms are difficult to shed, but only new, dynamic efforts on a landscape scale are likely to succeed in conserving biodiversity (Szaro 1994). The question of effects of a diversity mandate on other resource uses must be viewed from both a shortand long-term perspective. There will be trade-offs and commodity production may decline in the short-term, but in the long-term these trade-offs will result in gains in sustained productivity while maintaining biodiversity with its complete range of ecological processes. Ecosystem-level management of ecological systems is going to require innovative approaches to planning, monitoring, coordination, and administration. Future conservation at larger scales will always be confounded by the potentially large number of political authorities that conduct land management practices on watershed, basin, or even landscape scales (Knopf and Scott 1990). A "new" paradigm is needed, one that balances all uses in the management process and looks beyond the immediate benefits. Or maybe simply the implementation of an older vision described by Aldo Leopold:

> The practice of conservation must spring from a conviction of what is ethically and aesthetically right, as well as what is economically expedient. A thing is right only when it tends to preserve the integrity, stability and beauty of the community, and the community includes the soil, waters, fauna, and flora, as well as people.

Interest and concern within the United States regarding the conservation of biodiversity continues to affect social debate and political change. Institutional actions to protect, preserve, enhance, and maintain biodiversity build on a framework of existing legislation and regulation to ensure viable populations remain in that category. This is being accomplished by shifting management orientation to large landscapes and focusing on sustaining historic patterns, ranges, composition and function of ecosystems. For resources currently recognized as threatened, the extreme measures necessary to protect biodiversity have heightened national awareness to the trade-offs involved in short-term crises management versus sound, long-term landscape management. National attention toward conservation of biodiversity, both in the United States and abroad, continues to improve the institutional frameworks through which sustainable management strategies can be implemented.

REFERENCES

Bridgewater, P., D.W. Walton, and J.R. Busby. 1994. Creating Policy on Landscape Diversity. In Szaro, R.C. and D.W. Johnston (Eds.) Biodiversity in Managed Landscapes. Oxford University Press (In press).

Brussard, P.F., D.D. Murphy, and R.F. Noss. 1992. Strategy and Tactics for Conserving Biological Diversity in the United States. Conservation Biology 6: 157-159.

Crow, T.R., 1989. Biological Diversity and Silvicultural Systems. Pages 180-185 in Proceedings of the National Silvicultural Workshop: Silvicultural Challenges and Opportunities in the 1990's. [Petersburg, Alaska, July 10-13, 1989] USDA Forest Service, Timber Management. Washington, D.C. 216 pp.

Harrington, C., D. Debell, M. Raphael, K. Aubry, A. Carey, R. Curtis, J. Lehmkuhl and R. Miller. 1990. Stand-level Information Needs Related to New Perspectives. Pacific Forest and Range Experiment Station, Olympia Forestry Sciences Laboratory, Olympia, Washington. 25 pp.

Hunter, M.L., JR., G.L. Jacobson, JR. and T. Webb. 1988. Paleoecology and the Coarsefilter approach to Maintaining Biological Diversity. Conservation Biology 2: 375-385.

Knopf, F.L. and M.L. Scott. 1990. Altered Flows and Created Landscapes in the Platte River Headwaters, 1890-1990. Pages 47-70 In J. Sweeney (Ed.), Management of Dynamic Ecosystems. North Cent. Sect., The Wildl. Soc., West Lafayette, Ind.

Miller, K.R. 1994. Conserving Biodiversity in Managed Landscapes. In Szaro, R.C. and D.W. Johnston (Eds.) Biodiversity in Managed Landscapes. Oxford University Press (In press).

Raeburn, P. 1992. The Convention on Biological Diversity: Landmark Earth Summit Pact Opens Uncertain New Era for Use and Exchange of Genetic Resources. Diversity 8: 47.

Reid, W., C. Barber, and K. Miller (Eds.). 1992. Global Biodiversity Strategy: Guidelines for Action to Save, Study, and Use Earth's Biotic Wealth Sustainably and Equitably. World Resources Institute, Washington, D.C.

Reynolds, R.T., R.T. Graham, M.H. Reiser, R.L. Bassett, P.L. Kennedy, D.A. Boyce, Jr., G. Goodwin, R. Smith, and E.L. Fisher. 1992. Management Recommendations for the Northern Goshawk in the Aouthwestern United States. Gen. Tech. Rep. RM217. Fort Collins, CO: U.S.D.A. Forest Service, Rocky Mountain Forest and Range Experiment Station. 90 p.

Salwasser, H., J.A. Caplan, C.W. Cartwright, A.T. Doyle, W.B. Kessler, B.G. Marcot, and L. Stritch. 1994. Conserving Biological Diversity through Ecosystem Management. In Szaro, R.C. and D.W. Johnston (Eds.) Biodiversity in Managed Landscapes. Oxford University Press (In press).

Salwasser, H., 1990. Conserving Biological Diversity: A Perspective on Scope and Approaches. Forest Ecology and Management 35: 79-90.

Solbrig, O.T. (ed.). 1991. From Genes to Ecosystems: A Research Agenda for Biodiversity. International Union of Biological Scientists, Cambridge, MA.

Soulé, M. E. 1986. Conservation Biology and the Real World. In: Conservation Biology: the Science of Scarcity and Diversity, ed. M. E. Soulé, pp. 112. Sinauer Associates, Inc., Sunderland, Mass.

Soulé, M. E., ed. 1987. Viable Populations for Conservation. Cambridge University Press, New York.

Soulé, M. E., and B. A. Wilcox (eds.). 1980. Conservation Biology: An Evolutionary Ecological Perspective. Sinauer Associates, Inc., Sunderland, Mass.

Soulé, M.E. and K.A. Kohm (Eds.). 1989. Research Priorities for Conservation Biology. Island Press, Washington, D.C. 97 pp.

Szaro, R.C. 1994a. Biodiversity Maintenance. In: A. Bisio and S.G. Boots (Eds.) Encyclopedia of Energy Technology and the Environment, First Edition. Wiley Interscience, John Wiley & Sons, Inc., New York (In press).

Szaro, R. C. 1994b. Research Needs and Opportunities: The Response of Forest Biodiversity to Global Change . Pages 399-416 In T.J.B. Boyle and C.E.B. Boyle (Eds.) Biodiversity, Temperate Ecosystems and Global Change, [NATO Advanced Science Workshop, August 1519, 1993, Montebello, Canada] Springer Verlag, Berlin.

Szaro, R. C. 1993a. The Status of Forest Biodiversity in North America. J. Trop. For. Science 5: 173-200.

Szaro, R.C. and D.W. Johnston (Eds.). 1994. Biodiversity in Managed Landscapes. Oxford University Press (In press).

Szaro, R. C., and H. Salwasser. 1991. The Management Context for Conserving Biological Diversity. 10th World Forestry Congress [Paris, France, September 1991]. Revue Forestiere Francaise, Actes Proceedings 2: 530-535.

Szaro, R. and B. Shapiro. 1990. Conserving Our Heritage: America's Biodiversity. The Nature Conservancy, Arlington, Va. 16 p.

Thomas, J.W., E.D. Forsman, J.B. Lint, E.C. Meslow, B.R. Noon and J. Verner. 1990. A Conservation Strategy for the Northern Spotted Owl. Interagency Scientific Committee, Portland, OR. 427 p.

Walker, B.H. 1992. Biodiversity and Ecological Redundancy. Conservation Biology 6: 18-23.

West, T.L. 1992. Centennial Mini-histories of the Forest Service. USDA Forest Service FS518, Washington, D.C. 72 p.

Wilson, E.O. and E.M. Peter (Eds.). 1988. Biodiversity. National Academy Press, Washington, D.C. 521 pp.

A STRATEGY FOR BIODIVERSITY PROTECTION IN POLAND

Andrzej Weigle
National Foundation for Environmental Protection

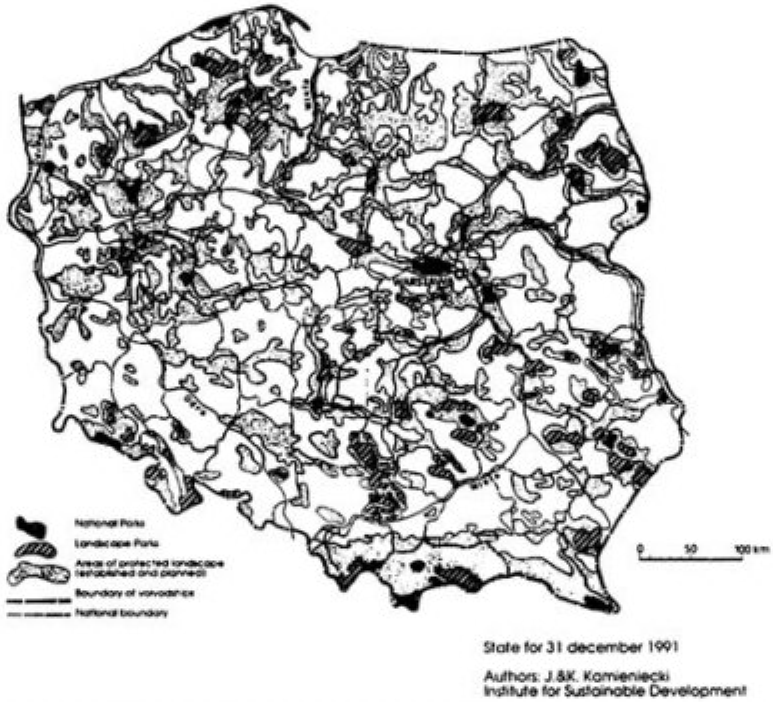
INTRODUCTION

The description of the strategy for the protection of biological diversity in Poland is quite a difficult task because, as somebody once explained to Napoleon: "first of all we don't have cannons." In other words, at the present time there is still no such document, there is not even an outline of it. In view of this, this paper will focus on other similar documents which are functioning in Poland; on the work carried out to date on the problems of biodiversity, including the National Case Study which has been prepared at the request of the United Nations Environment Program (UNEP) and in accordance with UNEP guidelines; and lastly on the tasks that Poland faces, and the way in which it intends to deal with them.

SECTION I

Poland has a long and distinguished tradition in the fields of biology, ecology, and nature conservation. The inventories of flora and fauna is at an advanced stage, and the habitats of many potential and real plant communities are mapped (Andrzejewski and Weigle 1993). A network of protected areas has been created, and it covers a large area (Map 1). However, there are no unambiguous and forward-looking programs for the protection of the natural environment at the level of the country as a whole. The changes introduced in Poland a few years ago have had many effects. The much-criticized centralized social and economic planning has disappeared, and the economy has switched over to a system that is subordinated to the laws of the market. It is these factors that were supposed to determine the way in which the country developed. Although there is a Central Planning Office and although there has been a need for a national development plan, it is only now that a 3-year plan is being prepared. This is to be discussed widely and negotiated in the future. There are also no departmental development plans. All we have are directions of action which have been adopted by the government. So in this we have clear proof that Poland is in a period of transition.

MAP 1 Nature and Landscape Protection in Poland



The systemic and economic changes which are taking place create a need for new legal regulations. To date, the actions of the government administration have been aimed mainly at the preparation of the draft versions of legal acts. Work has recently been done on seven statutes in the Ministry of Environmental Protection alone. Four of these have been enacted by parliament, and two are closely linked to the protection of biodiversity: The Statute on Nature Conservation of October 16th 1991 and The Statute on Forests of September 28th 1992.

The need for a strategy for ecological development was realized some years ago and the Department of Environmental Protection started work on an appropriate policy in the late 1980s. A number of documents were produced in the course of this work. However, many of these focused mainly on the problems of environmental protection. These documents include: The National Program for the Protection of the Natural Environment to the year 2010, which came out in 1988; and The Ecological Policy of Poland (with several versions from 1990, 1992 and

1993). This document was debated in parliament. Slightly different in character was the Strategy for the Protection of Living Natural Resources in Poland, which was produced in 1991. This also restricted itself to fairly general assumptions.

Work on the system of protected areas was of great importance and was completed by statute. The aim was to create a system of ecologically continuous nodes and belts which will ensure the stable functioning of the separate elements which make it up, i.e., populations, ecosystems, etc., The concept of the Large-scale System of Protected Areas details the present state of nature conservation and the plans for the future (Kozlowski 1992). It is founded upon elements with different protective regimes, including: National Parks, Nature Reserves, Landscape Parks, Areas of Protected Landscape, the protective zones around spas, protected watersheds, and areas protecting groundwater. However, this is not yet a cohesive system, particularly when it comes to a reflection of the real spatial links between the different elements. Another concept, the Ecological System of Protected Areas, provides a theoretical basis for checking the system (Rozycka 1977). This is based on the assumption that it is necessary to maintain the spatial continuity of natural systems while allowing various forms of human management to coexist with them. Unfortunately, there is a lack of any logical sequence in these projects. Methods for delimiting the system are not defined very well, and there is no nationwide concept. Plans prepared by different authors in several of Poland's voivodeships (or provinces) do not add up to a coherent system.

It is planned that both of these concepts (as well as regional programs) will be used in Poland's element of the European Ecological Network (EECONET), which is now being set up. This idea is being promoted by International Union for Conservation of Nature and Natural Resources (IUCN) and it includes the countries of Central and Eastern Europe. According to Liro (1994), its main aims are:

- To preserve the full complement of habitats which are typical for a given biogeographic zone;
- To protect the ecosystems and ecological landscapes which have been transformed least;
- To protect areas which are outstanding in terms of their high diversity or the way in which they sustain endemic or threatened species; and
- To protect those areas which make up the migration routes of animals at the European or Polish levels.

In recent last years some regional programs have been prepared. One of these, known as "The Green Lungs of Poland", is for the area of north-east Poland, which is exceptionally rich from the point of view of nature and which is not greatly contaminated. This area stands out from areas which are threatened ecologically, of which Poland has more than its fair share (Map 2). The principles for ecodevelopment are indicated by the assumptions of the regional policy for the Green

Lungs of Poland and the strategy for its spatial management (1992). Similar prerequisites underlie the pro-ecological strategy for the management of the Vistula River valley, which will cover more than half of the country (Kolodziejski 1993). The are also other existing programs, such as for the National Parks and for wetland areas, as well as projects for the drainage basins of individual rivers. These will not be discussed here because of their highly detailed nature.

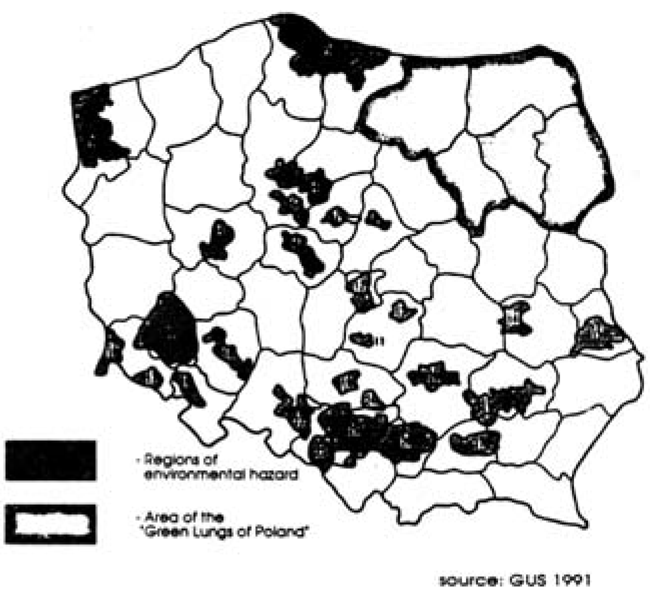
It is important to take into account all of the above mentioned documents if attempts are to be made to formulate a strategy for protecting biodiversity.

SECTION II

The work done so far has mainly been focused on eliminating the sources of threat and on improving the natural environment. It was only as part of the wave of world-wide discussion preceding the signing of the Convention on Biodiversity that the significance of, and threats to, diversity were dealt with more broadly.

Along with a number of other countries, Poland was asked by UNEP to prepare a "Country Study on Benefits, Costs and Needs in Relation to the

MAP 2 Regions of Environmental Hazard in Poland and Area of "Green Lings of Poland"



Protection of Biological Diversity". Formulating these country studies was part of the process by which the text of the Convention was prepared and negotiated. In Poland, it was the first summary which combined knowledge of biological diversity with attempts at an economic assessment of its value (1991).

The National Foundation for Environmental Protection was recommended by the Ministry of Environmental Protection, Natural Resources, and Forestry to take on this task, which was far from easy on account of its multi-disciplinary character. This Foundation is one of the biggest and most dynamic NGOs in Poland. It has considerable experience in working on nature conservation, a wide range of coworkers from various fields, and good organizational and technical support. A National Biodiversity Unit was created specially for the purpose, and the best specialists were invited to join it. This set-up guaranteed access to most of the required information and also ensured that the project was undertaken at the highest level. An exceptionally short time was available for the preparation of the case study (in effect only 3 months). As a result, the work was done by a relatively small team.

In preparing the case study, the team restricted itself to data already in existence. The information system in Poland is not well-developed and so the hardest task was to locate the existing data. A list of potential sources was created and detailed questionnaires were prepared. The results obtained were in most cases exhaustive. Compilation of economic data was mainly carried out on the basis of methods given in the "Guidelines" from UNEP (1991). However, the use of these methods was limited by the lack of any experience in this matter. As a result, the authors of this section emphasized that the approach taken was far from perfect and accompanied by sizable errors. For example, it turned out that the level of Poland's financial need (UNEP 1992) was considerably lower than that obtained in Germany. This would seem to be impossible to anyone familiar with the realities of the situation. The low level of awareness in society led to sociological studies being confined to analysis of overall attitudes to nature conservation and environmental protection. Biodiversity as such was not emphasized. Professional surveys were carried out on a random sample of 984 people. These were augmented by simulations and analyses of the press. The election program of the different political parties were also evaluated.

An important part of the work was an attempt to discover the threats which are of greatest significance to Poland's natural riches. According to Gliwicz (1994), such analyses should be carried out at two levels. They should begin with the macro-factors which do (or which soon will) come into conflict with the assumptions underlying the conservation of biodiversity. Micro-factors should then be identified. These factors lead to a decline in particular populations, to the pauperization of ecosystems, and to particularly sharp effects at local level. The case study named several threats which were considered most serious at the national level. These were:

- The poor state of the environment, and particularly the inappropriate management of water;
- The poor state of Poland's forests, which is connected with long-term mismanagement of the resource as well as with a lack of any strategy in the department of forestry for changing the productive functions of forests;
- Lack of control of the processes associated with changes in ownership and in society as a consequence of the changeover to a market economy; and
- The lack of any vision for the spatial management of the country and its regions.

"The Polish Red Book" (1993) provides an example of the detailed analysis of micro-factors, and it deals with the species threatened with extinction. The threatened species and areas require that a specific approach be applied. The Polish case study does suggest certain solutions (Table 1).

TABLE 1 Areas and Species Particularly Important for the Retention of Biodiversity

A. AREAS	SPECIFICS (MOTIVES)	GENERAL STRATEGY
1. Areas of particular value for biodiversity; of high endemism; habitats and valuable species; natural and little transformed forest and marsh ecosystems, rare plant communities, etc.	1. The sites of in situ protection; National Parks, reserves, Landscape Parks, protected zones	1. Retention in an intact state or raising of biodiversity values
2. All forest areas (productive forests and others outside protected areas)	2. Forests are the richest ecosystems of central Europe	2. A change in the function of forests from the productive to the environmental-creating
3. Marshes, peatlands, floodlands, river banks	3. "Museums of evolution", habitats of high biodiversity, rare in central Europe	3. The retention of unchanged water relations
4. Areas of traditional agricultural (northeast and east Poland)	4. Areas of high biological value in spite of many centuries of agricultural utilization	4. Economic development decreasing their biodiversity
5. The whole century	5. In Poland, the pollution of the environmental is the biggest threat to biodiversity	5.Rehabilitation of the environment: the purification of waters, air and soil
B. SPECIES	**SPECIFICS (MOTIVES)**	**GENERAL STRATEGY**
6. Rare and endangered species	6. The threat of extinction	6. Increasing populations
7. Endemic and relict species	7. Genetic uniqueness	7. The retention of viable population
8. Particularly invasive species, pathogens, pests	8. Eliminating other species, economic losses, treat to health	8. Reduction in numbers, whilst retaining viable populations
9. All other species	9. Components of biodiversity	9. Retention of the entire genetic diversity within a species: the retention of the species' geographical range so-far maintained

SECTION III

The initial aim of preparing the case study was to provide UNEP the material necessary for the text of the Convention to be negotiated. However, it was soon realized that the longer term aim was to prepare a cohesive policy for the protection and utilization of biological diversity in Poland which could be implemented at all possible levels. This concept is compatible with the UNEP approach (Fig. 1). But this task implies a long and laborious process, and the decision-makers do not yet understand this adequately. The process of ratification of the Convention is still at the preliminary stage and no full analysis has yet been made of Poland's obligations under it. The Ministry of Environmental Protection, Natural Resources, and Forestry has approached the Institute of Environmental Protection with a request that legal, scientific, and financial implications be defined and the consecutive tasks in this area set out. It is obvious that all resolutions of the Convention must find a place in any future strategy for the protection of biodiversity. The very wide scope makes it necessary for both the action plan and its implementation to take in a number of departments and institutions. A possible way to this is to adapt already existing documents.

There is no doubt that the preparation of the national case study and the subsequent signing of the Convention have raised interest in these issues. New research projects have appeared, including one on the preparation of the methodology for analysis of biodiversity on the basis of satellite photographs, as well as an attempt at working out ways in which an evaluation can be given regarding the benefits and costs of improving the quality of the environment and costs of nature protection. Work has begun on the creation of the appropriate databases, and a program for the monitoring of living natural resources has been established (Symonides, ed. 1993). A further consequence will also be the work in association with the ratification of the Convention by the Polish parliament and the resultant adaptation of various regulations and program. However, we hope that it may eventually lead to the preparation and implementation of program for the protection of biodiversity at the national and regional levels, as well as at the branch level (in forestry, agriculture, industry, planning, etc.).

The main obstacle to a multi-stage process for the preparation of a program of biodiversity conservation is the lack of uniformity and consistency in the actions of those responsible for this sphere, which in turn is a result of frequent political changes. Two years have passed since Poland signed the Convention, but it is only now that preparations are underway for the ratification procedure. Even the most well-prepared strategy will be nothing more than a document on the shelf if it is not followed by a detailed plan of action and by a guaranteeing of appropriate financing. It is therefore necessary to draw up a program whose points of reference will be at the level of the overall economic policy of the country as well as at specific levels. The weakness of Poland's information technology is also a serious hindrance. It emerged in the course of the preparation of the case study that various units lack knowledge of the work carried out elsewhere. This means that projects overlap frequently and that there is a lack of interest on the part of others. Such conditions make it much more difficult for reports and compilations of this type to be created, and more importantly, they provide a severe hindrance to the implementation of a research policy.

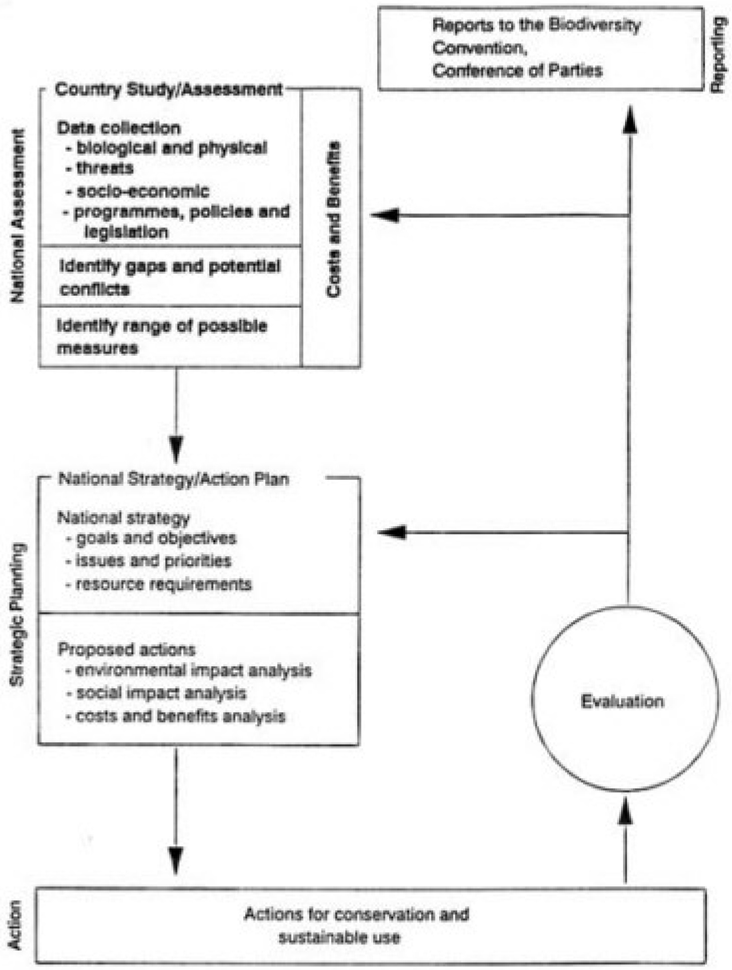


FIGURE 1 Context within which the Country Study Process Contributes to the Implementation of the Convention on Biological Diversity

There are other obstacles, too. The methodology of what is widely understood as "work on nature" is generally known and tested, but the economic aspects will require a great deal more work. There is also a lack of coherence to legal regulations, but at least the work now in progress leaves room for hope that the problem will be solved before too long. Financial problems are a different matter. Documentation work is relatively cheap and money for it can be obtained from national or foreign sources. However, it is only to a very limited extent that particular projects have been put into effect. This may be exemplified by the financial constraints which have resulted in the closure of seed banks for old varieties of crop as well as collections of livestock which are unique on the world scale.

CONCLUSION

In summary, it can be seen from the above that Poland faces a large amount of work in connection with nature conservation that is based on the principles of the protection of biodiversity. We have to preserve the greatest possible diversity of life for future generations, but we must remember that we are mainly talking about quality rather than quantity. An example might be oligotrophic and dystrophic lakes which are disappearing in Poland. Species-poor they may be, but they are valuable in terms of the quality of this delicate system.

The Convention on Biodiversity is the first international document of this rank which has been prepared with nature in mind. It is important to realize what possibilities it creates and to act in accordance with its requirements by preparing a detailed National Program for the Protection of Biological Diversity, which will become the basis for a long-term policy for the functioning of the country.

It would seem that national case studies prepared at regular intervals (perhaps every five years) could constitute an ideal method by which to monitor the changes in biodiversity at the genetic, species and ecosystemic levels, as well as the costs, benefits and needs related to this. It would also make it possible to define the priorities in scientific research, and the scope of that research.

REFERENCES

Andrzejewski, R, and Weigle, A. (eds.). Country Study on the Costs, Benefits, and Unmet Needs of Biological Diversity Conservation; National Foundation for Environmental Protection, Warsaw 1991 (Polish version - Polish Case Study of Biological Diversity; NFEP, Warsaw 1993)

Biodiversity Country Studies, Synthesis Report; UNEP, Nairobi, 1992

Gliwicz, J. Biodiversity Convention: Concept, Researches, Strategy, Manuscript; NFEP 1993

Guidelines for the Preparation of a Country Study on Costs, Benefits and Unmet Needs of Biological Diversity Conservation within the Framework of the Planned Convention on Biological Diversity; UNEP, May 1991

Guidelines for Country Studies on Biological Diversity; UNEP, Nairobi, May 1993

Kozlowski, S. The Protection of the Natural Landscape within the Concept of the Large-scale System of Protected Areas, in: "Selected Problems of landscape Ecology"; Department of Studies of the Agricultural and Forest Environment, Polish Academy of Sciences, Poznan 1992.

Kolodziejski, J. (eds.). Pro-ecological Strategy for Vistula Management, NFEP, Warsaw 1993

Liro, A. A Concept for the National Ecological Network ECONET-PL, Introduction to Project, manuscript; IUCN, Warsaw 1994.

Monitoring Animate Nature; NFEP, Warsaw 1993

The National Programme for the Protection of the Natural Environment to the year 2010; Ministry of Environmental Protection and Natural Resources, Warsaw 1988.

Rozycka, W. A Proposal for the Formation of an Ecological System of Protected Areas; Man and Environment 1/4 Warsaw 1977.

A Strategy for the Protection of Living Natural Resources in Poland; Department of Studies of the Agricultural and Forest Environment, Polish Academy of Sciences, Poznan 1991.

A Strategy for Spatial Management in the Functional Area "The Green Lungs of Poland"; Warsaw 1992.

PROBLEMS IN TRANSBOUNDARY PROTECTED AREAS IN UKRAINE

Stephan Stoiko
Institute of Ecology of the Carpathians
Ukrainian Academy of Sciences

Ukraine, according to size (603,700 km^2), population (52 million), and industrial potential, is the second largest East European country. As it borders on seven countries, environmental cooperation, especially concerning biodiversity protection in transboundary regions, is a very important issue. The International Union for Conservation of Nature and Natural Resources (IUCN), UNESCO, UNEP, the World Wildlife Fund (WWF), and other international organizations have also recognized the importance of this cooperation.

Ukraine is situated in three geographical zones: the steppe zone (40% of the territory), the forest-steppe zone (34%), and the broad-leaf forest zone (26%). Therefore the country is characterized by significant biodiversity. Its aborigen flora includes: 4523 vascular plants, about 800 species of bryophyta, 1000 species of lichens, and 4000 species of algae. A list of fungi and mixomicetes together would include about 15,000 species. The animal kingdom includes 694 species of vertebrates (101 mammals, 344 avifauna, 20 reptiles, 17 amphibians, and about 200 fish) (Markevich 1984; Holubec and Zaverucha 1987). In the biogeographical aspect, the most interesting parts of the country are the Ukrainian Carpathians (37,000 km^2) and the Crimean mountains (7,000 km^2). The flora of vascular plants in the Carpathians includes about 2120 species (92 endemic) and about 2400 species in the Crimea (240 endemic) (Stioko and Tashenkevich 1991; Rubcov 1978).

During the last thousand years, the large qualitative and quantitative changes took place in the structure of the natural vegetation and in the composition of flora and fauna. The area of forests decreased to one third. At present the forests cover only 14.2% of the area of Ukraine. During the last century, such vertebrates as *Otis tetrax, Equus tarpan, Pteromus volans, Bos primigenius, Marmota alpina, Rupicapra rupicapra*, and *Bison bonasus* (which was reintroduced 20 years ago) have disappeared. At present 430 vascular species (10% of the Ukrainian flora), 56 species of bryophyta, 53 species of lichens, 58 species of fungi, and more than 100 species and sub-species of animals are included in the Red Data Book of Ukraine.

The system of protected areas consists of 9 categories and includes 12 zapovidnyk (strict reserves) (130,000 ha total), 3 biosphere reserves (159,585 ha), 3 national parks (123,200 ha), 293 nature reserves (35,600 ha), and more than 3700 other protected areas. Their total area make up 1.4% of Ukraine's territory. There are plans to gradually enlarge the protected areas to cover 3-4% of the country.

Ukraine inherited from the totalitarian regime an unsatisfactory ecological situation in many parts of the country. The state of nature became even worse after the Chernobyl accident. More than 106,000 ha of forest have been damaged by radionuclides. From the Chernobyl zone, 140,000 people were evacuated. In 1986 the population in Ukraine living on a territory contaminated with cesium-137 (over 1 Ci per square m or 37 kBq per square km) was 1.6 million.

For the second time in Ukraine's history, mortality exceeds the birth-rate; the first was during the engineered Great Famine in 1933, whose victims numbered 7-8 million. Therefore, it is very important to collaborate with foreign countries to preserve and optimize the state of the environment.

Another important environmental issue is the protection of the basins of the transboundary rivers, such as: the Danube (whose delta is on the Romanian-Ukrainian border), the Tisza (with Hungary and Romania), the Latoritsa and Uzh (with Slovakia), the Dnister (with Moldova, Belarus, and Russia), the Prut (with Moldova and Romania), the West Bug (with Poland), and the Pripiat (also with Belarus). Presently there are only inter-state agreements on preserving the basins of the Dnieper, Tisza, West Bug, and Danube.

The most important tasks regarding these transboundary rivers are: normalization of a hydrological regime; water purity protection; biodiversity protection in aquatic and river corridor ecosystems; and joint organization of hydromonitoring. The most important socio-economic tasks are the rational use of the local recreation potential in the border river zones and development of ecotourism and water-sports.

Common preservation of valuable landscapes, ecosystems, and biological resources is a very important task in such transboundary biogeographical regions as Polissya, Roztocha, and the Carpathians.

Polissya is situated on the territory of Ukraine, Belarus, and Poland. It is significant in the international TELMA program as a large swamp region. Shatsk National Park (32,500 ha) was organized in 1983 in the Ukrainian part of Polissya in order to preserve natural forests (Pinetum sylvestris, Querceto roboris-Pinetum, Alnetum glutinosae, and Piceetum abietis relictum), bogs, and lake ecosystems. There are 22 lakes covering 64.2 km^2.

On the territory of this national park, the flora of vascular plants includes about 800 species, 60 of them rare (including *Cares davalliana Sm., C. ubrosa Host., Cipripedium calceolus* L., *Drosera anglica Huds., D. intermedia Hayne, Oxycoccus microcarpus Turcz. ex Rupr.,* and *Salvinia natans* L.) (Stioko, Jashchenko, and Zhizhin 1986). The lakes and bogs of the national parks have ecological significance for waterfowl, wading birds, and migratory birds.

On the Polish side of the border, not far from the Ukrainian Szatsky National Park, is the Polesie National Park (4,813 ha). Scientific cooperation may be developed with the active commitment of both neighboring parks.

Based on the geomorphological and ecological aspects, Roztocha is an important cross-border region as well. Its relatively low hills (max. 400m) form the eastern part of the European watershed between the Baltic and Black Sea basins. Some tree species growing in this region (i.e., *Quercus petraea* Liebl., *Fagus sylvatica* L., *Abies alba* Mill.) are on the eastern boundary of their areas. A list of the vascular plants in the Ukrainian part of the Roztocha would include more than 910 species; 120 of these are rare, such as: *Acorus calamus* L., *Allium montanum* F.W. Schmidt, *Andromeda polifolia* L., *Aster amellus* L., *Carex davalliana* Smith, C. *humilis Leys., Cimicifuga europea* Schipcz., *Drosera anglica* Huds., *Hottonia palustris* L., *Melittis sarmatica* Klok., *Salix myrtilloides* L., *S.rosmarinifolia* L., *Salvinia natans* (L.) All., and Saxifraga hirculus L.

Ukrainian zapovidnik Roztocha was organized in this region for the preservation of natural forests (Pinetum sylvestris, Quercetun petraeae, Carpineto-Quercetun roboris, Fagetum sylvaticas, and Fageto-Pinetum sylvaticae), bogs, rare plants, and animals. On this strict reserve there are 756 species of vascular plants, 182 species musci, and 23 species hepaticae (Soroka 1990; Danilkiv and Soroka 1989). The area of the zapovidnyk, which used to be 2084 ha, has been enlarged to 9000 ha.

Rotztochansky National Park (7,811 ha) is situated in Poland near the Ukrainian Roztocha Nature zapovidnik. Scientific cooperation should be developed by both neighboring protected areas.

It is absolutely necessary to widen international ecological cooperation in the Carpathians. This giant mountain system (with an area of 381,000 km^2, longitude 1300 km) (Kondracki 1989) includes more than 50 peaks over 2000 m a.s.l. It is situated on the territory of 6 countries, and approximately 25 million people are connected by the mountain ecosystems ecologically and economically.

The Carpathians are characterized by considerable biological diversity due to various geological, geomorphological, and climatic conditions. There are about 2700 species of vascular plants of this territory (representing nearly 25% of European flora) (Stioko and Tashenkevich 1993). The list of endemic plants includes more than 240 species which need special protection.

At present eleven biosphere reserves (414,811 ha) and a broad net of various categories of protected territories are organized in the Carpathians for preserving unique and valuable landscapes, ecosystems, and biological diversity.

There are a few transboundary regions in the Carpathians where common ecological investigations are carried out and must be continued in the future. Maramorosh cristalline massif (Pop Ivan, 1940m), which is situated on the Ukrainian-Romanian border, is one of them. Virgin forests (Fagetum, Acereto-Fagetum, Fageto-Abieto-Piceetum, Piceetum abietis), dwarf-shrub ecosystems (Pinetum mugi, Dushekietum viridis, Juniperetum sibirici), and sub-alpine and alpine meadows (polonina) cover a considerable area. Czech botantists A. Zlatnik (1938) and M. Deyl (1940) investigated the forests, soil, and climate on the Ukrainian part of Pop Ivan before World War II. The explorer of the Slovak Tatra National Park (Dr. I. Voloshchuk) recently repeated the investigations of the structure of the virgin forest by using the same plots of Prof. Zlatnik. The Ukrainian part of Pop Ivan is included in the Carpathian biosphere reserve. It is necessary to organize a bilateral Ukrainian-Romanian biosphere reserve for the protection and continual monitoring of the valuable virgin ecosystems of the Maramarosh massif.

Primary flood forests (Populetum nigrae, Salicetum albae, Fraxinetum excelsioris), which have significant value for water protection, grow in the Tisza basin on the Ukrainian-Hungarian border. For the common investigation of the coenoic structure and the estimate of the hydrological role of the coastal forest ecosystems, the establishment of a common flood-forest protected area is urgently needed.

Useful ecological collaboration between Ukrainian, Polish, and Slovak botantists takes place in Ost Beskidien. The East Carpathian Biosphere Reserve was created in 1993 on the basis of the Polish national and landscape parks (108,924 ha) and the Slovak East Carpathian protected landscape (40,601 ha). The Ukrainian Ministry of Nature Conservation is now ready to join the Ukrainian landscape reserve Stuzhitsa (14,665 ha) to this biosphere reserve. It would be the first trilateral biosphere reserve in the world.

The common characteristics of the East Carpathian Biosphere Reserve is given in special publications (Denisiuk and Stojko 1992, 1993). Therefore only the Ukrainian part will be described.

The history of the Stuzhitsa reserve is very long. The Hungarian forest ministry first appreciated the scientific importance of the virgin Beskids forest just before World War I. The first forest reserve in the East Carpathians, "Stuzhitsa," was established in 1912 on an area of 331.8 ha. Due to Czech Professor A. Zlatnik, the preserved area was enlarged to 560 ha in 1932. The basic forest investigations in this area have been carried out by Prof. Zlatnik (Hadach et al 1991). In 1974 Ukraine established a 2592 ha state landscape reservation on the Stuzhitsa massif. Its area was increased to 14,665 ha in 1992 for the organization of the trilateral biosphere reserve.

The climatic conditions in the Beskidiens in the late holozen period was optimal for development of beech zonales forests. Average temperature in the highlands (400-1267 m) is 7-5.3 C, and atmosphere precipitation is 900-1250 mm. Under these favorable ecological conditions, beech formed a wide vegetation belt from 400 to 1260 m a.s.l.

In the lower part of the Stuzhitsa massif on the terrace of the floods, Petasito albae-Alnetum incanae occur. Cirsietum rivularis, ChaerophylloPetasitetum albi and Equiseto palustris-Caricetum remotae grow in wet places.

Dentario glandulosae-Fagetum and Galio odoratae-Fagetum have developed in the middle altitudes of the edaphic conditions most suitable for beech. There are fragmentary phytocoenoses Carici brisoides-Fagetum and Allio ursini-Fagetum in the humid localities.

On the slopes with southern exposure, Carici pilosae-Fagetum and Festuco altissimae-Fagetum associations are situated. The sourthern rocky slopes are occupied by the Lunario-Aceretum pseudoplatanae and Mercurialidoso-Acereto-Fagetum phytocoenoses.

Fagus sylvatica L., *Acer pseudoplatanus* L., and *Sorbus aucuparia* L. form the shrub biomorpha on the upper timber-line 1200-1260 m high. Myrtillo-Acereto-Fagetum (humilae) and Myrtillo-Sorbeto-Fagetum (humilae) are very rare in the Carpathians. The main reasons of the depressed growth of these trees are not severe climatic conditions, but the influence of strong winds.

The sub-alpine belt of Stuzhitsa is small. It is worth noting that here is the western border of *Dushekia viridis*, which is absent in the Slovak Beskidy. The following herbaceous phytocoenoses are spread though the sub-alpine belt: Nardetum strictae, Athyrietum alpestre, Rumicetum alpini, Vaccinietum myrtilli, Calamagrostidetum arundinaceae, and Poaetum chaixii (fragmentary). Some rare plants grow here, such as *Scorzonera rosea* Waldst. et Kit., *Melampyrum herbichii* Woloszcz., *Lilium martagon* L., *Anemone narcissiflora* L., *Tozzia carpatica* Woloszcz., *Orchis laxiflora Lam.*, and *Veratrum album* L.

The Stuzhitsa massif is important for the rare populations of animals. Such rare vertebrates as *Ursus ursus, Rus scrofa, Felix lynx, F. sylvestris, Martes martes, Carnis lupus, Cervus elaphus, Mustela erminea, Meles meles, Sciurus vulgaris carpathicus, Sorex alpinus,* and *Neomys fodiens* live here. More than 100 species of birds can be found here. The list of rare birds *include Aquila chrysaetos, A. pomarina, Bubo bubo, Strix uralensis marcroura, Prunella modularis, P. collaris, Ciconia nigra*, etc. From the rare herpetofauna and amphibians, there are *Triturus montadoni, Lacerta agilis, Salamandra salamandra, Vipera berus, Rana dalmatica*, etc.

In the composition of flora in Stuzhitsa massif, nemoral species predominate. From a floristic, geologic, and geomorphic point of view, Stinka ridge, which is 800 - 1000 m and situated on the Ukrainian-Slovak border, is the most interesting. On the rocky southern slope, such rare species are *Saxifraga paniculata* Mill., *Jovibarba preissiana* (Domin) Omelcz. et Chopik, *Ranunculus oreophyllus* Bieb., *Pedicularis hacquetii* Graff, and *Festuca saxatilis* Shur are located. Also, some thermophyle species grow here, such as *Sedum annuum* L., *Veronica collina* Wallr., and *Melittis melissophyllum* L. Over 20 rare and threatened species from this area have been included in the Ukrainian Red Data Book. Ukrainian, Czech, and Slovak botantists have proposed organizing a common Slovak-Ukrainian Stinka botanical reserve on about 200 ha. (Note: An investigation of the flora has been carried out in cooperation with the following Czech, Slovak, and Ukrainian botanists: E. Hadach, I. Terrai, L. Tasenkevitch, and M. Bural).

It is known that biosphere reserves have multi-functional importance. With regards to this idea, it is necessary to note that the Lemki, a Ukrainian ethnic group, live in the Beskidien mountains. In the village of Topolia (in the Slovak part of the biosphere reserve), the famous Ukrainian writer Alexander Dukhnovits was born. There are many cultural monuments (wooden churches, old cemetaries, wood-and-stone crosses, old wooden houses, etc.) on the territory of the biosphere reserve. Therefore the implementation of the trilateral biosphere reserve will strengthen the Lemki's and other Carpathian mountain traditions and customs. The protected area should give a chance for preserving not only natural but also the rich cultural heritage for the three nations which are closely connected by history and the environment. The rise of ecological measures in the territory of the biosphere reserve also will lead to economic achievements and thus to the prosperity of the local people.

REFERENCES

Danilkiv, I.S. and Soroka, M.I., Mokhopodibni derzhavnoho zapovidnika "Roztochia", Lviv, 1989, p. 167 (in Ukrainian).

Denisiuk, Z. and Stoiko, S., "O powolanie Medzynarodowego Rezerwatu Biosfery 'Beskidy Wschodnie' w Karpatach," Chronmy przyrode ojczysta, R. XLVIII, 1992, Krakow, pp. 14-39 (in Polish).

Denisiuk, Z. and Stoiko, S., "International Polish-Slovak-Ukrainian Biosphere Reserve 'Eastern Carpathians", Ukrainian Botanical Journal, vol. 50, no. 3, 1993, pp. 96-113.

Deyl, M., Plants, Soil, and Climate of Pop Ivan: Synecological Study from Carpathian Ukraine, Opera bot. cechica, Prague, 1940, p. 290.

Hadach, E., Mikhalik, S., Shimon, T., Stoiko, S., Tasenkevich, L., and Dihoru, G., "Spisok endemichnikh roslin Karpat," Zapovidni ekosystemi Karpat, Lviv, Svit, 1991, pp. 223-234 (in Ukrainian).

Holubec, M.A. and Zaverucha B.V., "Sovremennoe sostoanie genofonda flory," Geneticheskie Resursy Rastenij i Zhivotnikh Ukrainskoj SSR, Sbornik nauch. statej. Kiev, 1987, pp. 9-23 (in Ukrainian).

Kondracki J., Karpaty, Wydanie drugie, Warsaw, 1989, p. 260 (in Polish).

Markevich, O.P., "Tvarini," Ukrainian Rad. Encyclopedia, vol. 11, Kiev, 1984, pp. 53-58 (in Ukrainian).

Rubcov, N.I., Rastitelnij mir Krima, Simferopol, Tavria, 1978, p. 128 (in Russian).

Soroka, M.I., Sudinni rosliny derzhavnoho zapovidnika "Roztochia", Lviv, 1990, p. 274 (in Ukrainian).

Stoiko, S.M., Jashchenko P.T., and Zhizhin M.P., Shatskij prirodnij nacionalnij park, Lviv, Kameniar, 1986, p. 44 (in Ukrianian).

Stoiko, S.M. and Tasenkevich, L.A., "Phlanzengeographische Stellung und Schutz von Flora und Vegetation der Ukrainischen Karpaten", Verhandlung-Zool.-Bot. Ges., Osterreich, 1991, pp. 165-177.

Stoiko, S.M. and Tasenkevich, L.A., "Some Species of Endemism in the Ukrainian Carpathians", Fragmenta Floristica et Geobotanica, 2 (1), 1993, pp. 343-353.

Zlatnik, A., Prozkum prirozenych lesu na Podkarpatske Rusi, Dil prvni, Vegetace a stanoviste reservace Stuzica, Javornik a Pop Ivan, Prague, 1938, p. 244 (in Czech).

BIODIVERSITY PROTECTION STRATEGY IN THE REPUBLIC OF BELARUS

Pavel Parfenov

Belarus GEF Forest Biodiversity Protection Project

The Republic of Belarus is situated in a temperate zone which is divided into two sub zones: temperate broad-leaf and temperate coniferous. Belarus has an area of 20 million ha and population of 10.3 million. Critical ecological problems have arisen in Belarus from the economic pressures and the effects of socialized production. Numerous large-scale industrial enterprises (mineral fertilizer plants, synthetic fibers, plastics and resin factories, oil processing, and automobile plants) are situated on the territory. About 1,500,000 tons per year of toxic industrial waste enter the atmosphere from stationary sources alone; in addition, motor transport produces almost the same amount of pollution. The state of the environment is also aggravated by transboundary pollutants transported to Belarus by prevailing western winds.

The Republic of Belarus has 8.1 million ha of forests, which is approximately 35% of its land area. Regarding the country's biodiversity, botanists have registered nearly 1,600 species of higher plants, 58 species of fish, and 286 species of birds. The territory of the Republic is also inhabited by 47 species of mammals. Intensive anthropogenic modifications of natural complexes and an ever increasing consumption of natural and, particularly, biological resources has led to extensive quantitative and qualitative degradation of the environment. These modifications are clearly revealed by the large reduction or extinction of many rare animals and plants. The conservation of biological diversity of animals and plants is therefore an acute problem. The necessity of preserving the flora and fauna, biological diversity, and purity of gene pool became greater after the Chernobyl disaster (April, 1986), which contaminated a fifth of Belarus' territory and severely damaged the region's flora and fauna.

Among the many aspects of this urgent problem of biodiversity conservation, it is necessary to note the following:

- Ethical: Man as Homo sapiens should not tolerate the complete extinction of any species of living organisms that appeared on the Earth as a result of evolutionary processes;

- Aesthetic: Domesticated and tamed animals and ornamental plants are a source of cultural and spiritual human needs, and prevailing (background) species add a specific touch to the landscapes, enhancing their natural beauty;
- Ecological: Every living organism represents an element of complicated ecological systems, having many functional links (including trophic links as well) with other elements. Population extinction of any organism in the ecosystems can cause significant adverse and irreversible ecological modifications;
- Biological (scientific): Every species is a stage in the progressive evolutionary development of biota, an indicator of complicated historical processes of biosphere development. Biological changes are also induced by various anthropogenic impacts, which is of great importance for paleogeographic reconstructions, determination of modern tendencies, and forecasting of probable local, regional, and biosphere modifications;
- Pragmatic (practical): Every biological species is an actual or potential source of various resources, initial material for selection work, and carrier of specific gene pool with encoded positive characteristics and traits.

Preservation of biodiversity should be carried out on the basis of three approaches: 1) species (preservation of separate species and their populations); 2) coenotic (preservation of animal and plant communities); and 3) ecosystem (preservation by means of creation and activity of Nature Reserve areas). All these approaches are well applied in Belarus. Overall, 182 species of animals, 180 plants, 17 fungi, and 17 species of lichens are presently taken under official protection and listed in the Red Data Book. Sixty separate rare and age-old trees or their groups are designated memorials of nature. Coenotic and ecosystem approaches of biodiversity preservation have been used in the development of the General Plan of Protected Territories. There are now three Nature Reserves (Berezinsky Biosphere Reserve, Pripyatsky Landscape Hydrological Reserve, and Polessky Radio Ecological Reserve), one National Park (Belovezhskaya Pushcha), 340 memorials of nature (Botanical Parks, places with unique plantations, and some places with rare plants), and 72 State Protected Areas (botanical, biological, hydrological, zoological, landscape, forest, lake, hunting, cranberry, and memorial). Additional National Parks are planned. The total area of Protected Territories is about 6% of Belarus. These areas contain 68% of the flora of the country.

Natural ecosystems are regarded as an ecological counterbalance to the anthropogenic landscape, for example, the agricultural and urbanization processes. Protection of a definite number of such ecosystems is an obligatory condition for potential self-renewal and balanced development of an overall nature-anthropogenic system. The protection of the region's natural ecosystems it is an important, yet difficult, task.

All Nature Reserve territories in Belarus they are the property of the State. This has created both positive and negative aspects. On the positive side, it is easy to carry out general nature protection activities. On the negative side, there are a large number of territories, but the financial resources are insufficient to adequately manage these resources.

Preservation of biodiversity should be promoted by:

- Protection of all types of ecosystems as separate natural complexes;
- Protected territories should create their own mechanisms for the maintenance of their ecological balance in all regions or in all concrete ecosystem (lake, meadow, wetland, etc.); and
- The amalgamation of all protected areas into a united and uninterrupted territorial system, which will ensure the protection of the most typical landscape elements of Belarus. Application of the "migratory channels" principle to main forest tracts and river valleys will guarantee the protection of ecological links of the typical aquatic and terrestrial ecosystems and their gene pool in three Belarus biogeographical zones (northern Belarusian Lakeland, central, southern Belarusian Polessye) (Fig. 1).

These problems cross the borders of Belarus. One of the main points of the World Nature Protection Strategy is the inclusion of all biogeographic provinces into a nature reserves network, for instance, Biosphere Reserves. European nature reserve territories should be linked by the international network of "migratory channels" (Fig. 2). This network must consist of the region's most valuable and typical natural objects and also disturbed ecosystems for the purpose of their restoration. Belarus' nature reserves should be connected with nature reserves of all the bordering countries (Poland, Lithuania, Latvia, Ukraine, and Russua) by "migratory channels," and through them, with all protected areas of Europe.

Within the bounds of the global network of protected representative territories, Belarus' protected territories are typical elements of natural ecosystems of the temperate zone of the Northern Hemisphere and are situated inside of a zone with intensive development of industry and agriculture. The network of nature reserves in Belarus is very diverse and corresponds to present requirements. The state's legislation strengthens and protects these territories. However, there are many difficulties in biodiversity preservation, which are accounted for by following reasons:

- Political instability in Belarus;
- Economical difficulties, which result in poor technical and financial resources dedicated to the nature reserves;
- Poor public information and educational programs on nature protection;
- Absence of developed ecological tourist network and services; and

- Absence of an ecologically minded culture, particularly in the citizens in the local nature reserves.

Only the solution of these problems will stimulate the preservation of natural biodiversity in Belarus.

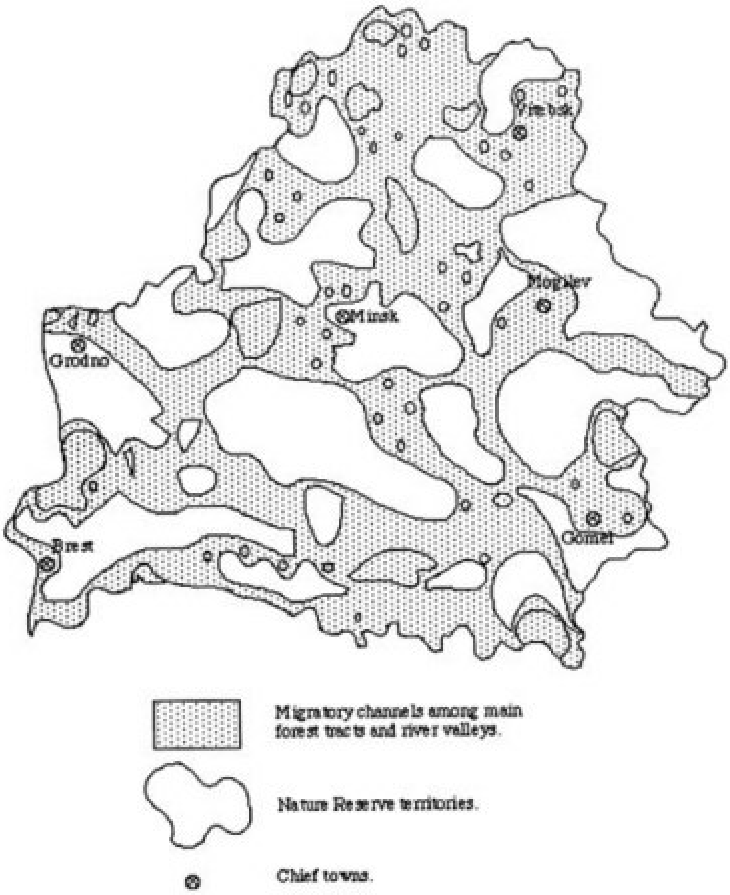


FIGURE 1 Approximate Network of Migratory Channels in Belarus

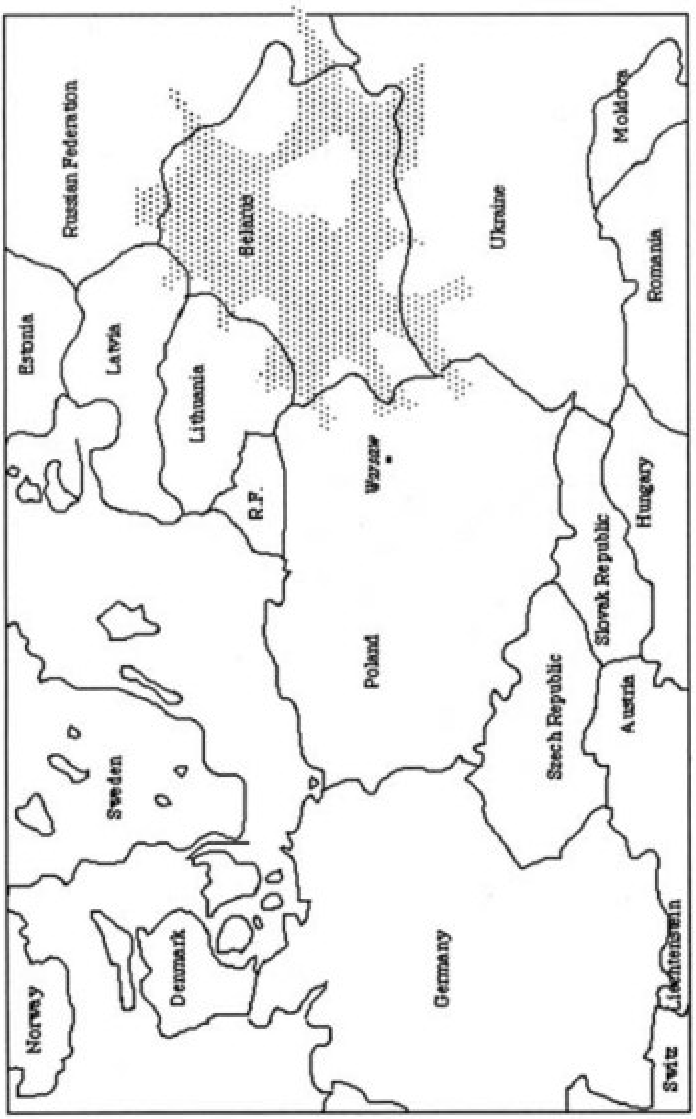


FIGURE 2 Location of "Would-Be" Migratory Channels Between Belarusand Adjacent Countries

BIODIVERSITY PROTECTION PROJECT FOR THE SLOVAK REPUBLIC

Zuzana Guziova and Peter Straka
Slovak Ministry of the Environment

WHAT IS BIODIVERSITY?

Biodiversity is the variability of all forms of life on Earth at the ecosystem, species, and intra-species levels. The term became frequently used in connection with preparations for the United Nations Conference on the Environment and Development in Rio de Janeiro. Biodiversity protection involves a set of activities oriented towards the preservation life on Earth in all its forms. It is not the "classic" nature protection oriented only towards free-living animals, wild plants, and communities in which the above species occur, for it is also concerned with so-called economic species and their breeds or cultivars, as well as micro-organisms.

Today, as we approach the 21st century, biodiversity protection is understood to be one of the key topics of environmental protection. This is also illustrated by the fact that this subject is addressed in the special Convention on Biological Diversity presented for signing at the aforementioned Rio conference.

GLOBAL ENVIRONMENT FACILITY (GEF)

Biodiversity protection is one of the four areas of interest of the so-called Global Environment Facility, an international program announced at the beginning of the 1990s with a view to financing and providing expert support to "developing" countries seeking to resolve global environmental problems. Besides biodiversity protection, the GEF is concerned with protecting the ozone layer, protecting international waters, and global warming. The Global Environment Trust Fund, also known as the Core Fund, is the part of GEF which awards grants, mainly to governments, for the implementation of national projects addressing the four aforementioned topics. The funds are administered by the International Bank for Reconstruction and Development (The World Bank).

The GEF and Slovakia

Slovakia became a GEF beneficiary country in autumn 1993. An agreement concerning a Global Environment Trust Fund grant was signed in Washington, D.C. on September 16, 1993, by the World Bank and the Slovak Republic as represented by the Ministry of the Environment. The $2.3 million grant is designated for the Biodiversity Protection Project, one of five similar projects operating in Central and Eastern Europe (the others are in Poland, the Czech Republic, Belarus, and Ukraine).

The agreement came into force on October 20, 1993, after the Ministry of the Environment established a GEF Biodiversity Protection Office to administer the project, in accordance with the requirements of the agreement.

The Goals and Orientation of the Project

The goals of the project are to strengthen biodiversity protection in Slovakia and support international cooperation in the area. At the center of the project are activities which are innovative in Slovakia with regard to environmental protection practices and which will have a long-term impact if successful. A further important aspect of the project is institution building in the form of improved technical equipment and communications possibilities in selected nature protection institutions, as well as professional and language training for their employees.

The Implementation of the Project

The project is divided thematically into three relatively independent programs (biodiversity protection, institutional support, and conservation), which are to be put into practice through projects concerned with applied research, studies, strategies, practical protection, and the purchase of technical equipment. The implementation teams of these projects and the suppliers of equipment and devices are chosen on the basis of bids, the character of which is determined by the type of project and/or supply involved. The topics of the projects are bound by the above-mentioned international agreement, as are their budgets.

The project is focused on three protected areas in Slovakia: Tatra National Park (Tatransky narodny park - TANAP), the Protected Landscape Area (Chranena krajinna oblast - CHKO) of the East Carpathians, and the Protected Landscape Area (Chranena krajinna oblast - CHKO) of Zahorie, the floodplain area of the Morava River. The common feature of all these areas is that they are situated on frontiers and are included among the "Ecological Bricks of our Common European Home." Besides their protection category under Law No. 1/1995 of the Code of Law on State Nature Protection, they also have international statutory protection. The TANAP and part of the East Carpathians CHKO are Biosphere Reserves within the framework of the UNESCO Man and Biosphere Program, while the inundation area of the Morava River is a wetland of international importance monitored under the Ramsar Convention on Wetlands of International Importance as Waterfowl Habitats.

THE BIODIVERSITY PROTECTION PROGRAM

This program supports various kinds of activities which are important for protection in-situ and ex-situ from the planning stage through implementation. A management plan will be elaborated for the East Carpathians CHKO, which will also contain a design for an efficient management model for this territory from the standpoint of biodiversity protection. The elaboration of a Conservation Strategy for the International Biosphere Reserve of the Eastern Carpathians will also be an element of the planning activities and will set out the main goals and principles for the protection of this area of international importance. Besides planning, practical problems of managing key ecosystems will also be addressed and resolved. Particular emphasis will be placed on forests, meadows, and above all alpine meadows. The question of preventing erosion is of key importance in biodiversity protection in the East Carpathians because of the area's flysch geological basement. As a consequence, some project activities will be directed towards reconstructing tree stands on slopes and technical steps to slow outlets.

Carrying Capacity

Addressing this task involves preparing the methodology and verification procedures through a convenient demonstration project, as well as designing the management, legal, and economic tools needed to regulate the number of visitors to an acceptable level.

Establishing the Foundation for the Protection of Diversity in the East Carpathians

The beginning of the 1990s saw the resumption of cooperation along the Slovak-Polish-Ukrainian border. In accordance with an Agreement on cooperation signed by the ministers responsible for nature protection, proposals were signed to link the above frontier territories to form Biosphere Reserves. In 1992, the International Coordination Council of the Man and Biosphere Program approved the proposals, and an international Biosphere Reserve was created. The establishment of the foundation will create conditions for bringing together the financial means to promote activities directed towards biodiversity protection in the East Carpathians. The foundation will be registered in Switzerland and governed by a 14-member Board of Trustees. The initial capital of the foundation will be provided by a contribution from the John D. and Catherine T. MacArthur Foundation and a contribution from the GEF.

INSTITUTIONAL SUPPORT PROGRAM

The institutional support program aims to improve the situation regarding technical equipment and communications for the administrations of the protected areas lying at the heart of the project. The administrations will be equipped with high-performance computers, which will enable them to elaborate a territorial information system (GIS) based on the Arc/Info systems, which will be an aid to daily management, modeling, and planning. Local communications between field staff and the administrations will be facilitated by providing radio-communications systems. The connection of the administrations to the SANET (INTERNET) system provides more efficient communications with the GEF Biodiversity Protection Office and above all ensures direct communications between administration staff and foreign scientific institutions, universities, and partner protection organizations. This connections also allows on-line databases to be accessed.

The programs also include improving the professional skills of state nature protection staff through participation in courses and visits at home and abroad and through support for foreign language study.

Within the framework of this program, a field station will be built at Nova Sedlica for the CHKO East Carpathians. This station will also serve as a tourist information center.

A special part of the institutional support program, and of the project as a whole, is the Small Grants Program for non-governmental nature conservation organizations in Slovakia. From the standpoint of the utilization of financial resources, this is the only part of the project that is "open" in the sense of not being limited territorially.

The program in TANAP will concentrate on improving conditions for collecting and preserving seed and seedling material from forest species by purchasing a drier for seed extraction from cones, cooling boxes for storing seeds, and air-conditioning for greenhouses. Research and monitoring capacities are also included in the project, including telemetric monitoring of critically endangered species, mapping and monitoring of the karst environment, and monitoring of the occurrence and deposition of heavy metals in animal tissues (by analysis of feathers and bones).

The goal in the inundation area of the Morava River will be to renaturalize selected side branches of the river and to draw up regulations for the appropriate management of the alluvial forests in the area. This will include the conversion of poplar monocultures into stands with a species composition corresponding to local conditions. Forest regeneration will be the key question to address.

The mapping of biotopes will be carried out concurrently. Methods and intensities of meadow management will be determined, and work will be done to transform arable land into meadows corresponding to site conditions. The only acceptable methods will be those which are suitable for the protection of meadow biodiversity and which also take into account the need to protect nesting birds.

European pond terrapins (*Emys orbicularis*) taken from a population living in northern Hungary will be bred and reintroduced within the framework of the program on ex-situ protection.

Attention will also be paid to restoring functions in selected water corridors.

THE CONSERVATION PROGRAM

Sustainable Development Strategies

A development strategy will be elaborated for each area involved in the project. The strategies will be oriented not only towards the protected areas themselves, but also towards their "zones of influence," i.e., areas connected with the Park or Protected Landscape Area (CHKO) on the basis of economic or other activities and ecological relations. Essential in the preparation of strategies will be an evaluation of current influences (including economic influences) on the use of the area, as well as an assessment of influences on regional biodiversity protection and on the local inhabitants. The next step will be to identify alternative uses of the area and evaluate their long-term economic and ecological effects. A change of heart among local communities regarding the value of regional biodiversity (or at least the beginning of such a change) can only be achieved by involving the public in the process. This should contribute to an improved understanding of the importance of biodiversity and the advantages of alternative ways of using it.

The Carrying Capacity

A very important task in planning and management is to determine the carrying capacity of an area, i.e., the acceptable number of visitors to protected areas or parts of them from the standpoint of the ecological impact, protection of local culture, and protection of the tourist him/herself.

The Small Grants Program

The small grants program is designed to catalyze and promote activities among non-governmental organizations oriented towards nature protection, alternative and traditional relations between man and society and nature, the sustainable utilization of natural resources, and the prevention of damage to elements of nature. The small grants (up to a maximum of $7,000) will be awarded by the Small Grants Board on the basis of their evaluation of proposals submitted. Besides the topical orientation of the project, the evaluation will also consider the degree of innovation in the approach taken to solve the problem, the territorial importance of the topic, and the level of public participation. The organizational capabilities of the NGO in relation to the project submitted represent a further important criterion. Preference is given to practically-oriented projects which involve significant public participation, which help to raise awareness of the need for and means of biodiversity protection, and which ensure sustainable development. The duration of a grant-supported project may not exceed 12 months.

THE FUTURE

The current Biodiversity Protection Project is being conducted within the so-called "pilot phase" of the GEF. It should therefore terminate in June 1996. The GEF enters its second phase in autumn 1996, if the Core Fund is replenished. The second phase of the GEF will be even more closely connected with the subsequent process of the UN Conference on the Environment and Development. In the area of biodiversity protection, it will be oriented towards supporting countries in meeting their obligations under the Convention on biodiversity and above all in preparing their national biodiversity protection strategies. We believe that Slovakia will be successful in its application for a grant in this phase as well. Nevertheless, winning the grant is not in itself the goal. Rather, the primary goal is (and always will be) to contribute to the protection and preservation one of the Slovakia's greatest treasures—its nature.

PRESERVATION OF BIOLOGICAL DIVERSITY IN TRANSBOUNDARY PROTECTED AREAS OF BELARUS AND POLAND

Victor Parfenov
Institute of Experimental Botany
Belarusian Academy of Sciences
Michael Pikulik
Institute of Zoology
Belarusian Academy of Sciences

INTRODUCTION

Belovezhskaya Pushcha, with its centuries of complicated history, will be of the greatest concern here. Whatever that history may be from the standpoint of politics, Belovezhskaya Pushcha can be regarded as an element which has united the intention of people not only to use natural resources, but also to conserve them.

RETROSPECTIVE OF THE DEVELOPMENT OF BELOVEZHSKAYA PUSHCHA

Belovezhskaya Pushcha is a unique complex with protected forests and diverse plants and animals, and it is a source of national pride for both the Belarusian and Polish people. It has acquired world fame for the conservation of wild flora and fauna (primarily in large forest massifs), as well as for numerous studies conducted by many researchers from different countries to determine the ways in which natural ecosystems function. Knowledge of the relationships involved is of very great importance if the trends in human-induced transformations of landscapes are to be estimated. Belovezhskaya Pushcha has contributed much to the restoration of the European bison, a unique animal species in the area. It is one of the most representative protected areas with regard to the biological diversity of plants and animals in the forest zone of Europe. For this reason, a very careful and ecologically-justified approach to solving the problems of conservation in this unique natural complex is required.

Increasing importance is being attached to the use of Belovezhskaya Pushcha as a natural reference standard against which to assess rising human pressure on the natural environment as a result of industrial development, drainage activities, intensive farming, enhanced recreational pressure, transport, and other economic loads.

Belovezhskaya Pushcha was declared a national nature reserve as far back as 1939. However, the reserve was transformed into a State Hunting Reserve in 1957. As time has passed (and especially in recent decades), it has become clear that the status and activity of the hunting reserve is inconsistent with the main role of Belovezhskaya Pushcha as a model and reserve of nature and that substantial degradation of this natural complex has occurred as a result.

Contrary to scientific recommendations and the requirement of a hunting reserve project, the Belovezhskaya Pushcha area supports a high density of hooved game (wild boar, red and roe deer), which is maintained by supplementary feeding and which consequently depletes natural food sources, eliminates undergrowth, and changes the tree stand structure in a harmful way. As a result, natural regeneration has stopped, forests, rivers, plants, and animals are losing their model value, and the integrity and functioning of the natural ecosystems have been disturbed.

SCIENTIFIC PROBLEMS

Data from studies conducted by the Research Department of Belovezhskaya Pushcha since 1948 have emphasized that wild ungulates were the essential determinants of forest regeneration in Belovezhskaya Pushcha. In the period 1948 to 1950, the relatively low density of hooved animals (10 wild boar, 9 roe deer and 7 red deer per 1000 hectares) ensured that the composition of the natural undergrowth did not differ much from that of the maternal tree stand, while the incidences of damaged trees were just over 1% for pine and birch and 9% for hornbeam and oak trees, with almost no damage to spruce trees being noted. In contrast, the results obtained in the period 1972 to 1992, when ungulate density was substantially greater (24 red deer, 11 roe deer and 16 wild boars per 1000 hectares), indicated that even spruce trees were used by the animals for feed. Between 1% and 5% of the spruce trees 0.5 to 2.5 meters high were damaged, as were of 20-30% of the birch trees, 50-80% of the pine trees, and 60-90% of the oak and hornbeam trees. Similarly, while up to 5000 understory oak trees per hectare were recorded under the oak wood canopies in the 1950s, this count in 32 test plots fell to as little as 100 to 400 per hectare in 11 plots in the 1970s. About 60% of the trees were damaged by ungulates. Meanwhile, two experimental plots within a metal fence had oak regrowth with 15,000 to 20,000 trees per hectare.

The threat to bison populations posed by a high incidence of disease is another causes of great anxiety. A total of 27 bison died in the period 1982 to 1987, and 45 were culled. This figure includes 15 animals with eye disease and 21 with lesions of the external genitals. No careful investigations of the causes of the diseases have been made. There are cases of farm stock grazing and herding.

To the detriment of plant and animal biodiversity, the core was transferred in 1982 from the center of Pushcha to its periphery, located next to drained land. This relocation has decreased the scientific and practical value of the data on the state of natural complexes obtained under the Chronicle of Nature Program.

The uniqueness of Belovezhskaya Pushcha and the dangerous ecological situation faced by it led to discussions of the possibility of a more reasonable proportioning of the conservation and economic functions. Lengthy discussions included a proposal from leading Belarusian scientists that the State Hunting Reserve (SHR) be reorganized into a reserve enjoying the highest form of protection available in the former Soviet Union. In the end, however, the SHR was transformed into a State National Park (SNP), a designation which leaves all the problems of biodiversity conservation unresolved.

PROBLEMS OF OPTIMIZING THE PROTECTIVE REGIME IN BELOVEZHSKAYA PUSHCHA

Two sets of problems have to be addressed. On the one hand, it is necessary to heed the interests of residents, their traditional way of life, the potential for jobs, and the impossibility of relocating them beyond the protected area. On the other hand, there is an urgent need to preserve the natural state of the ecosystem. Such potentially conflicting interests force us to divide the area into several zones with different conservation regimes, in a manner that follows the principles set out for Biosphere Reserves.

Given the real situation and the necessity to give complete protection to the largest possible area, three zones have been identified within Belovezhskaya Pushcha State National Park: a core zone under absolute protection, a protected zone, and a buffer zone.

The area designated as the core (30% of the whole area) was identified on the basis of its having the highest diversity of natural complexes, the best-conserved primary forest, meadow, and water ecosystems, a diversity of forest types, aerial integrity, and sufficiently large size.

Areas with the farmsteads of residents and with land used traditionally in agriculture should be excluded from the core zone and placed within either the protected or buffer zones, depending on the intensity of their economic use. Any human intervention in the natural development and functioning of the biogeocenoses, except for arranging mineralized bands, firefighting activities, and research, is forbidden in the core zone.

The protected zone (about 60% of the total area) is the main part of the Reserve. Its regime is intermediate between that of the core and buffer zones. All activities carried out there are under the control of the Scientific Department and should be aimed solely at conserving disturbed natural complexes and increasing their stability, as well as restoring natural biogeocenoses. Activities in the protected zone are restricted to necessary, scientifically-justified human intervention in the ecosystems. All activities should promote the restoration of primary forest types and the maintenance of animal populations at levels corresponding to the natural forage base.

The buffer zone has areas with the traditional extensive cultivation of crops in the vicinity of settlements and areas with the farmsteads of local residents, as well as forestry, drained land, arable land, and grassland.

One important problem is controlling the numbers of hooved game animals. It may be solved by culling or catching ungulates. The personnel of the reserve have accumulated extensive experience in hunting, and there are enough specialists, tools, and equipment to allow for the shooting and catching of large numbers of animals. Efficient methods exist for the live catching of wild boar, red and roe deer, and bison. In the winter of 1987, for example, 500 wild boar and red deer were caught for slaughter outside the Reserve.

Heavy culling of wild boar and red deer is necessary, while less intensive efforts are required for roe deer and elk. To solve the general problem, in view of the biological characteristics of each type of ungulate (reproduction, horns, etc.), it is suggested that animals be culled by different methods and on different dates (for more detail refer to "Scientific Grounds of Controlling the Number of Wild Animals in Belovezhskaya Pushcha," approved by the Scientific Board of the Institute of Zoology, Academy of Sciences of Belarus).

Also recommended are activities for the conservation of bison, which derive from the Symposium on the Conservation of Bison in Belarus (1992). These recommendations can be presented briefly as follows:

- To develop a state "Program of Conservation, Dissipation, and Management of Bison Resources in Belarus," which, apart from practical recommendations, should set out scientific grounds for the strategy and tactics of resolving bison-related problems in the next 10 to 15 years;
- To expand the set of studies concerned with diseases of bison and the genetics of their population;
- To create an experimental basis for research into the diseases of bison and develop efficient methods for their prevention and treatment;
- To reduce the number of hooved game animals to the reasonable level recommended by the Institute of Zoology of the Academy of Sciences of Belarus; and
- To develop the practice of establishing free herds of bisons in Belarus.

In following the approved recommendations, it was necessary for the Ministry of Forestry of the Republic of Belarus to establish a free herd of bison in Volozhin District, and this was done in the spring of 1994. The Ministry should continue to establish new herds as suitable land is found. It should also develop principles for selective culling in free herds, including limited hunting. To keep numbers at the most reasonable levels, the Ministry should also entrust the Commission for Bison with the keeping of a Pedigree Book for the Beloveshzkii bison subspecies, in coordination with the International Pedigree Book of Bison in Warsaw.

THE SCIENTIFIC BASIS FOR ACTIVITIES AIMED AT CONSERVING BIODIVERSITY IN BELOVEZHSKAYA PUSHCHA

All activities aimed at conserving the biodiversity of Belovezhskaya Pushcha should have an adequate scientific basis. At present, a wide range of studies is in progress under a World Bank Project entitled "Conservation of Biodiversity of Forests in Belovezhskaya Pushcha."

Simultaneously, a program of ecological research into the ecology of the biome of Belovezhskaya Pushcha is being developed under a joint project of the Academy of Sciences of Belarus and the Polish Academy of Sciences. Late April 1994 saw a meeting of the working group in Kamenyuki to coordinate this program and submit it for approval by the presidiums of the academies of sciences of Belarus and Poland. The main objectives, which are very important for the development of effective recommendations for conserving the biodiversity of Belovezhskaya Pushcha, are developing a dynamic model of the functioning of the Belovezhskaya Pushcha biome, including estimations of: a) biotic and abiotic components of the environment and their roles in the forest landscape; b) natural and human-induced changes in the vegetation cover, fauna, and ecosystems; c) the functioning of ecosystem components (populations of model species and plant and animal groups); d) the ecological basis of economic activities in the protected areas; and e) the present state and future dynamics of biological and landscape diversity, as well as strategies for their conservation.

To increase the effectiveness of studies carried out to estimate the state and dynamics of the biodiversity of Belovezhskaya Pushcha, it would seem useful to arrange periodic publications of collected papers, especially joint works.

CONCLUSIONS

In achieving the general aim of conserving the biodiversity of Belovezhskaya Pushcha as a transboundary protected area, the following strategic problems can be distinguished:

- Interstate problems (the conservation and management of protected objects by the international community) should be resolved at the level of the governments of Belarus and Poland;
- National problems (the perfection of the management structure and the optimization of the status of protected areas) should be handled by each party given the general aim of conserving biodiversity in forest landscapes;

- Research-management and scientific problems (the development of joint research projects, the unification of research methodologies, and joint research which takes into consideration the characteristics of the Polish and Belarusian parts of Belovezhskaya Pushcha) should be resolved by cooperation between the national Academies and the Scientific Departments of the protected areas, with financial support from the states, academies, and international research foundations.

BIODIVERSITY PROTECTION IN COUNTRIES WITH ECONOMIES IN TRANSITION

Zuzanna Guziova
Slovak Ministry of the Environment

Everyone on earth understands the outstanding cultural value of Egypt's Pyramids, but only a small number of people understand that the same applies to natural ecosystems. Furthermore, man can survive if the Pyramids are destroyed, but the degradation of natural ecosystems would result in the extinction of mankind. Not understanding this could have tragic consequences if not changed by the world's people.

The environmental conservation movement has existed for years on both the national and international levels. The most recent high-level environmental summit, the United Nations Conference on the Environment and Development, fully reflected the complexity of the problems which development entails. Different interests of various groups were expressed during the meeting, ranging from a proclamatory approach on the needs of environmental conservation while maintaining harmful technologies and hesitant environmental policy to sincere expressions of interest in harmonizing development and conservation. The Earth Summit in Rio de Janeiro also brought into everyday use the new term "biodiversity," a topic which at the same time became the subject of one of the most important environmental conventions ever written, the Convention on Biological Diversity. There is no doubt as to the need for this Convention, but many questions have arisen regarding how to put its recommendations into practice.

Biodiversity is by no means evenly distributed over the planet. Certain areas are naturally far richer than others, and natural richness has also been influenced by many years of exploiting natural resources in each particular area. Nevertheless, more or less pristine areas are still found on each continent, and they are important sources not only for actual and potential use, but also for biodiversity itself. These last remnants of natural ecosystems serve as the Earth's "safety net."

The protection of outstanding natural areas and endangered plant and animal species is necessary, but protection alone is not enough. The Convention has made a step forward in dealing with the protection of all life forms, even those which have resulted from biotechnology. Such protection is organized differently from country to country, and very much depends on social and economic situations.

There is a formerly socialist group of countries in Central and Eastern Europe which are now known as countries with economies in transition. Decades of state ownership of land provided for the establishment of a relatively dense network of protected areas rich in endemic and relict species. The on-going transition of the economies within the region has given rise to specific problems to solve, particularly the privatization and re-privatization processes, which may involve dangers for biodiversity.

One of the legal successors of the former Czechoslovakia, the Slovak Republic, is a small Central European country with a forest cover of nearly 40% (of a total area of 49,035 square kilometers or 18,928 square miles). With more than 5 million inhabitants, it has a population density of 107 inhabitants per square kilometer.

Having 40 years of socialist history and associated economic problems, the country still has relatively well-preserved natural ecosystems, which is partially reflected in the fact that (as of January 1, 1993) areas protected by the national Nature Conservation Act (including their buffer zones) cover 27.03% of the country's territory. This is attributable to the long-lasting state nature conservation policy as well to relief/site conditions in the country. However, the changing ownership of land as a result of both privatization and re-privatization, combined with a lack of financial resources for environmental issues, now poses a great danger to the preserved natural ecosystems.

The aforementioned dense network of protected areas of various categories and types is one of the positive facts of history. On the other hand, this network has been established more on the basis of the knowledge and interests of individuals and interest groups than on complex analyses of valuable natural features and the need to protect them. This is a negative feature because the network is extensive and includes areas which do not require strong conservation control (and even areas with intensive economic activities). On the other hand, territories requiring intensive and strong protection lack not only human but also financial resources needed for effective protection.

Nature conservation was understood as the activity of a small group of people studying nature, taking care of outstanding natural phenomena, or completing endangered species lists. But this definition is too limited. Nature/biodiversity conservation can even play an important role in improving a country's economy if a reasonable balance between man and the environment is maintained.

Early in the 1990s, when ownership relations changed as a result of political changes throughout the region, this incorrect understanding of the role of nature/biodiversity protection within the national economy produced serious problems. A lack of economic analysis of the potential positive effects of nature conservation activities on the long-term prosperity of local areas or the country as a whole is combined with the effects of the interests of new or newly-restored landowners, who are mostly oriented towards economic figures and often lack even the most basic knowledge of ecosystem processes.

Thus, improving the population's understanding of biodiversity and the role of biodiversity protection in broader circumstances must be a substantial element of biodiversity conservation (and a precondition, if it is to be effective). It must be made clear that protecting biodiversity means more than just maintaining the existing number of species within the respective ecosystems. Such an approach would result in conservation of the present state. Actions must be taken to protect biodiversity on all its three levels—genetic, species, and ecosystem—in order to preserve the sustainable production capability of ecosystems, which is the support mechanism for all life forms, including humans.

On the policy level, biodiversity protection strategies should include the following:

- Canging economic criteria to reflect the effectiveness of the use of natural resources considering their regeneration capability;
- Analyzing the effectiveness of alternative land uses from the long-term perspective (this is extremely important, especially in this region and in a period when new owners are making decisions on the future use of their land);
- Determining the social and cultural value of species and ecosystems and including this information in economic analyses;
- Changing legal and economic tools to stimulate ecologically-sound ways of using natural resources;
- Promoting intensive biocentrically-oriented environmental education based on the idea that economic growth is part of a country's development and not its main goal;
- Changing the common view that conservation activities are of interest to a small group of strange people and promoting the understanding that conservation is a modern and interdisciplinary applied science comprising not only biological knowledge, but also economic analyses and ethical principles;
- Determining the carrying capacity of ecosystems, considering not only local site conditions, but also effects of global changes on carrying capacity;
- Considering aspects of consumption as an inseparable part of population growth and integrating this into development strategies/prognoses;
- Utilizing biodiversity prospecting, not only for consumption for commercial/industrial uses, but also in relation to its potential non-consumption use (the "soft" tourism industry); and
- Analyzing the financial flows resulting from natural resource use and allocating these equally between development and conservation purposes at the local, regional, and national levels.

The protection and sustainable use of biodiversity are new economic and ecological principles, principles which must become an inseparable part of policy at both the national and international levels. It must be the ethic of the third millennium.

III

BIOSPHERE RESERVES AND NATURAL CONDITIONS IN CENTRAL EUROPEAN BORDER REGIONS

BIALOWIEZA NATIONAL PARK AND BIOSPHERE RESERVES

Czeslaw Okolow
Bialowiewa National Park
Vjacheslav Vasilievich Semakov
State National Park Belovezhskaja

GENERAL DESCRIPTION

Bialowieza Primeval Forest today encompasses 150,000 hectares on both sides of the Polish and Belarusian border. The Polish (western) part covers 62,500 ha, and the Belarusian (eastern) part, 87,500 ha. Over the course of time, the Forest has developed mature stands of undisturbed origin, a unique phenomen in this European lowland zone of deciduous and mixed forests. These stands developed naturally, practically free of human influence. Local soil and climatic conditions have guided the development of the stands' multi-species and multi-aged structures. The stands also have characteristic spatial distribution and a zonal character of vegetation specific to the post-glacial plains of this part of Europe. These factors have ensured the "biodiversity" of the Forest. Following are some data on the biodiversity:

Flora:	Species	Fauna;	Species
Vascular plants	> 1000	Mammals	62
Bryophytes	> 250	Birds	237
Lichens	334	breeding permanently or irregularly	167
Fungi	> 3000	Reptiles	7
mushrooms	450	Amphibians	12
Myxomycetes	> 80	Fishes	24
Aerophytic algae	156	Insects	> 9000
		butterflies and lepidopterous	> 1050
		beetles	> 2000
		hymenopterous	> 3000
		dragonflies	23
		Snails and other gastropods	61
		Spiders	> 200

Because the knowledge of many systematic groups is far from satisfactory, the above data are changed annually based on the results of current investigations. It should be noted that many rare species of Poland and Belarus are found only in Bialowieza Primeval Forest. Just as there are rare or threatened species through the world which are relics of natural habitats, such is the case with primeval forests. One example of such a species is the largest mammal in Europe, the European bison. The ecology of Bialowieza Primeval Forest and the lack of natural ecological barriers or isolation have resulted to many endemic flora and fauna species. But the unusual biodiversity of this ecosystems is exemplified by the fact that over 100 species of cryptogamous plants and invertebrates were first discovered here. In the Polish part of Bialowieza Forest, 25 natural plant communities (16 forest and brushwood, 9 non-forest), 51 seminatural plant communities, and 30 synantropic communities are known.

The extent of the biodiversity in this unique forest ecosystem is still unknown. For example, a study of only one forest section (144 ha) noted nearly 2000 species of cryptogamous plants, and this investigation, due to a lack of taxonomists, was restricted to certain chosen groups. The forest community of Tilio-Carpinetum, in which 425 species of Chalcid-wasps were found, provides another example. The process of differentiation and diversification still continues. The long-term influence of special habitat conditions provide niche characteristics and local ecotypes consisting of several organisms, such as trees like the Norway spruce. Daily investigations of butterflies found local races or subspecies characterized with larger size and darker colorations than those in populations outside forest.

STATE OF PRESERVATION AND MANAGEMENT OF ECOSYSTEMS

Polish Part

The Bialowieza National Park, the oldest national park in Poland, was created in 1921 and encompasses 5,446 ha. The main focus of the park is the Strict Nature Preserve, which comprises 4,747 ha. Other components of the national park are the Palace Park (49 ha), the European Bison Breeding Centre (276 ha), and the buffer zone between the Strict Preserve and the surrounding farmland. However, even the largest portion of the park is not big enough to safeguard all the types of flora, fauna, and vegetation indigenous the Polish part of the forest. The Strict Nature Preserve does not, for example, contain a number of the forest communities common to the western part of the forest such as the cowberry pine forest (Vaccinio vitisideae Pinetum). Similarly, it has not been possible to reserve the necessary habitat for large predators. According to a recent study, an adult male lynx in the Bialowieza Forest inhabits a range between 10,000 and 20,000 ha.

In the managed part (54,255 ha) of the forest, which occupies the remainder of the Polish part of the forest, there are 13 complementary nature reserves covering

2,364 ha, including a Permanent soil Plot (485 ha) (Fig. 1). There are also over 800 individual trees, mainly oaks, which are protected as monuments of nature. Seed stands are another form of protection. However, forests designated for recreation did not guarantee the necessary ecological protection. In the managed forest surrounding the national park, changes are taking place at an increasing rate. A water storage reservoir built at Narew river on the northern edge of the forest (3200 ha) threatens the national park. Another serious threat is air pollution, which not only comes from distant sources, but also from nearby heating installations which use low quality black coal and which are located sometimes less than 1 km from the Strict Nature Preservation.

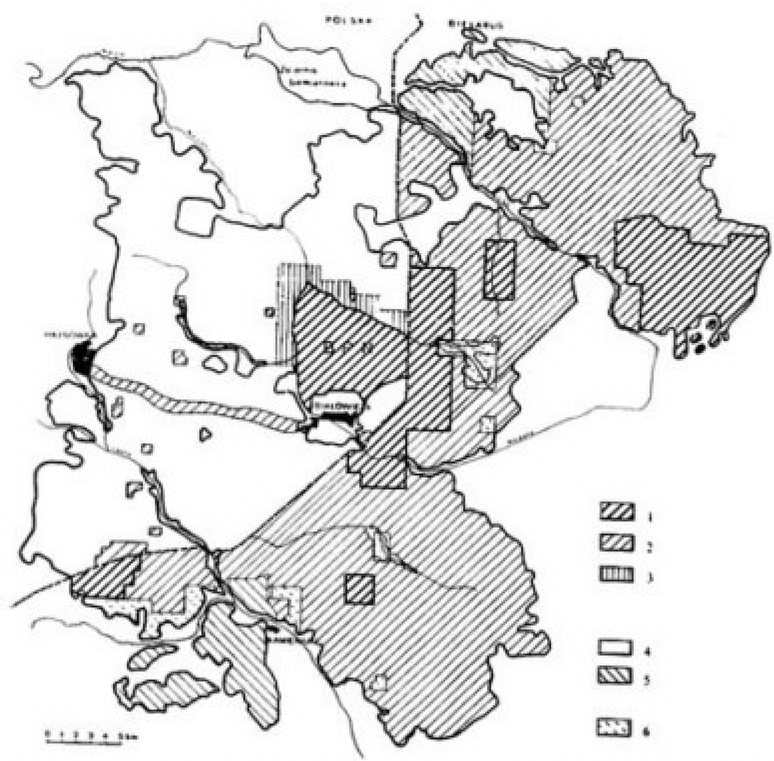


FIGURE 1 Bialowieza Primeval Forest. Categories of Protection and Land Use: 1. Strict Preserve, 2. Partial Preserve, 3. Buffer Zone of Strict Preserve of BNP, 4. Managed Forests, 5. Intensive Tourism and Recreation, 6. Traditional Farmland and Cattle Breeding

Since 1977, Bialowieza National Park has been designated as a biosphere reserve. However, it contains only the core zone without other zones with different levels of protection and human activity. In 1979 it was designated as the only natural World Heritage Site in Poland.

Belarussian Part

In the eastern part of the Bialowieza Forest, a "zapovedenik" (the Strict Nature Preseve) was established after the war. Later, in 1957, a hunting and nature protection unit was set up to serve primarily as a hunting ground for officials. In 1991 it was designated a national park. The park consists of 87,500 ha, of which 15,600 ha are under strict protection, 57,000 ha are partially protected, and 11,300 ha are designated for public tourism and recreation. There is also a zone of traditional farmland and cattle breeding (3,900 ha). A buffer zone of 82,000 ha surrounds the park.

Today, the National Park "Belovezhskaja Pushha" is the only one in the Belarussian forest complex with mature stands (52 percent of the stands are over 100 years old). There are 48 species of plants listed in the *Red Data Book* (25 percent) and 82 species of animals. The only natural population of silver fir in Belarus is in this Forest, along with the largest herd of free-roaming European bison. In December, 1992, part of the park was joined with the World Heritage Site in Poland to create a unique international European environmental site. In 1993, UNESCO designated it a biosphere reserve. In a survey of the threats to the Belarussian biodiversity, it is necessary to mention the density of the red deer population. These and other game animals have had a negative influence on the structure of the stand. In addition, a 2-meter high fence along the national border serves as an artificial barrier for most of these animals as well as for the European bison.

SCIENTIFIC RESEARCH

The following factors cause Bialowieza Primeval Forest to be a special research:

- The exceptional natural state of the ecosystems, which have been altered only minimally by human activity;
- The strict protection of large areas (especially in Bialowieza National Park), which allow the possibility to conduct long-term investigations on permanent study plots;
- The presence in this Forest of complex zones which have varying levels of protection and human activity. Such zones include strict reservations, partial reservations, managed forests, forests designated for public tourism and recreation, and traditional farmland;

- The biodiversity and genetic materials as well as numerous rare and endangered species of plants, fungi, and animals which are often relics of primeval forests;
- The exceptional biogeographical setting within the natural distribution range of numerous species of plants, animals, and types of vegetation; and
- The existing wealth of printed materials and documentation of the various studies conducted over almost a century.

Publications on Bialowieza Primeval Forest include the four volumes of "Bibliography of Bialowieza Forest" (Karpinski J. J., Okolow C. 1967, Okolow C. 1976, 1983, 1991); the fifth volume of this bibliography is now at press. There is also an bibliography of the Belarusian part of the Forest (Koval'kov M. P. et all 1985). There are over 3,900 publications which present the results of various original investigations conducted in Bialowieza Forest. (Over 1,600 include the Bialowieza National Park).

Polish Part

Thanks to the creation of Bialowieza National Park in 1921, today there are five scientific institutions in surrounding villages: the Department of Natural Forests, the Forestry Research Institute, Bialowieza Geobotanical Station of Warsaw University, the Mammals Research Institute of the Polish Academy of Science, the Laboratory of Plant Population Demography of the Polish Academy of Science's Institute of Botany, and the Workshop of Ecology and Protection of Natural Habitats. Bialowieza National Park also has its own small research unit. In addition to the local research organizations, scientific institutes from all over the country carry out projects at the National Park. The Scientific Council of Bialowieza National Park (an advisory body for park authorities) coordinates all investigations in the park. Changes in stands free from human impact are investigated at numerous long-term research sites, the oldest of which date from 1936. Editors of scientific papers such as "Acta Theriologica", "Phytocoenosis", and "Parki Narodowe i Rezerwaty Przyrody" (National Parks and Nature Reserves) are in Bialowieza, where the results of the studies are published. Such papers are also presented during numerous seminars carried out in the park. Finally, Bialowieza National Park is the editor of European Bison Pedigree Book.

Belarussian Part

The national park "Belovezhskaja Pushha" has its own research division which conducts research on topics such as climatology, flora, vegetation, and zoology, with special attention to select groups of insects, birds, mammals and European bison. Investigations of the forest structure are carried out at permanent research sites, the oldest of which have existed for nearly 50 years. Until now, external scientific institutes were not engaged in research in the National Park. However, interest in this unique research environment is growing, and if more funding becomes available, the number of institutes conducting research in the park will be increase.

All investigations are accomplished under the coordination of the Scientific Council. In addition to the different research projects conducted in the park, the annual "Nature Chronicle" contains numerous systematic data concerning the course of phenology and other natural phenomena such as numbers of game and predatory animals or oak acorn crops. Employees of the national park participate in conferences and seminars where they present investigation results. The national park "Belovezhskaja Pushha" publishes its own periodical paper. Between 1958 and 1976, it issued a periodical called "Belovezhskaja PushhaIssle dovanija," which, since 1977, has been published under the name "Zapovedniki Belorussii Issledovanija." Its contents include materials from all protected territories in Belarus.

TRANSBOUNDARY COOPERATION

The oldest area of cooperation is associated with the breeding of European bison. In 1961, the first Polish-Soviet conference on this subject took place, with subsequent conferences in 1963, 1967, and 1971. Irregular meetings have also been held without closer practical cooperation. Today, the situation is different. Directors of both national parks are officially members of the Scientific Councils of the park on either side of the border. Thanks to the support from GEF, a unified investigation was begun of air pollution and the impact of pollution on chosen indicator plants. Wide-ranging research on the genetics of native tree species was also begun, and the genetic bank was established. Traditionally, work has been coordinated on the ecology, biology, and physiology of the European bison. The year 1993 marked the beginning of the cooperative investigation using telemetry of the migration and range of wolves and lynxes. Signed in 1993, a protocol of cooperation for the park dictated that the park's employees can visit either part and participate in scientific conferences organized in Bialowieza or Kamieniuki. Employees can cross the state borders in the forest without an official border pass. Currently, the Academies of Sciences in both countries are trying to set up an international ecological institute located in Bialowieza Primeval Forest.

Management and protective measures on both side of the border must be coordinated in order to allow the development of cooperation in the field of protection and investigation in Bialowieza Forest. It is necessary to find uniform methods of scientific investigation which enable researchers to compare results obtained in both parts of the forest. It is especially important to prepare a unified classification of vegetation. Because both countries currently use completely different geobotanical methods, the results of the work (vegetation maps) cannot be compared. Another problem vital to practical cooperation is the communication between management authorities of both parks. (Today, the only fail-safe method of communication is telex. Other methods, for example, by telephone, take too much time and are not reliable.)

REFERENCES

Koval'kov M.P., Baljuk S.S., and Budnicheanko N.I. 1985 Bialowieza Primeval Forest. An Annotative Bibliography of Homeland Literature (1835-1983) ed. V.I. Parfenov, Minsk (Russian).

Karpinski J.J., Okolow C. 1967 Bibliography of the Bialowieza Forest (up to the end of 1966), Warsaw. (Polish with English and Russian summary).

Okolow C. 1976, 1983, 1991. Bibliography of the Bialowieza Forest. Bialowieza, Part II. 1967-1972, Part III. 1973 1980, Part IV. 1981 1985. (Polish with English and Russian summary).

THE TATRA NATIONAL PARK AND TRANSBOUNDARY BIOSPHERE RESERVE

Zbigniew Krzan

Tatra National Park

The 217 km^2 Tatra National Park (TNP), created in 1954, is now one of the largest of the 19 national parks in Poland. To the east, south, and west, TNP adjoins the Slovak Tatra Park, which is located across the border. The city of Zakopane and the Podhale region lie close to the northern park border. The lowest point of the park is 850 m above sea level, and the highest point, Mount Rysy, is 2,499 m above sea level.

The eastern part of the TPN, the "High Tatras," is predominantly composed of crystalline rocks (granite) and has a typical high-mountain glacial landscape with pointed peaks and a large number of lakes. The largest lake is Morskie Oko, which covers 35 ha, while Wielki Staw Polski is the deepest, with a depth to 79 m. The "Western Tatras" are mostly composed of limestones and dolomites and have typical karstic relief with underground streams and about 500 caves. The zonation of plant communities is clearly visible in TNP and is closely related to altitude. The lower slopes are dominated by mixed forests which are structurally and ecologically diverse. Tree species include beech, silver fir, spruce, sycamore and many other woody plants. In addition, the area has secondary spruce forests, artificial stands vulnerable to disease, infestations of insects, and other problems associated with monocultures. Growing higher up, from about 1,250 meters above sea level, are coniferous stands of spruce and arolla pine. Most of this upper forest is natural or seminatural. Above the timber line (at about 1,500 m above sea level), these forests gradually merge with a zone dominated by dwarf mountain pine. In turn, towards the tops of the ridges and peaks, the dwarf mountain pine is replaced by alpine grassland and arctic-alpine communities associated with bare rock and scree. The area has many plant and animal species, including Tatra or Carpathian endemics, glacial relicts, and many endangered or rare species.

The Tatra National Park is accessible for tourism, recreational skiing, and other sports. There is a well-developed and permanently-marked trail system for summer hiking, which has a total length of about 250 km and various levels of difficulty, ranging from typical walking paths to routes for experienced alpine climbers only. Park regulations permit tourists to walk on marked routes only, and a fee is collected for entering the park. The developed tourist infrastructure is present in the town of Zakopane and nearby villages. The mountains themselves have a system of hostels and lodges which are open year-round, while the Park borders have parking areas, viewpoints, and restaurants. Both a cable car and chair lifts to Kasprowy Wierch summit allow those with different levels of expertise to participate in recreational skiing. There is also well-developed infrastructure for competitive skiing just inside the border of the park, with ski jumps, slalom slopes, down-hill runs, and cross-country areas. There are also designated areas for mountain climbing, with training centers and camping sites at various elevations.

The Park has a visitor center and a program for ecological education. The center introduces visitors to the environment of the Tatras, the history of its protection, and current nature conservation problems through both permanent and temporary exhibitions, videos, and occasional lectures and slide presentations. The visitor center is surrounded by a garden which, by simulating the Tatra plant zones, allows educational activities to be organized for schoolchildren and interested groups of specialists. The guide center also provides information and sells publications concerning the mountain environment.

Acting through four main departments (Forest Management, the Research Station and Museum, Touristic and Nature Protection, and Administration), the National Park Authority works towards the elimination or reduction of human activities, such as tourism and air and water pollution, which are likely to cause conflict with nature conservation.

To achieve effective protection of TNP and its wildlife, it is essential that modern conservation legislation be in place. In 1991, a new state law on nature was passed which places the park management in a better position to negotiate with individuals and organizations concerned primarily with economic gain from activities in the park. The new law also enables TNP to exert influence over economic activities and development in areas next to the Park which could have an impact on the Park itself. In addition to effective legislation, a long-term management plan is needed which incorporates detailed plans for different habitats and threatened species or features. Plans for various aspects of management have already been drawn up, while others are still in preparation. To manage the National Park effectively, these different plans must be integrated in a single general strategy for the Park. Such a strategy, entitled a "Protection Plan for the Tatra National Park," is now in preparation.

Finally, the Polish and Slovak Tatra National Parks have been approved as an International Biosphere Reserve within UNESCO's MAB Program (figure 1). The idea of establishing a Biosphere Reserve in the Tatra Mountains originated in the 1980s in the National Park Councils of both the Polish and Slovak areas of the mountains. Groups of experts began to work on a concept for a future Biosphere Reserve covering both National Parks. Park areas which are most valuable and least transformed by man have been included in the core zone of the Reserve, while surrounding areas constitute a buffer zone. Zonation became the subject of numerous consultations and negotiations aimed at obtaining a single, dense core numerous consultations and negotiations aimed at obtaining a single, dense core representing all the ecosystems which are most valuable and most characteristic of the Tatra Mountains. The Biosphere Reserve also has a transitional and cultural zone which includes traditionally developed areas. The Tatras are known for an unusually colorful folklore which is still active. The folklore is unique to the four cultural regions surrounding the Tatra Mountains: Podhale, Spisz, Orawa, and Liptow.

The joint work has resulted in a designated Biosphere Reserve covering 145,600 hectares, of which about 20,000 hectares are in Poland. One third of the area is within the core zone. This is a homogenous area, with a similar history of exploration, protection, and development on both sides of the border. The bilateral MAB Biosphere Reserve is the reward of the nearly two centuries of the endeavors of generations of Poles and Slovaks to attain the most efficient protection of the exceptionally valuable features of these unique mountains.

The Biosphere Reserve concept not only incorporates enhanced protection for the most sensitive areas in Park (where human activity should be strictly limited), but also encourages the conservation of cultural landscapes and traditions, such as pastoralism and sustainable forestry. Biosphere Reserve status has not precluded tourism, sport and recreation, which in fact continue. The concept of the international Polish-Slovak Biosphere Reserve should help to ensure harmonious coexistence between the local community and the protected wildlife and wilderness quality of the Tatra Mountains, as well provide a good example of effective cooperation between Poland and Slovakia in the field of nature conservation.

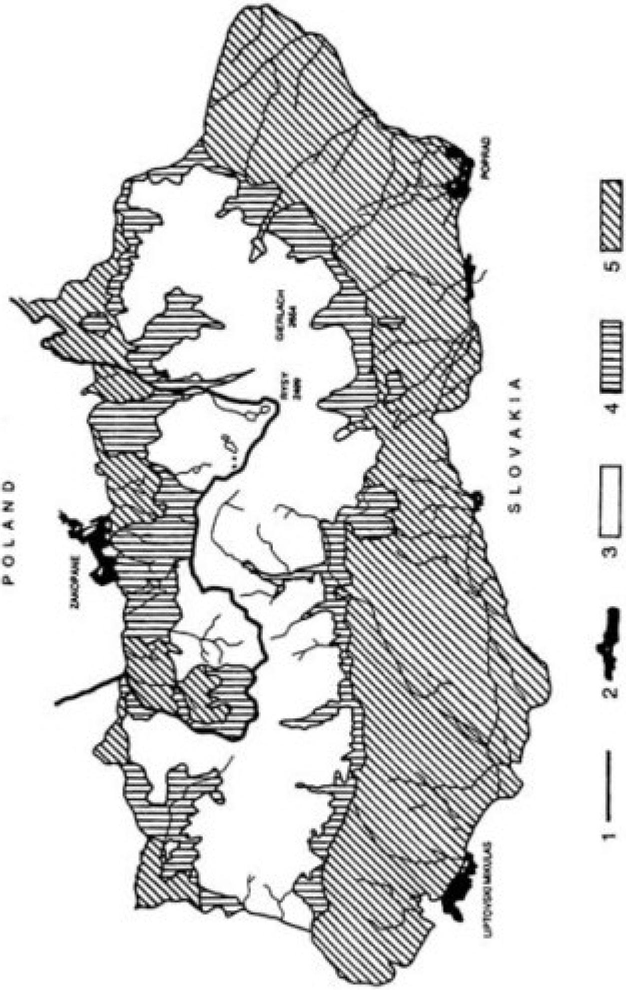


FIGURE 1 Zonation of the Tatra Transfrontier Biosphere Reserve:1) State Border, 2) Towns, 3)Core Zone, 4) Buffer Zones, 5) Transition Zone

PROBLEMS OF NATURAL DIVERSITY PROTECTION IN THE TATRA NATIONAL PARK AND BIOSPHERE RESERVE

Zbigniew Krzan, Pawel Skawinski, and Marek Kot
Tatra National Park and Biosphere Reserve

Like the rest of Poland, the Tatra Mountains lie in the temperate climatic zone. This means that forests constituted their natural primordial vegetation cover. However, the high-mountain character of the area has ensured that the Tatras have considerably greater natural diversity than other regions of the country. The geological structure, relief, climate, and water relations in this area have influenced the richness of a specific vegetation and fauna. The high natural diversity of the Tatras has been a product of both natural variation and changes brought about by centuries of human intervention with nature in the area.

NATURAL DIVERSITY

The current geological structure of the Tatras is the result of long-lasting development. Acid, decay-resistant metamorphic and crystalline rocks constitute the core of the mountains. On the north side, this crystalline core is overlain by folded sedimentary rocks from the Mesozoic Era. These strata are composed mainly of limestones, dolomites, sandstones, and shales, which create a mosaic of very varied lithology. This lithological diversity has found its reflection in the diversity of soils developed on the substratum of these rocks.

Residual fragments of Pliocene relief do remain in the Tatras, but the dominant relief was established in the Pliestocene as a result of the actions of glaciers. The lower sections of glaciated valleys were modified by fluvioglacial waters, while small unglaciated valleys were the result of the action of fluvial processes. Areas built from carbonate rocks exhibit karstic relief, with typical phenomena such as karstic springs, caves, and karst microrelief. This relief is currently being modified by contemporary morphogenetic processes (Kotarba, 1992) (Figure 1).

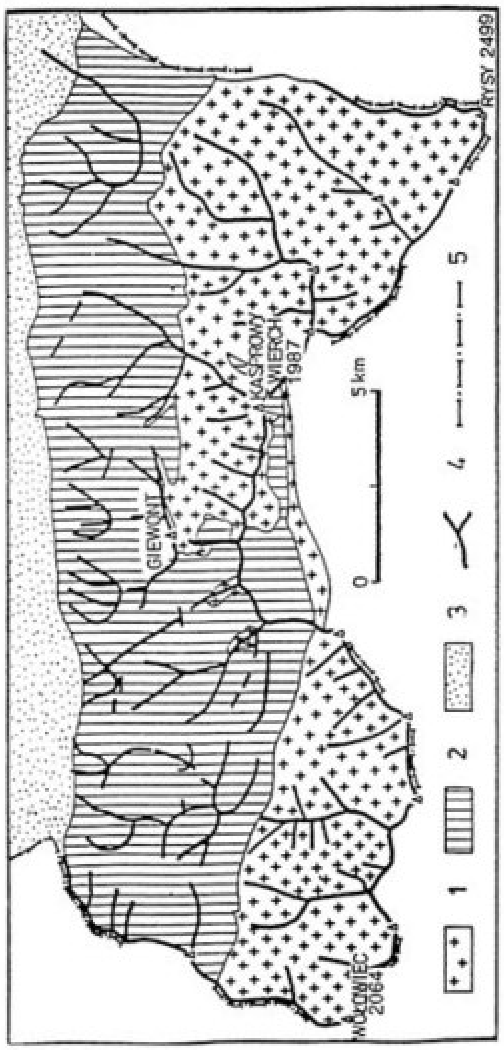


FIGURE 1 Geomorphological and Orographical Sketch of the PolishTatra Mountains: 1. Crystalline RocksPrevailing; 2. Sedimentary Rocks (mainly limestones) Prevailing;3. Flysch Rocks; 4. Ridges; 5. Borders ofthe Country (after M. Klimaszewski and L. Starkel, 1972)

The climate of the Tatras is the result of the situation of the latitudinal mountain chains within the Carpathian are of central Europe. The mountains are located in the transitional zone between two types of climate (the polar-marine and the continental), and this has favored the creation and maintenance of higher biodiversity. In turn, the significant elevation of the Tatras is an important factor which differentiates mean annual temperatures along an altitudinal gradient and which results in the separation of altitudinal climatic belts. The great variety of landscapes gives rise to varied mesoclimatic conditions and the wide and mosaic-like variation in microclimatic conditions which are of overriding importance for biodiversity (Niedzwiedz, 1992).

The Tatras are characterized by a diversity of hydrographic phenomena, including permanent and periodically flowing streams, springs, underground flows, ultraoligotrophic high mountain lakes, and a smaller number of dystrophic lakes. The waters of the Tatras show typical features of mountain areas, including low temperatures, streams with high levels of oxygen, and lakes that are nutrient-poor and icebound for long periods of time. Simultaneously, however, variable climatic conditions and quality of the substrate have given rise to the great natural variations in the conditions for aquatic organisms in the different basins. The lakes of the Tatras are mostly isolated from one another, and this is a factor explaining the occurrence in them of rare communities of aquatic organisms.

As a consequence of the diversity of the abiotic environment, the Tatras are also highly varied floristically and faunistically. Altitudinal zonation is the most characteristic feature of the vegetation (Figure 2). The lower parts have lower montane mixed forest with a significant degree of biodiversity. Beech, fir, spruce, sycamore, and other species of trees grow in such areas, as well as a rich understory. Also occurring in this zone are the secondary stands, monocultures of spruce which remain as a result of the past industrial exploitation of the forests. Higher up, above 1250 meters above sea level, is the spruce-dominated upper montane forest. Stone pipes sometimes also occur in this belt. The majority of these forests are of natural character.

A belt of dwarf mountain pine occurs above the timberline in the Tatras (at altitudes of around 1550 m a.s.l.). Extending above this is a zone of alpine grassland meadows, and farther above this, arctic-alpine communities associated with summital zone of bare rock and scree. Plants occurring in the Tatra National Park include those encountered in the lowlands as well as typically montane species adapted to life in the difficult climatic and soil conditions (Mirek & Piekos-Mirkowa, 1992).

Good conditions for a considerable number of animal species are created by the variations in vegetational environments and by the limited degree to which these have been degraded. Occurring here are animals once widespread throughout the country but later restricted by man to less accessible terrain. Examples of these are predators like bears, wolves, lynxes, and golden eagles, as well as numerous species restricted to high-mountain areas, of which the most notable are the chamois and the alpine marmot. The natural faunistic richness of the Tatras is exceptional by international standards (Glowacinski & Makomaska-Juchiewicz, 1992).

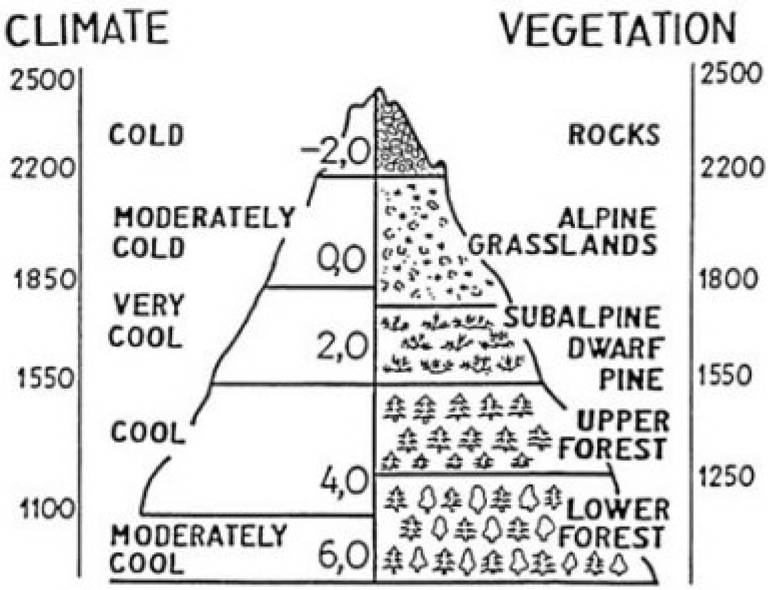


FIGURE 2 Zonality in the Tatras

SECONDARY DIFFERENTIATION

The natural diversity of the Tatras has undergone far-reaching modifications as a result of diverse human activities. Some of these have resulted in increased biodiversity, while others have impoverished nature in the Tatras in a significant way. While human management of the lands that are now Poland has been continuing for over 15,000 years, its influence in the Tatra Mountains was not clearly felt until the thirteenth century, when settlers bent on developing pastoral life appeared at the foot of the mountains. Settlement took place at least half a century after that in the Polish lowlands. Significant settlement and shepherding were only in evidence in the area from the sixteenth century onwards. However, grazing thereafter constituted the main form of economic utilization until as recently as 1960 to 1980, when gradual limitation occurred as a consequence of the purchase of the alpine meadows from private hands and the increasingly uneconomic nature of this type of management. Pastoral life in the Tatras is now carried on in a limited way as a cultural activity.

The most important effect of grazing on nature in the area was the felling and burning of forests to enlarge grazing areas. The grazing of sheep led to penetration of the Tatras from the piedmont (at 900 m) to the zone of mountain meadows at 2300 m. In woodland clearings, grass was fertilized naturally, cut, and taken down to the villages at the foot of the mountains, where it served as winter fodder. This activity lasted for several centuries and resulted in the creation in clearings of seminatural communities with light-demanding vegetation requiring a fertile substrate. Floristic and faunistic components entered the clearings from meadows, herb communities, light alder woods, and lichenaceous grasslands. It is probable that some components of the flora (for example, the crocus) were brought in by shepherds but are now totally adapted to life in the Tatras. This type of management undoubtedly led to the destruction of forest vegetation, but on the other had, it also had a colossal impact in enriching the floristic and faunistic biodiversity of the area. It is true that the natural timberline has been lowered along 70 percent of its length (in some places, even by 300 m) and that the area of the belt of dwarf mountain pine has been reduced by about 30 percent. However, it is also true that possibilities have a the same time been afforded for the development of floristically-rich grassland communities.

From the fifteenth century onwards, industry joined settlement and shepherding as one of the human activities in the Tatra Mountains. The area's forests were the raw material base for this expansion, which was to embrace mining, steel making, and the timber industry. The exploitation of trees was mainly concentrated in the more easily accessible, multi-species stands of the lower montane forest, where faster-growing spruce was increasingly introduced.

Industry in the mountains gradually ceased to be a viable economic proposition, and as the associated activities ended, the transformation of forests also ceased. Nevertheless, the effects of several centuries of industry can still be seen in the form of widespread deforestation and the considerable area of artificial monocultures of spruce which occupy rich mixed-forest habitats alien to them. The result of this has been the drastic impoverishment of the floristic and faunistic diversity of large areas of the Tatras, and, as a further consequence, the now clear sensitization of this impoverished lower montane forest to the action of destructive factors, especially the most dangerous, air pollution (Mirek, 1992). The issues presented here are only two of the many and are cited to illustrate the different effects of human activities on nature.

THE PROBLEMS OF PROTECTING BIODIVERSITY IN THE TATRAS

The first activity for the protection of biodiversity should be the definition of the scope and limits of the natural diversity which is to be subject to protection. Protection should not extend to everything which provides secondary enrichment of nature int he Tatras, but neither should all the artificially induced phenomena of elevated diversity be eliminated. The questions which arise are therefore which particular facets of diversity should be protected, and in which regions. Whatever the answers, they will always be arbitrary, but they should at least result from scientific analysis of the problems.

The clearings in the Tatras provide an excellent example. On one hand, they serve biodiversity in an outstanding way, but on the other, they are formations that have arisen artificially as a consequence of the past economic utilization of the mountains. Should they then be left to be eliminated naturally, or should they be protected via human intervention in natural processes? And if the choice is made to protect them, then what is the motive? Is it merely for biodiversification? Other protected areas are witnessing the elimination of so-called "weeds," exotic species of trees and shrubs, and of their animal equivalents introduced by man. This is done in spite of the fact that these weeds enrich biodiversity. Perhaps a reason for the protection of the clearings should be the fact that they were created a long time ago. In these circumstances, there arises a question as to the age limits for features of biodiversity that are to be protected. Is it to be 10, 100, or 300 years, and if one rather than another, then why? Finally, a reason for protecting the clearings might be their landscape and economic functions. But in this case, why not also extend and utilize them?

Sometimes the need to increase natural diversity in the Tatras does not create such controversies. An example here might be replacing artificial forestry monocultures with more natural mixed forest. It is, after all, clear that the latter will be more appropriate to the habitat, will show greater natural stability, and will in addition be more attractive in terms of landscape.

However, questions arise here, too, albeit ones of a technical nature concerning the way in which the reconstruction is to be achieved. Should the work involve the intensive forestry associated with the gathering of seeds and the cultivation, introduction, nursing, and protection of seedlings and saplings? Or should it happen via a longer route, leaving spontaneous natural processes to take their own course? In the latter case, it is necessary to be aware of the fact that the return to the natural state will take an unusually long time, will involve different successional stages, and will necessitate the protection of all natural factors and influences, including those destructive to the forest like windthrow, disease, and infestations of insects. So in this case, the area will need to be embraced by strict protection, with all the consequences that this has.

A PLAN OF PROTECTION

As in other protected areas, the protection of the natural diversity of the Tatrzanski National Park raises many questions and concerns and not-easily-resolved dilemmas: what to protect, why to protect, and how to protect? Such decisions, however well founded on solid scientific bases, will always be arbitrary in the end, and the goals should be made more precise in a protective plan. TNP is now preparing its own plan of this kind and will define therein the particular natural objects in the Park for which the main aim of protection will be to preserve natural diversity. For each of these objects, there must be a strictly defined and concrete aim for active protection, as well as definitions of the types and scope of the steps to be taken to achieve this aim. The introduction for realization of the plan of protection should be followed by active protective measures which must be subject to constant control in the form of monitoring observations. The plan itself must be modified continually in relation to the effects of the measures applied.

CONCLUSIONS

- The current natural differentiation of the Tatra Mountains is the result of natural biodiversity and human activities over long periods of time.
- The high natural biodiversity is an expression of the unusually complex geological structure, the varied relief, the specifics of the climate, the multiplicity of aquatic phenomena, and the richness of the vegetation cover and fauna.
- Human influences on nature in the Tatras have had various effects on biodiversity. Some, like shepherding, enriched the area's vegetation and fauna, while others (for example, industry) had a decisive effect in limiting the diversity of nature.
- The protection of the biodiversity of nature requires the making of arbitrary decisions to define the particular objects which should receive such protection, as well as precise definitions of the aims of protection and the ways in which this is to be realized.
- The active protection of biodiversity in the Tatras will be one of the basic elements of the plan for the protection of TPN. As they are implemented, the aims and principles outlined in this plan must be subject to continuous control in the form of an extensive system for the monitoring of nature. In the light of the effects of the actions outlined, the protective plan must then be subject to periodic updating and modification.

REFERENCES

Glowacinski, Z., Makomska-Juchiewicz, M., 1992, Fauna of the Tatra Mountains. Mountain Research and Development, 12(2), pp. 175-191

Kotarba, A., 1992, National Environment and Landform Dynamics of the Tatra Mountains. Mountain Research and Development, 12(2), pp. 105-129

Niedzwiedz, T., 1992, Climate of the Tatra Mountains. Mountain Research and Development, 12 (2), pp. 131-146

Mirek, Z., Piekos-Mirkowa, H., 1992, Flora and Vegetation of the Polish Tatra Mountains. Mountain Research and Development, 12(2), pp. 147-173

THE FUNCTIONING OF THE GEOECOLOGICAL SYSTEM OF THE TATRA MOUNTAINS

Adam Kotarba
Institute of Geography and Spatial Organization
Polish Academy of Sciences

The massif of the Tatra Mountains meets most of the conditions needed to qualify it as a high-mountain area. Therefore, it may be recognized as the only such area in Central Europe besides the Alps (Troll 1972). The high-mountain character of the natural environment of the Tatras is defined by the following: hypsometry (relative altitudes, and the length and inclination of slopes); geomorphology (classic glacial relief with the group of forms created by mountain glaciers); climate (altitudinal differentiation of climatic parameters); and flora (altitudinal zonation of the natural vegetation) (Fig. 1).

The Tatras differ from classic alpine ecosystems in the incomplete development of the nival altitudinal zone. However, a seminival zone representing a variety within the nival type does exist, and it occurs in mountains lacking the appropriate geomorphological conditions for the development of snowfields and glaciers (Hess 1965). The seminival or bare rock zone is peculiar to the Tatra Mountains, occurring in neither the highest glaciated mountains of Europe, nor the mountain massif elsewhere in the Carpathian-Balkan arc but lower than the Tatras (Pawlowska 1962). It is also difficult to separate the subnival altitudinal zone, which lies between the snowline and the alpine zone identified by the range of the more or less complete cover of soil and vegetation (the "high alpine zone" in the Alps.) From the geoecological point of view, the features characteristic of this zone are present in the Tatras in an altitudinal belt slightly above and slightly below the orographic boundary of the snowline, which occurs at an altitude of 2150 to 2300 m above sea level. This zone is characterized by the presence of frost debris and contemporarily-developing structural soils. Floristically, this corresponds to the zone of open pioneer vegetation.

The feature identifying the Tatras most closely with the Alps is a well-developed zone of alpine meadows. However, this zone does not occur immediately above the treeline, but rather is separated by the zone of dwarf mountain pine, which is again a feature unique to the Tatras.

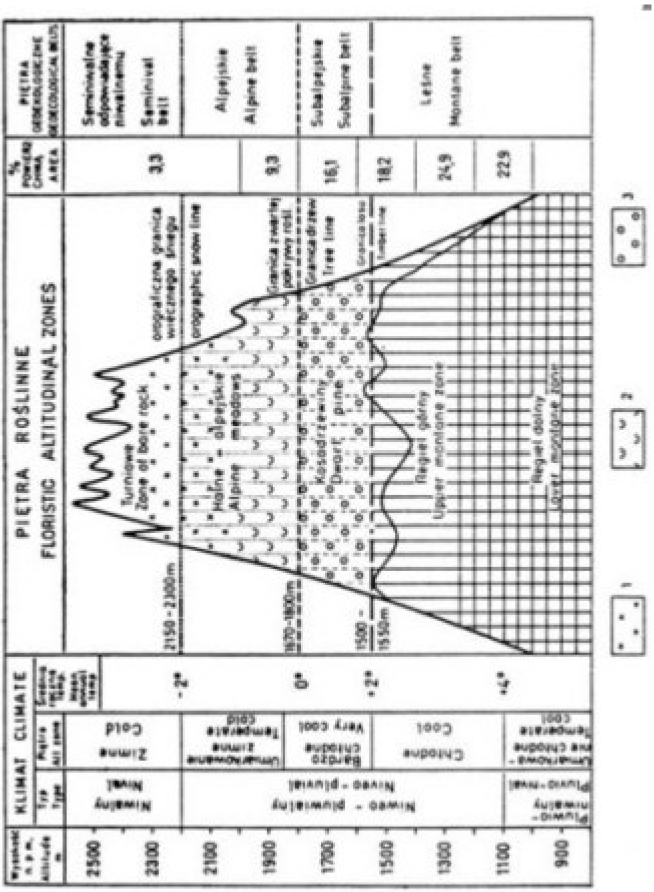


FIGURE 1 The Natural Environment of the Tatra Mountains

Although relatively small in comparison with Europe's other high mountains, the Tatra Massif nevertheless represents a significant climatic barrier to masses of air penetrating from the north. A consequential characteristic feature of these mountains is therefore the high annual, monthly, and daily rainfall totals (with the last particularly evident in summer). There is a considerable difference in the amounts of atmospheric precipitation reaching the northern and southern slopes of the Tatras. The maximum annual totals—on the order of 1600 to 1900 mm of precipitation per year—are noted on the slopes with a northern exposure and at altitudes of between 1400 and 2000 m above sea level. (Niedzwiedz 1992). The greatest daily fall of summer rain was 300 mm, noted at Hala Gasiennicowa in the High Tatras on June 30, 1973. However, daily falls exceed 200 mm about once in 50 years and reach or exceed 85 mm every two years at the altitude of the treeline (Cebulak 1983). The action on the substrate of elements of the climate (heat, precipitation, snow cover, and wind) leads to its destabilization and a reduction in its resistance to the destructive processes widely understood as erosional. Particular geoecological belts of the mountains differ in the geomorphic processes controlled by the climate, vegetation cover, geological and soil conditions, and in the ways in which they are affected by these conditions.

Consideration of the intensity, duration, and vertical differentiation of processes occurring in the Tatras allows one to determine whether the processes are altitude-related or not. Additionally, consideration of these factors permits recognition of processes of short duration and high intensity that create relief, as well as recognition of processes acting continuously but with moderate or weak intensity. Altitude-related processes limited to the geoecological zones above the timberline include frost creep, free and bound solifluction, a group of nivational processes, and deflational/aeolian processes. Processes not related to altitude, or those which may occur at all geoecological altitudinal belts of the Tatras, include physical weathering and rockfalls, chemical denudation, slope wash, and linear/fluvial erosion, soil creep, and talus creep.

The geomorphological activity of avalanches and debris flows is possible in two or three altitudinal zone, especially in those above the timberline. The range of influence of the high-mountain morphogenetic system is presented in Fig. 2. Detailed research into the course and intensity of contemporary geomorphic processes in the Tatras shows that the different geoecological zones are vulnerable to differing extents to their destructive or constructive action (Kotarba 1976). Geomorphic processes of high intensity create micro- and mesoforms within slopes and valley bottoms. Falls of debris, avalanches of snow and earth, and rockfalls transform scree slopes. These falls can create either erosional troughs, depressions, and niches, or they can create hummocks, levees, and accumulation tongues. These forms are created in the course of a few minutes and may change the relief of a slope so significantly that it may alter local topographic conditions.

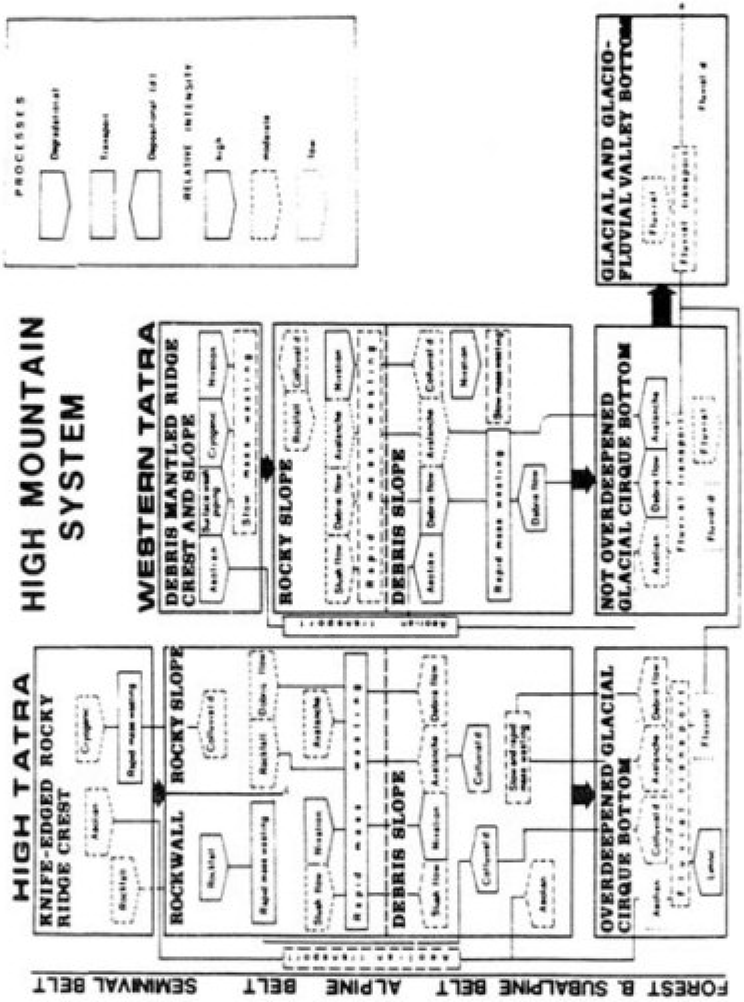

HIGH MOUNTAIN SYSTEM
HIGH TATRA
WESTERN TATRA
KNIFE-EDGED ROCKY RIDGE CREST
ROCKWALL
ROCKY SLOPE
DEBRIS SLOPE
OVERDEEPENED GLACIAL CIRQUE BOTTOM
DEBRIS MANTLED RIDGE CREST AND SLOPE
ROCKY SLOPE
DEBRIS SLOPE
NOT OVERDEEPENED GLACIAL CIRQUE BOTTOM
GLACIAL AND GLACIO-FLUVIAL VALLEY BOTTOM
SEMINIVAL BELT
ALPINE BELT
FOREST B. SUBALPINE BELT

FIGURE 2

The morphological consequences of the action of these fall processes remain visible to the naked eye for hundreds of years. Their ages may be defined with the aid of lichenometric dating (Kotarba 1989). Many of the forms created by these high-energy processes originated in the period of the Little Ice Age, especially during its decline in the first half of the 19th century, when a clear deterioration in the climate was observed generally around the world. At this time in the Alps and other glaciated mountains of the world, the largest advances of glaciers in the last 10,000 years were observed. In the Tatras, however, the effects were restricted to intensified alluviation of the high-mountain slopes, which manifested itself through frequent and high-energy geomorphic processes of the debris-flow, avalanche, and rockfall types. Processes of these kinds have been clearly limited for much of the 20th century. However, a tendency towards the renewed enhancement of the alluviation of debris slopes has been noticed in the last 15 to 20 years (Kotarba & Stromguist 1984; Kotarba 1989).

Table 1 presents the main processes leading to the transformation of Tatra debris slopes in the different climatic and altitudinal zones. An index of the activeness of processes, based on long-term measurements of their intensity, shows clear vertical differentiation. The highest values are attained in the section between 1550 and 1850 m above sea level, which is in the very cool climatic zone and which coincides with the cover of dwarf mountain pine. Similar, but somewhat lower, values were calculated for the zone at an altitude between 1850 and 2200 m above sea level in the cold zone with alpine meadows. This indicates that the area of the Tatras located directly above the timberline is particularly threatened by natural geomorphic processes which produce significant transformations in the geoecological system. Thus, it is especially important to realize that the earliest and clearest environmental impacts of changing global trends in climatic indices will be visible in borderline landscape/altitudinal zones, particularly in the timberline zone. The fact that intensified alluviation has been noted in the last 15 to 20 years in areas of the northern slopes of the Tatras above the timberline may thus be a signal that such changes are occurring in the mountains of the temperate zone (Kotarba & Stomguist 1984).

There are significant changes in the relief of the Tatras at altitudes between 1550 and 1850 m above sea level. In the Slovak part, the debris flow tracks are as long as 2 km (Nemook 1982). Janacik (1971) described a catastrophic debris flow which occurred in the Osobota Group of the Western Tatras in July 1970. This flow shifted a 21,675 m^3 mass of debris. According to Midriak (1984), the greatest volume of debris ever transported in Tatra debris flow tracks was 25,000 m^3. However, in the last decade, large debris flows have occurred with increasing frequency in an area above the timberline around the Research Station of the Institute of Geography and Spatial Organization of the Polish Academy of Sciences, which is located at Hala Gasienicowa in the High Tatra. Masses of debris of 5000 m^3 each were eroded and displaced along the routes of several debris flow tracks created during this period. These amounts are small in comparison with those in the Alps, where a single catastrophic debris flow may involve the

TABLE 1 Dominant Morphogenetic Processes on Basal Debris Slope Forms in the Polish Tatra Mountains

Present-day activity in vertical climate zones							
Principal factor	Principal transfer process	Principle slope form	temperate cool 900-1100	cool 11001550	very cool 1550-1850	temperate cold 1850-2200	cold 2200-2663
Gravity	falling, rolling, bouncing, sliding	rockfall talus	+	++	+++	+++	?
Snow	snow	avalanche talus	-	+	++	+++	++
	avalanching		-	-	no information	++	++
	slow-moving snow sliding on snow surface				++		
Snow and	slush	alluvial talus	-	-	++	+	-
water Snow	avalanching		+	+	++	+++	+
meltwater	ephemeral		+	+	+++	+	+
Rain storm	stream flow						
water	rainwash, debris flow						
Interstitial ice	internally induced mass movement of debris, creep	rock glaciers			-	-	
Freeze-thaw	creep frost	block slope	-	-	++	+	+
changes	creep, sliding	debros-mantled slope	+	++	+++	+++	++
		Activity index:	4	7	19	17	9

Process: - inactive, + weak, ++ strong, +++ very strong displacement of 500,000 m^3 of scree. Nevertheless, these phenomena play a very significant role in the small area of the Tatras.

These data indicate that the greatest threats to the geoecological system of the Tatras are posed to the interior of the mountains in the area above the treeline. The threats decrease towards the highest summits of the Tatras as well as towards the foot of the mountains. Increased anthropogenic pollution and the acidification of precipitation (Kot 1992) weaken the stability of Tatra ecosystems and may lead to faster degradation of the geoecological system in the near future.

REFERENCES

Cebulak E., 1983. Maximum Daily Rainfalls in the Tatra Mountains and Podhale Basin. Zesz. Nuk. UJ, Prace geogr. 57, 337-343.

Hess, M., 1965. Pietra Klimatyczne w Polskich Karpatach Zachodnich. Zesz. Nauk. UJ, Prace geogr. 11.267 p.

Janacik, P. 1971. Niektore poznatky z inventarizacneho vyskumu v chranenej krajinej oblasti Mala Fatra. Geogr. casop. 23: 2, 186-191.

Kot., M., 1992. Recent Changes of Surface Waters Chemistry in the Granitic Part of the Tatra National Park - Poland. Acid Rain Research report No. 19/1992. Norwegian Institute for Water Research NIVA, Oslo.

Kotarba A., 1976. Wspolczesne modelowanie weglanowych stokow wysokogorskich. Prace geogr. IGiPZ PAN, 120, 128 p.

Kotarba, A., 1989. On the Age of Debris Flows in the Tatra Mountains. Studia Geomorph. Carpatho-Balcanica 23, 139-152.

Kotarba A., Kaszowski L., Krzemien K., 1987. High-Mountain Denudational System of the Polish Tatra Mountains. Geogr. Studia Special Issue 3, Inst. Geogr. and Spatial Org. PAS, 106 p.

Kotarba A., Stromguist L., 1984. Transport, Sorting and Deposition Processes of Alpine Debris Slope Deposits in the Polish Tatra Mountains. Geogr. Annaler 66A, 4, 285-294.

Midriak R., 1984. Debris Flows and their Occurrence in the Czechoslovak Carpathians, Studia Geomorph. Carpatho-Balcanica 18, 135-149.

Nemcok A., 1982. Zosuvy v Slovenskych Karpatoch, VEDA, Bratislava.

Niedzwiedz T., 1992. Climate of the Tatra Mountains. Mountain Research and Development 12: 2, 131-146.

Pawlowska S., 1962. Plant World of the Tatras. Tatrzanski Park Narodowy, Krakow, 187-239. (in Polish).

Troll C., 1972. Geoecology and World-Wide Differentiation of High-Mountain Ecosystems. In: Geoecology of the High Mountain Regions of Eurasia. Proc. Symp. IGU Commission of High Altitude Geoecology, November 1969. Mainz. 1-16

VYCHODNE KARPATY/EAST CARPATHIAN BIOSPHERE RESERVE

Zuzana Guziova
Slovak Ministry of the Environment

INTRODUCTION

Situated in eastern Slovakia at the junction of the boundaries of Slovakia, Poland, and Ukraine, the Vychodne Karpaty/East Carpathians Biosphere Reserve is part of the tri-national Eastern Carpathians Biosphere Reserve. The area, being part of the Eastern Carpathians, coincides ecologically with the important transition between the Western and Eastern Carpathian ecosystems. This unique geographical position distinguishes the area in Slovakia, which is mostly within the Western Carpathian ecosystems.

Although the area only became a Biosphere Reserve (BR) in 1992, nature conservation dates back to 1906, when the Stuzica reserve was founded near the current border with Poland and Ukraine. Between that time and 1977, several other nature reserves were established, primarily to protect the well-preserved fragments of Eastern Carpathian virgin forests. More complete protection was granted to the area in 1977 when it became a Protected Landscape Area (PLA) of 96,910 ha under the national Nature Conservation Law.

The Biosphere Reserve coincides with the eastern part of the PLA and covers 40,601 ha. In accordance with the Biosphere Reserve concept, the area is further divided into three zones. Each zone falls under a different management regime that corresponds with the natural values of the zones. The core area, covering 2,643 ha, has seven separate parts which represent the best preserved natural ecosystems of beech and fir-and-beech forests, as well as of mountain meadows. The buffer zone of 14,373 ha comprises mostly forest land where stands generally have appropriate species composition, but where spatial and age structure reflect inappropriate management practices in the past. The second buffer zone of 23,585 ha is the largest zone. It differs from the others in having agricultural and forest land, which is used intensively, as well as permanently settled villages.

MANAGEMENT

The Biosphere Reserve is managed by the Administration of the Eastern Carpathians PLA, which is based in Humennne. Under the supervision of the Director, specialists coordinate the management of natural resources within the territory. They help prepare silvicultural and agricultural management plans for enterprises active in the territory of the reserve. The Administration also proposes new Nature Reserves, Protected Sites, and gene pool plots on the basis of scientific recommendations. For rare and endangered plant and animal species, the Administration prepares specific conservation strategies based on the knowledge of population biology. Conservation volunteers from several local NGOs assist the Administration with necessary conservation measures, such as mowing mountain meadows to minimize both direct and indirect risks to species and their biotopes.

The state environmental authorities have overall jurisdiction in the activities and management of the Eastern Carpathians PLA/BR. They verify and provide legal support for the scientific recommendations and proposals submitted by the Administration.

VALUABLE NATURAL FEATURES

The bedrock of the Eastern Carpathian BR is formed almost entirely from flysch rocks of the Dukla Unit of the Upper Cretaceous period and Palaeocene. Sandstone and shale create a complex of strata more than 5,000 m deep. Most of the slopes of the area are covered by deluvial clay and clay-sand loams and talus deposits.

The region has typical smooth flysch relief. The eastern part of the Reserve is in the Bukovske Vrchy Hills. The border ridge with Poland, the highest point of the Reserve, dominates the landscape at altitudes between 797 and 1,208 m. From the main east-west ridge, several smaller mountain ridges stretch southward (separated by the valleys of the Ruske, Runina, Nova Sedlica, and Ulic rivers). The lowest point of the Biosphere Reserve, at 200 m, is in the Ulic Valley, where the Ulicka Riverflows out of Slovakia. The western part of the BR is within the Laborecke Highlands at 600 to 800 m. Their relief reflects their relatively late development and the resistance and structure of their bedrock.

Cambisols and luvisols on flysch sandstone are dominant in the Eastern Carpathians BR. Below 700 m, they are base saturated, while at higher elevations, they are unsaturated and loamy to clay-loamy. Brown and illimeric soils prevail on the agricultural land at lower altitudes.

Since the flysch rocks weather rapidly, and erosion, especially by water, endangers the soils. The mean potential soil loss in the BR is 32.7 m^3 per hectare per year. Landslides are common, particularly on slopes with clay bedrock. The weathering products of flysh bedrock tend to swell in wet conditions and subsequently slide.

The Polish border ridge is the European watershed between the Baltic and Black Seas. The Slovak section of the Eastern Carpathians BR is drained by the fan-shaped Ulicka, Ublianka Zbojsky Potok, Cirocha, and Udava basins, whose streams feed into the Bodrog river. The region has very low accumulation capacity despite the abundance of woodland. The Starina reservoir was constructed on the Cirocha river in 1987 to accumulate and permit the use of surface waters. The reservoir has a volume of 60 mil m^3 and supplies drinking water to the largest towns of Eastern Slovakia.

The climate reflects the diversity of the relief. Three zones of the Slovak climatic classification can be recognized. The warm zone, with a mean annual temperature of 7 to 8 degrees celsius and mean annual precipitation of 800 mm, is found in the lowest parts of the Cirocha and Ublianka Valleys. The moderately warm zone extends from 400 to 800 m and has a mean annual temperature of 5 degrees celsius and a mean annual precipitation of 900 mm. The highest parts of the region are in the cold zone and have a mean annual temperature of 4 to 5 degrees celsius and a mean annual precipitation above 1000 mm. Highest temperatures usually occur in July, when the maximum mean temperatures range from 20.2 to 24.2 degrees celsius. The coldest month is January, when minimum temperatures fall between -8.6 and -8.2 degrees celsius.

The flora of the Eastern Carpathians Biosphere Reserve is species-rich and biogeographically outstanding. The Bukovske Vrchy Hills form the botanical frontier between the Eastern and Western Carpathians; several Eastern Carpathian endemics reach their western limits in the BR. Other species such as the flax (*Linum trigynum*) and traveller's joy (*Clematis vitalba*) reach their northern limits here. Other notable species are medium nipplewort (*Lapsana intermedia*) and *Hacquetia epipactis* from the northwest. A detailed inventory of vascular plants has identified over 1,000 species in the Slovak section of the Biosphere Reserve. The known occurrence of 800 species of fungi, more than 300 bryophytes, and more than 100 lichens further illustrates the floristic wealth of the reserve.

Forests are the most common type of vegetation, covering almost 80 percent of the area. The meaning of the name Bukovske Vrchy—the Beech Hills —reflects the dominance of the beech (*Fagus sylvatica*) within the stands. Other species enrich the composition of the Biosphere Reserve forests based on their ecological tolerance of soil and weather conditions. Accordingly, the lowest parts of the reserve include oaks (*Quercus robur, Quercus petraea*) and hornbeam (*Carpinus betulus*) along with limes (*Tilia platyphylla, T. cordata*) and maples (*Acer platanoides* and *A. campestre.*) Fir (*Abies alba*) occurs in higher and wetter locations. Valuable deciduous trees, such as Scotch elm (*Ulmus montana*), ash (*Fraxinus excelsior*) and sycamore (*Acer pseudoplatanus*), grow in sites with more humus on talus. Maple-beech forests at the highest elevations (between 1,000 and 1,190 m) are affected by negative ridge phenomena.

Non-forest communities are mostly secondary and arose due to cattle grazing. The most significant are "poloninas," or grasslands at the timberline, which are species-rich and representative formations of the Eastern Carpathian mountains.

Grasses and rushes such as *Nardus stricta, Deschampsia caespitosa*, and *Luzula luzuloides* distinguish the poloninas, but they also include species recognized as Dacian migroelement (*Campanula abietina, Aconitum lasiocarpum, Dianthus compactus*). Since grazing has ended on the poloninas, the expansion of *Calamagrostis arundinacea* has lessened the richness of species. This loss of human-induced biodiversity is a specific management problem of the Biosphere Reserve.

Subdominant *Anthoxantum odoratum* and *Agrostis tenuis* characterize the meadows and pastures of low and middle elevations respectively. Non-forest communities are also represented by specific vegetation of wet meadows and springs which is of great nature conservation importance.

The zoological value of the region is also high. A unique range of animal species and communities reflects the geographical location at the junction of the Eastern and Western Carpathians. So far, about 1,400 animal species have been found, including more than 1,100 species of invertebrates. Invertebrates include representatives of almost all the principal systematic groups. Among invertebrates, the class of insects, with about 950 species, is the best represented. Populations of vertebrates were influenced in later years by the degree of disturbance of particular ecosystems. Of special note is the presence of large predators, including lynx and bear. Small carnivores such as wild cat and badger are abundant. Red and roe deer populations are too high and create specific management problems with respect to the regeneration of some tree species, especially fir. In recent year, the rare ungulates *Bison bonasus* and *Alces alces* have occasionally been observed. Several species occurring in the Biosphere Reserve can be traced to early stages of the development of the Carpathian fauna. For example, *Dicellophilus carniolensis* is a Tertiary relic, while *Duvalius subterraneus, Sicista betulina, Picoides tridactylus, Turdus torquatus*, and *Sorex alpinus* are glacial relics.

There are many endemics of the West Carpathians: *Chromatoiulus sylvaticus, Agardia bielzii, Helicigona faustina, Trechus pulpani, Nebria fuscipes* , and *triturus montandoni*. However, the East Carpathian endemics *Leptoilus byconyensis stuzicensis, Polydesmus polonicus, Carpathica calophana, Stenus obscuripes* and *Deltomerus carpathicus* are also present. Several species previously unknown to science have been discovered in the territory, such as *Tachydromia carpathica* and *Lioides nitida sedlicensis*.

The botanical and zoological importance of the Biosphere Reserve is further emphasized by the fact that 23 of its vascular plants are protected by law. Another 22 are seriously endangered, 33 very endangered, 52 endangered, and 86 rare in Slovakia. Similarly, a total of 27 species of invertebrate and 148 vertebrates found in the region are protected by law. The peregrine falcon (*Falco peregrinus*) is even included in the IUCN Red Data Book. The most valuable biotopes or best preserved ecosystems have been recognized as Nature Reserves or Protected Sites with strict protection regimes. These cover 1,384 ha or 3.4 percent of the area.

PEOPLE AND AREA

The region of the Eastern Carpathian Biosphere Reserve was settled in the Early Stone Age. The next wave of colonization occurred in the late 14th century when Ruthenian pastoral-agrarian people arrived. This was the beginning of the Wallachian colonization, a period which lasted until the 17th century. The Wallachian colonization was responsible for the essential landscape features of the region, including the basic settlement pattern and the botanical heritage of the poloninas.

Currently, more than 3,000 (3,721 in 1991) permanent inhabitants live in 10 villages in the eastern part of the area. Seven villages in the western part were evacuated during the construction of the Starina reservoir. The economic and cultural center of the region is the town of Ulic (1,200 inhabitants).

Most of the local people work in forestry. Although more than half of the forests are privately owned, they are all still managed by state enterprises. Of the total area of forest, some 23,334 ha serve chiefly for timber production, while 1,178 ha, mostly on steep slopes, are designated for protection against soil erosion. The remaining 7,391 ha include areas such as the fragments of the virgin forests, which are most important for nature conservation. These last "special use forests" also include forests in the sanitary zone around the Starina reservoir.

Agricultural land covers 6,480 ha. The climate dictates that agricultural activities are based primarily on the production of crops for fodder. Wheat, rye, barley, and oats are also cultivated, and the traditional crop is buckwheat.

The cultivation of private village plots over many generations has resulted in a mosaic of little fields and meadows that give the landscape a unique pattern. Agricultural enterprises remain active in the area but are in decline as a result of the re-privatization process in Slovakia.

Tradition and the production of crops dominantly for fodder were primary reasons that farmers bred cattle and sheep on the Biosphere Reserve. The Starina Reservoir and its sanitary zone have limited agricultural activities. Large pastures are now abandoned, as they become overgrown, biodiversity decreases.

Tourism and sports in the territory have been limited, but could, if developed, play an important role as a future source of income for local inhabitants.

The Eastern Carpathian Biosphere Reserve has not only preserved fragments of natural ecosystems, but also the biodiversity resulting from human activities. It therefore deserves to be a part of the international network of Biosphere Reserves and, as such, should be protected for future generations. Its future conservation and development should be parallel to the protection and development of the entire area of the tri-national Polish-Slovak-Ukraine reserve. This approach emphasizes the global importance of the region.

REFERENCES

Guziova, Z. and Bural, M. 1994. Vychodne Karpaty/East Carpathians Biosphere Reserve. In: Biosphere Reserve on the Crossroads of Central Europe, EMPORA Publishing house, Prague.

Guziova, Z. et al. 1992. Proposal for Poloniny National Park. Manuscript.

Guziova, Z. et al. 1992. Nomination of the Eastern Carpathians Biosphere Reserve. Manuscript.

Voloscuk, I. et al. 1988. Vychodne Karpaty- chranena krajinna oblast. Priroda, Bratislava.

BIESZCZADY NATIONAL PARK

Zbigniew Niewiadomski
Bieszczady National Park

The Bieszczady National Park covers 27,064 ha in the south-east corner of Poland, where the borders of Poland, Ukraine and Slovakia meet. The National Board for the National Parks of the Ministry of Environmental Protection, Natural Resources, and Forestry administers Bieszczady National Park, which was created on August 4, 1973.

The present borders of the Park should not be considered final. Many believe that the Park should be expanded to include the entire Upper San Valley and some forest complexes located to the north and west of the present boundary. Factors which support the enlargement of the Park include a sparse population in the area (low by Polish standards at 4 people per km^2), the low usage of the land, the unprofitability of the forest-agriculture economic model in Bieszczady, and the wide state ownership of the forested and post-agricultural areas adjoining the Park. Consequently, the Park desires a final area of about 41,000 ha.

The development of the Bieszczady region is expected to include the gradual professional re-orientation of the population towards the tourism industry. Tourist villages should grow in the immediate vicinity of the Park and extensive areas of the San Valley should be devoted to hiking, horseback riding, and cycling, as well as to fishing, nature photography, and ecological education. The protection of the natural resources of the Bieszczady may thus gain allies in the local population, who will earn incomes by servicing the tourists visiting the National Park and the Eastern Carpathians International Biosphere Reserve (IBR).

It was initially proposed 20 years ago that an internationally protected area be established in Bieszczady, but the political situation at the time did not favor implementation. In 1990, however, at the UNESCO MAB Conference in Kiev, the Polish party proposed the creation of a Biosphere Reserve in the Eastern Carpathians under the UNESCO Man and Biosphere Program. The Ministers of Environmental Protection of the three countries accepted the proposal and signed an agreement in Ustrzyki Dolne in 1991. Preparations to apply the project began immediately. The proposal gained official backing from the UNESCO MAB Headquarters in 1992 for the Polish and Slovak parts and in 1993 for the Ukrainian part.

The total area of the Eastern Carpathians IBR is about 164,000 ha, of which 66 percent (108,725 ha) is in Poland, 24.7 percent (40,601 ha) is in Slovakia, and

8.9 percent (approximately 14,600 ha) is in Ukraine. The Polish section includes the National Park, as well as the San Valley and Cisna-Wetlina Landscape Parks, which were created in 1992 and which cover 36,635 and 46,025 ha respectively. The Slovak section includes a part of the "Vychodne Karpaty" CHKO (Area of Protected Landscape), which to be upgraded to the status of a national park under the name "Poloniny" National Park. On the Ukrainian side, the IBR currently includes the Stuzyca Nature Reserve. It is also possible that the Ukrainian sector could implement the planned Nadsanie Landscape Park, a move that would allow for extensive protection of the drainage basin of the Upper San River on both sides of the border.

The concept of the Biosphere Reserve is founded upon the idea of a zonal system of protected land. In this system, the most naturally valuable core zone is subject to strict protection, while the surrounding buffer zone is partially protected. In the outermost transition zone, attempts are made to minimize the negative impacts of human activities. In Poland, the core and buffer zones are both within the boundaries of Biesczadzki National Park, while the surrounding transition zone is administered separately.

The Eastern Carpathians IBR was created to promote cooperation in the protection and rational use of the natural resources of the Bieszczady Mountains, in scientific research, and in monitoring the environment and ecological education. In addition, the IBR seeks to strengthen the links between the people of the Eastern Carpathians through cooperation and the joint protection of cultural heritage. The Carpathian forests play a significant role in water protection, and hence in the agriculture and industry of central European countries. The IBR is also an important element within the officially recognized European region of the Eastern Carpathians, which was established by Poland, Slovakia, Ukraine, and Hungary.

Poland's Bieszczadzki National Park is dominated (84 percent cover) by forests. Beech forest is the major type, constituting 80 percent, with a mixture of fir and sycamore. The natural, and sometimes even primordial, character of these stands is unique in Europe. Also unique, at least from the Polish point of view, are the floristically-rich alpine pastures and meadows which the Park protects. The area's raised bogs are also of interest. The geographical location of the Park ensures the occurrence of species from both the Western and Eastern Carpathians, resulting in the wealth of the flora. In Poland, 57 rare species of plants are protected, with 12 of these being classified as endangered in the country as a whole. The fauna is also of interest; the Park preserves all of the original mammalian predators, including the brown bear (*Ursus arctos*), wolf (*Canis lupus*), lynx (*Felis lynx*), wild cat (*F. silvestris*), and otter (*Lutra lutra*). The majority of the original group of large herbivores can also be found in the Park: European bison (*Bison bonasus*) and red deer (*Cervus elaphus*). The red deer, in its Carpathian form, is the most magnificent to be found in Europe. Rare birds are also well represented in the Park, with notable species including golden eagle (*Aquila chrysaetos*), lesser spotted and spotted eagles (*A. pomarina, A, clanga*), short-toed eagle (*Circaetus gallicus*), eagle owl (*Bubo bubo*), and Ural owl (*Strix uralensis*).

Bieszczady National Park is divided into zones that are under strict or partial protection. Strict protection covers 18,536 ha, which, as of December 1991, represents 44 percent of the total area of this type found within all Poland's National Parks. This attests to the unique value of the Park's natural resources on the Polish scale. The areas under strict protection fall within six legally recognized Strict Nature Reserves. All human activities are excluded from these areas, with the goal of observing natural ecological processes and maintaining nature without disturbing it through protective measures. Activities are thus restricted to scientific research that will not cause changes in nature, and sightseeing is only allowed from marked tourist paths and nature trails.

Strict Nature Reserves located outside the Park, in the transition zone of the Biosphere Reserve, should enjoy the same status as the core zone. However, this would require their surroundings to be secured with a buffer zone.

Zones under partial protection, which cover 8,528 ha of the Park, act as buffer zones for the areas under strict protection. These buffer zones protect against the negative effects of human activities, particularly those resulting from traffic along communication routes and the anthropogenic influence of inhabited areas. Human intervention, tourism, and recreation are permitted in partially protected areas. Scientists also conduct research and collect plant and animal samples in these zones. However, the fundamental activity in the partially protected zones is the active protection of natural resources with the goal of returning the environment as closely as possible to its natural state. This is achieved through the restructuring of forest stands, regulation of animal populations, intervention in the species composition of plant communities, the nursing and cultivation of desirable elements, and the elimination of elements alien to the native biocoenoses. The Protective Plan for Bieszczadzki National Park, which will facilitate such protective actions, is now being drawn up. This Plan is expected to provide model solutions for other National Parks in Poland.

Attempts to use the mountain valleys for large-scale agriculture considerably damaged the Bieszczady area. Extensive areas in the San Valley and in Wolosate were cleared and drained in order to "recultivate" the land for cattle breeding and other agricultural industries. However, drainage reduced the land's retentiveness and often partially destroyed the raised bogs unique to the area. Agricultural activity also damaged the alluvial ecosystems and belts of trees along watercourses, which represent natural ecological corridors for flora and fauna. The inclusion of these areas within the National Park stopped such environmentally unfriendly processes, and work is now beginning to restore the level of retentiveness and the ecosystems which have been destroyed.

In addition to increasing economic utilization, the development of the settlements and roads (especially the Bieszczady "ringroad") crossing the most naturally valuable areas enabled motorized tourism to invade Bieszczady. The number of tourists to Bieszczady rose from only about 1500 in 1953 to around 3 million visitors per year just twenty years later (a small National Park was established in 1973). However, the trend of tourism is now changing again due to society's reduced affluence. Specialized mountain tourism, which is less harmful to the Park, is taking the place of mass tourism, and the number of tourists visiting the Park annually has fallen to around 350,000. The Park intends to stimulate the development of tourist villages in the surrounding area. This strategy promotes the use of the Lake Solinski area for vacationing and recreation as well as the establishment of camping sites along the Park boundaries. These tourist villages will create a barrier system which will restrain and dissipate the influence exerted by tourists upon the areas most valuable from the point of view of nature conservation.

Ecotourism, or the linkage of walking or hiking with ecological education and wildlife photography, is continuing to grow in popularity. The Park intends to develop ski racing and mountain tourism by foot and horseback. Plans also include a network of ecological education points around the Park and IBR. The Park is working on a camp ground in Wetlina with the goal of reducing the number of stays within the Park itself. An unfavorable factor at present is the lack of a visitor center linked to the regional tourist information network.

In addition to all this, the Park is working with the Polish Tourist and Country lovers Society (PTTK) to conserve the network of marked tourist trails and to install shelters along them. Litter left by tourists must also be removed. A network of parking lots furnished with rest rooms will be built, and traffic and parking will gradually be limited in order to reduce the negative effects of traffic along the section of the Bieszczady ring road which passes through the Park. This project is being financed by the European Union.

Many tourists enjoy the research farm for East Carpathian ponies in the Park, and when they pass through Ustrzyki Dolne, they discover that the Park's Natural History Museum is one of the most attractive in any of the Polish National Parks. A further tourist attraction is Poland's oldest narrow-gauge mountain railway, which began operating almost a century ago. If Poland, Slovakia, and Ukraine sign an agreement on a tourist convention for the Eastern Carpathians Biosphere Reserve, the Park would attract international interest. In fact, potential border crossing points within the IBR have already been selected, but will be limited to tourists on foot, horseback, or bicycle. Encouraging motorized traffic would hinder the nature conservation in this unique European protected area.

The Park's main goal of protecting nature would be an impossible task without the cooperation of economically or socially active entities in the area. Such groups include the State Forests and the local authorities, as well as school children, local inhabitants, ecological and tourist organizations, and admirers of the Bieszczady Mountains throughout Poland. In turn, it is critical that the Park's representatives help design economic plans and the spatial management of the Bieszczady region. Volunteer groups also assist the Park constructively. Examples of valuable volunteer work include the "Clean Mountains" campaign run by young students and the activities of the Mounted Nature Conservation Guard in Przemysl. Volunteers have also cooperated to conserve and renovate cemeteries, an important element of the region's heritage.

The Park has taken steps to create a network of ecological education points for tourists, local people, and young students. As a sanctuary for nature in the Bieszczady Mountains, the Park may thus become a major center in Poland for the promotion of ecological knowledge and nature conservation. Brochures, information booklets, and guides also serve to advance popular knowledge about nature. The Scientific Research Institute of the Eastern Carpathians International Biosphere Reserve, created in 1993 in Wolosaty, facilitates scientific research within the Reserve and helps organize conferences. An IBR cooperation center is also to be established nearby in 1995. In turn, one of four International Ecological Institutes to be created in Poland is planned for Ustrzyki Dolne.

The most time consuming and costly undertaking in the Park is providing a sewage treatment system to all the settlements and buildings. This project is supported financially the National Fund for Environmental Protection and Water Management, and its completion will ensure that all water running within the Park is of Class I purity. A further step will be to eliminate local sources of air pollution through changes in the heating systems of buildings.

The park personnel are divided into two categories. One group consists of permanent employees whose payroll is included in the State budget and who work for the Park Service, in administration, and in the museum. Employees of a self-financing auxiliary holding comprise the other group of employees. Their tasks include active conservation in the zone under partial protection as well as the rebuilding and renovation of the tourist infrastructure.

In conclusion, the most important concerns for the park management are the following:

- BNP on its own is neither entitled to nor able to undertake the activities of the Biosphere Reserve, mainly due to constraints on financial and human resources. The Park budget does not cover the costs of cooperation with Biosphere Reserve partners. BNP therefore needs the cooperation and commitment from other bodies involved in the Biosphere Reserve, such as the State Forest administration. The support of local communities is also needed.
- It is crucial for the long-term planning of conservation activities that the state continues ownership of both forest and post-agricultural land in the vicinity of strictly protected areas within the borders of the Biosphere Reserve. State ownership can prevent unrestrained development in areas of high natural value and allows for possible enlargement of the National Park in the future.
- The implementation of the International Biosphere Reserve project will be subject to legal problems, such as the lack of a coordinating structure legally entitled to conduct activities. There are also many legal gaps and a lack of regulation connected with basic activities, such as traffic control

on the public roads crossing the National Park or cross-border radio communication.

- The Park lacks qualified personnel to carry on interpretative and educational activities, and it also lacks cooperation on the international scale for Biosphere Reserve purposes. At the same time, the Park faces the continued loss not only of conservation specialists, but also of foresters and rangers. Wages are extremely low compared with those in the State Forest administration. The remote location and difficult living conditions, combined with housing problems and low wages, cannot attract the necessary specialists.
- The Park lacks technical monitoring and telecommunication equipment.
- The National Park will be subject to increasing stress from visitors due to new border crossings in the Biosphere Reserve and to the attractiveness of tourism in protected areas. Financial support from the European Commission provides for part of the protective action. However, the Park still lacks funds to control the flow of tourists (e.g., through a visitor center or entrance points) or for environmental education facilities. The plan to replace part of the road across the Biosphere Reserve with a more nature-friendly forest train (to be acquired from the State Forest administration in 1995) is as yet without financing.

KARKONOSZE NATIONAL PARK AND KARKONOSZE/ KRKONOSE BILATERAL BIOSPHERE RESERVE

Maria Goczol-Gontarek
Karkonosze National Park & Biosphere Reserve

The Karkonosze/Krkonose Bilateral Biosphere Reserve is located within the Karkonosze, the highest range of the Sudety Mountains, on either side of the Polish-Czech border. It is easy to understand why the Karkonosze are also called the Giant Mountains if one looks at them from the foothills or from the Jelenia Gora Basin.

Geologically, the Karkonosze are old mountains, with the Polish side being composed mostly of granite. Post-glacial cirques date back to the Quaternary period, during which glaciations influenced the present landscape. Vast flat areas on the ridge are also a characteristic feature of the landscape, as are numerous rock groupings.

The climate of the Karkonosze is both cool and very wet; rain and snowfall at higher altitudes reach 2000 mm per year, and snow depths may exceed 10 m. High rainfall combines with the many springs to create numerous streams and waterfalls, as well as a few oligotrophic lakes and peatbogs. Peatbogs are characteristic of the Karkonosze and occur on both the flat surfaces on summits and on slopes.

Five well-developed vegetational zones can be distinguished in the Karkonosze. However, the cool, humid climate and low elevation of the massif determine that zones occur at lower altitudes than in other mountain ranges of Central Europe, for example, at altitudes 300 to 400 m lower than in the Tatras.

Much of the foothill zone is urban, industrial, and agricultural. The lower forest zone grows to 1000 m above sea level and is dominated by natural communities of mountain beech and Sudetic beech. However, the most of the beech was cut for industrial use and were replaced with Norway spruce, whose natural area of occurrence is restricted to a narrow belt at altitudes between 1000 to 1250 m above sea level.

Above the forest is the sub-alpine zone, which is the most valuable and richest zone with the highest diversity of vegetation. Sudetic dwarf mountain pine (*Pinetum mughi Sudeticum*) constitutes the dominant sub-alpine community.

Smaller communities are composed of deciduous sub-alpine brushwood, relic brushwood with Silesian willow (*Salix silesiaca*) and downy willow (*S. lapponum*). The most colorful are the herb communities. Numerous wet areas influence the landscape and vegetation of the sub-alpine zone. The sub-alpine peatbogs, located at the summits of the Karkonosze, are unique to the mountain ranges in Central Europe and include many post-glacial relic plants.

The alpine zone occurs on the highest peaks, Sniezka and Wielki Szyszak. The flora of the Karkonosze includes 1250 taxa of vascular plants, while the Polish part includes 700 such species as well as 450 species of Bryophyta, 400 species of Lichenes, and 80 species of Myxophyta. Among them are many rare plants, glacial relics, and endemics. Examples of endemics are the basalt saxifraga (*Saxifraga Moschata ssp. basaltica*) and the Karkonosze Bellflower (*Campanula bohemica*), while glacial relics include cloudberry (*Rubus chamemorus*), northern twinflower (*Linnea borealis*), downy willow (*Salix lapponum*), Sudety lousewort (*Pedicularis sudetica*), and Arctic saxifrage (*Saxifraga nivalis*).

The fauna of the Karkonosze mostly includes common lowland species. Endemic and relic taxa are restricted to a few species of invertebrates. Mountain vertebrates include brown trout (*Salmo trutta*), alpine newt (*Triturus alpestris*), and birds such as alpine accentor (*Prunella collaris*), water pipit (*Anthus spinoletta*), redpoll (*Carduelis flammea*), ring ouzel (*Turdus torquatus*), capercaillie (*Tetrao urogallus*), black grouse (*Tetrao tetrix*), and nutcracker (*Nucifraga caryocatactes*). About 100 bird species nest in the Polish part of the Biosphere Reserve, and there are 40 species of mammals, including the mouflon (*Ovis musimon*), which was introduced at the beginning of the twentieth century, and numerous bat species. For 200 years, there have been no large predators other than the fox in the Karkonosze Mountains.

The settlements in the foothills of the Karkonosze have existed since at least the ninth century. People began to penetrate the mountains in the Middle Ages primarily to seek gold and precious gems. Traces of their activities can be found even today, with old adits or signs cut into rocks. Mining, glass making, and weaving later became important industries, and deforestation connected with industry and settlement occurred over much of the area. The natural beech and mixed forests were replaced by Norway spruce forests at this time.

The first buildings in the mountains date back to the seventeenth century. At lower altitudes, there were villages of shepherds. There were huts for hunters, guards, and shepherds at higher altitudes near the main road. A chapel was built on the top of Sniezka, and the headwaters of the Elbe were consecrated. Subsequently, the number of pilgrims coming to the Karkonosze increased. In the eighteenth and nineteenth centuries, tourism grew quickly and tourism became the main source of income for the area's inhabitants. The Karkonosze Union (Riesengebirge Verein) was founded in 1880, and at the beginning of the twentieth century, the first activities aimed at the protection of nature in the Karkonosze were initiated: the designation of nature reserves and nature monuments.

Vallons, Italians, Frenchmen, Germans, Czechs, and Poles have all shown an interest in the abiotic nature of the Karkonosze. Schenckfeldt (1600) and Volkmann (1720) made mining and geological observations. K. V. Raumerthe published the first geological map of the area in 1813, and Berg (1919-36) prepared subsequent maps. The turn of the nineteenth century saw many scientists, including Partsch, analyze post-glacial structures and elaborate ideas on glaciation in the Karkonosze. Scientists from Wroclaw are continuing studies of the area's geology, geomorphology, and glaciation. The first meteorological observations were made on the top of Sniezka as early as 1824 (10-year seasonal measurements of temperature and air pressure). Systematic observation has continued since 1880, and the top of Sniezka now has an operational meteorological station of the Institute of Meteorology and Water Management (IMGW), which cooperates with the European network of meteorological stations. At the end of the nineteenth century, more stations were founded and some remain in operation to this day. In recent years, these stations have collected data on air, soil, and water pollution, as well as meteorological details.

Doctors looking for healing plants organized the first botanic expeditions to the Karkonosze. The first descriptions were made as early as the sixteenth century (Matioli 1563; Sebitz 1582; Schwenkfeldt 1601). In the eighteenth and nineteenth centuries, many botanists and collectors studied the flora of Karkonosze (Fiek 1881; Schube 1903), and extensive descriptions were published at the beginning of the twentieth century (Pax 1927; Limprich 1930). After the Second World War, Tolpa, Szweykowski, Madalski, and Fabiszewski conducted floristic and geobotanic research, while W. and A. Matuszkiewicz made extensive studies of plant communities.

The first zoological research primarily concerned the vertebrates. Descriptions of the fish of the Karkonosze were published at the beginning of nineteenth century (Weigel 1806; Kaluza 1815; Gloger 1833), and the next publications appeared at the beginning of the twentieth century (Lubosch 1902; Arndt 1923 and 1925; Pax 1921 and 1925). Ornithological research also began in the nineteenth century (Schneider 1892; Friedrich 1908; Mayhoff 1923; Martini 1926), with detailed studies being made by Dyrcz in the 1960s. Nineteenth-century papers on game mammals, rodents, and bats were published by Gloger, and a work on rodents and insectivore was published in 1973 (Chudoba, Haitlinger, Huminski). The 1980s and 1990s have seen extensive studies on bats and on some groups of invertebrates such as insects, arachnids, and molluscs. Entomologists from Poznan are currently studying several groups of insects and arachnids. Scientists from the University of Poznan and the Forestry Research Institute (IBL) in Warsaw, Wroclaw, and Krakowas have extensively researched forest management, reforestation, and forest ecology as the health of the forest has declined in recent decades. For 3 years, an extensive, interdisciplinary research project entitled "The Ecosystems of the Karkonosze Under the Circumstances of Ecological Stress" has been continued by scientists from the University of Wroclaw and from the Institute of Ecology of the Polish Academy of Sciences.

In 1994 Karkonosze National Park organized a science conference entitled "Geoecological Problems of the Karkonosze." This conference followed one which took place in 1991, when 50 papers were presented by scientists from Wroclaw, Poznan, Warsaw, Katowice, Krakow, Olsztyn, and the Czech Republic. This year, scientists from research institutes in Poland and the Czech Republic will present 70 papers based on the results of their latest research.

In 1959, Poland's Karkonosze National Park was established on an area of 5,500 ha. In turn, the Czech Krkonose National Park was established in 1963 on an area of 40,000 ha. In 1992, the Karkonosze/Krkonose Bilateral Biosphere Reserve was established, comprising the area of both parks. The most valuable portions of the Parks, including over 10,000 ha in the sub-alpine and alpine zones, are under strict protection and constitute the core zone of the Biosphere Reserve. The Polish part of the Reserve has core and buffer zones only, while the Czech side has all three zones: core, buffer, and transition. The Polish and Czech sides are now working together to prepare a common action plan for the Reserve and to determine the ways in which the two sides may communicate better. Karkonosze National Park is going to prepare a plan for nature conservation in the Park, which should outline the main goals of the Park's existence.

The Karkonosze mountains can be considered a single unit, so the Polish and Czech sides face similar problems which may be categorized into two main groups. The first of these is the deterioration of the health of the environment. Both natural and anthropogenic factors threaten the nature of Karkonosze. Natural factors include the difficult climatic conditions (cold and wind) and pests. Anthropogenic factors include historic forestry practices (the common replacement of natural mixed forest by spruce monocultures in the nineteenth and twentieth centuries) and air pollution (generated mostly by the "Black Triangle," but also by local industry). In the last few years, the situation has improved as the level of pollution has decreased, and the health of the forest has improved distinctly. Karkonosze National Park obtains the seedlings necessary for reforestation from its own nurseries, and work has begun on the reconstruction of the lower mountain forest. The Czech and Polish parts are participating in a common project for reforestation in the Karkonosze mountains.

Tourism is responsible for the second category of problems. Between 8 and 11 million tourists visit the Biosphere Reserve annually (2 to 3 million on the Polish side and 6 to 8 million on the Czech side). The network of tourist routes is well-developed, extending to about 200 km on the Polish side and more than 1000 km on the Czech side. The National Park has numerous shelters, ski lifts, and ski-roads as well as two chair lifts on the Polish side and one on the Czech side. New problems have appeared recently, as local authorities become more active with the changes taking place in Poland. Over the last few years, tourist organizations increasingly have been pressuring the Polish part, with many groups suggesting that more areas of the Park should be opened up for skiing. New methods of communication are still developing and settlements are being founded.

THE HYDROGRAPHIC SYSTEM OF POLAND WITH EMPHASIS ON BORDER REGIONS

Roman Soja
Institute of Geography and Spatial Organizations
Polish Academy of Sciences

Polish territory is hydrographically self-contained to an exceptional degree for Continental Europe. The term "hydrographic self-containment" means that an area (in this case, Poland) is characterized by concordance between national borders or the boundaries of administrative units and the courses taken by the divides separating drainage basins. The fact that the majority of rivers in Poland both begin and end on Polish territory signifies hydrographic self-containment. Thus, only 10 percent of the area drained by the Vistula and the Oder, Poland's two greatest rivers, lies outside the borders of Poland. Poland is also isolated hydrologically from neighboring marine basins; water across more than 99% of the country drains into the Baltic Sea, while that on only 1% is directed to the North Sea and Black Sea.

Poland's western border follows the courses of the Rivers Oder and Nysa Luzycka, but the drainage basins of the two rivers are extremely asymmetrical. The division with neighboring basins lies only 10 to 20 kilometers or less inside German territory. The Oder originates in a highly industrialized area of the Czech Republic near Poland's southern border. The Czech steel, chemical, and coal industries pollute the waters of the Oder, so that the Oder and Nysa Luzycka are little more than effluents with exceptional loads of toxic substances by the time they reach the Polish border. In addition, oil-derived substances poison the Oder and its small tributary, the Olza, several times annually. In Poland these pollutants are collected from the surface along the border sections, thus protecting the further course of the river. These unilateral actions cause disagreement regarding who should bear the cost of removing the pollutants, and successive signed agreements on this matter have failed.

A second problem along a section of the southern border is the pollution of the River Poprad, a river which originates in the Slovak part of the Tatra Mountains. The problem of the high level of pollution in this river is compounded by the fact that the Poprad is a tributary of the Dunajec. The Dunajec has the greatest water resources of any river in the Polish Carpathians. The water of the Poprad degrades the water quality of the Dunajec. These two cases (the Oder and the Poprad) constitute the only problems along the southern section of the Polish border with which the divide coincides.

A long section of the eastern border conforms to the courses of the rivers San and Bug. There are no significant problems with inflows of pollution from Ukraine within the drainage basin of the San. In fact, the water of this river's upper course is of natural chemical composition, which is a rare phenomenon in Poland. In contrast, the Bug, whose middle section forms the border with Ukraine, is one of Poland's more polluted rivers. Human activity and unfavorable natural conditions both cause problems. The Bug has a continental type of hydrological regime in which the flow increases considerably as snow melts in March and April, followed by months of consistently low flows. Effluents from the Ukrainian coal and food processing industries contaminate the Bug. The most catastrophic situation arises in autumn, when the sugar beet campaign begins and large quantities of waste water from sugar beet factories pour into the river.

There are many post-glacial lakes in northeastern Poland. The rich water resources of this area are lightly polluted, and water flows via small rivers to the Neman River into Lithuania and Russia.

Most conflicts regarding rivers flowing along the Polish border or into Poland regard water pollution. The Oder and Nysa Luzycka do not reach any norm for water purity at any point along their entire lengths; the water is beyond classification. To rectify this problem, both Poland and the Czech Republic must comply with management norms for water and effluents, and this is not likely to happen in the foreseeable future. The most significant progress has been in the regulation of pollution in the Poprad, as construction of a sewage works in Slovakia has begun. However, more extensive water management in the Poprad's drainage basin has been deferred since it would primarily benefit Poland. Although the Ukrainian side of the Bug's drainage basin is poorly managed, contemporary socio-economic changes should limit or stop the exploitation of hard coal, which would obviously help eliminate the discharge of the most burdensome effluents. Particular attention should be paid to maintaining, if not improving, the current state of purity of the upper San River in the Bieszczady National Park. This will only be possible through strict compliance to an agreement with Ukraine.

Poland's changing relief, and, later, human activities led to its hydrographic shape. In the glacial period, great rivers with latitudinal courses took the meltwaters of the Scandinavian ice sheet westward to the North Sea. The retreat of the ice sheet and the emergence of a river network resulted in a natural connection between the drainage basins of the Vistula and the Dnieper. The flat, marshy area in Belarus and Ukraine, known as Polesie, acted as a bifurcation area in the spring. Some waters of Polesie headed for the Dnieper and subsequently for the Black Sea, while others reached the Vistula via the Bug's tributaries. This natural link only disappeared in the nineteenth century, when the drainage of the marshes and bogs of Polesie began. The land became drier, spring meltwaters flowed away increasingly quickly, and a further fall in the low autumnal flow of the Bug signified the depletion of water resources.

Originally, there was no natural link between the drainage basins of the Oder and Vistula, or between those of the Oder and German rivers. The nineteenth century canals which formed artificial connections are of limited scope and are largely inactive today. The flows in the canals linking the Oder with German rivers are sustained with water from Polish territory.

TRANSBOUNDARY NATURAL SYSTEMS IN EASTERN POLAND AND A PROPOSAL FOR AN ENVIRONMENTAL PROTECTION STRATEGY

Bozena Degorska

Institute of Spatial Organization

Polish Academy of Sciences

Of all Poland's border areas, the one characterized by the greatest degree of geoecological diversification falls along the eastern edge of the country. This system of 11 physico-geographical transboundary regions of sub-provincial rank indicates the diversity of physico-geographical conditions and the valuable features of the landscape. In comparison, the western border crosses four physico-geographical regions and the southern border crosses six (Kondracki 1978). Notable types of landscape found along the eastern border include the following: coastal areas, the lakeland belt, the lowland belt, bog areas, uplands, foothills and mountains, and the valleys of the greater rivers.

Cooperation currently developing between Poland and Ukraine, Belarus, Lithuania, Kaliningrad District of the Russian Federation, and Slovakia has opened the chance to carry out research in the eastern border zone. Agreements are also now possible on the protection and management of the environment in this area. Ecology agreements have led to work on the monitoring of border waters and on the creation of transboundary structures for the protection of nature. The latter are exemplified by the Eastern Carpathian International Biosphere Reserve between Poland and Slovakia and by the Bialowieza Biosphere Reserve between Poland and Belarus. Such strategies are indispensable since the boundaries of natural units cross national borders.

Certain transboundary systems are open and are characterized by the most intensive exchanges of matter and energy with the surroundings (R. Chorley & B. Kennedy 1971). Included among the most dynamic natural elements are watercourses, which have become the major carriers of environmental pollution since industrialization began.

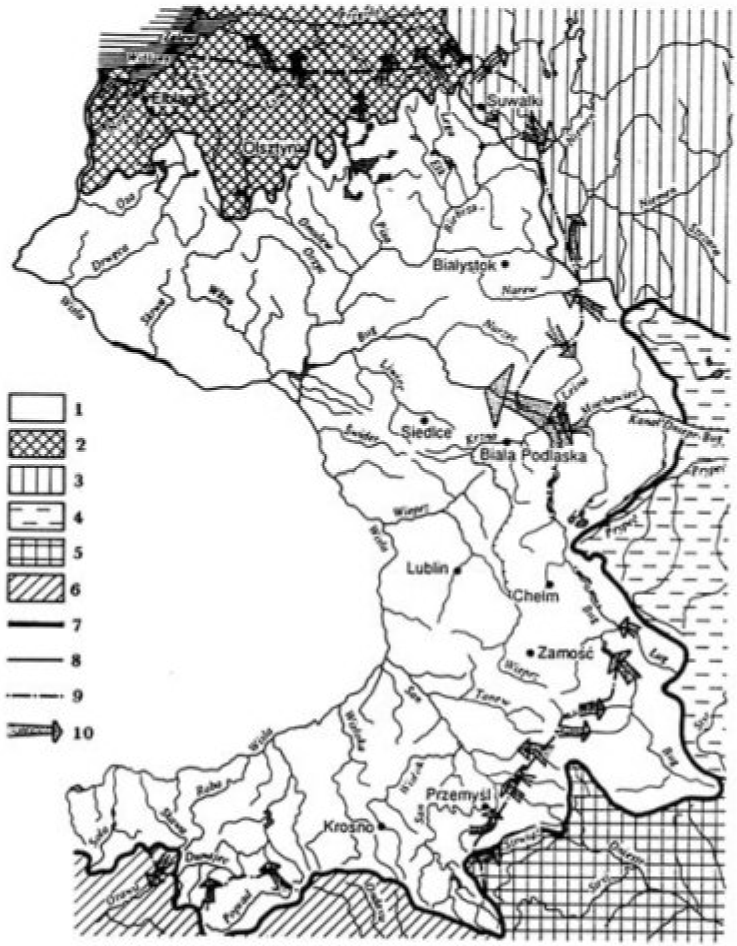


FIGURE 1 Direction of the Riverflow in the Cross-Boundary Rivers 1. Drainage basin of Vistula river; 2. Drainage basin of Vistula Lagoon; 3. Drainage basin of Neman; 4. Drainage basin of Dniepr; 5. Drainage basin of Dniestr; 6. Drainage basin of Danube; 7. Major water divide; 8. Water divide of 1 rank; 9. State border; 10. Direction of riverflow

The water quality of the rivers in the eastern border zone is unsatisfactory. Data from the State Environmental Protection Inspectorate show that in 1991 the quality of water in the larger rivers did not meet the statutory norms for physico-chemical and biological criteria. Waters of Quality Class III were only noted along short sections (3.7% of the Bug river, 3.2% of the Wieprz, 11.7% of the Wislok, 14% of the Elk, and 36% of the Pasleka). The best Class I water was restricted to the Biebrza and some lengths of the Suprasl. The high degree of pollution of the Bug is of particular concern since its drainage basin should meet the requirements of a protected drainage basin.

Familiarity with the flow and boundaries of a drainage basin is necessary in order to recognize the geographical environment, especially for cases involving spatial planning, environmental protection, and ecology. Figure 1 schematically presents the flow of surface water in the eastern border zone. One can see that this zone lies within the drainage basins of two seas: the Baltic Sea (with drainage via the Vistula or Neman Rivers, or the Vistula Lagoon) and the Black Sea (with drainage via the Dnieper, Dniester or Danube).

In order to distinguish transboundary ecological areas, analysis of physico-geographical features of the environment may be combined with an assessment of the ecological situation. In this way, the rank of transboundary ecological areas, dominant categories of protection, and areas of conflict may be identified.

In the zone under analysis, the following major transboundary ecological areas should be included:

- Bieszczady Mountains, the border area between Poland, Slovakia, and Ukraine;
- Roztocze area, on the border region between Poland and Ukraine;
- The drainage basin of the Bug River, on the borders of Poland, Ukraine, and Belarus;
- Bialowieza Primeval Forest, on the border between Poland and Belarus;
- Mazurian/Lithuanian Lakeland, by the border between Poland and Lithuania;
- Vistual Lagoon, on the border area between Poland and the Kaliningrad District of the Russian Federation; and
- Romincka Forest, on the border area between Poland and the Kaliningrad District of the Russian Federation.

The spatial aspects of these transboundary ecological areas have been categorized on the supranational, national, regional, and local scales.

- The supranational (international) scale has units which include natural links of European rank. These are:

- the Bieszczady Mountains, as a unit of the Eastern Carpathians representing part of the whole Carpathian system; and
- the Mazurian/Lithuanian Lakeland, which is continuous (via the Pomeranian Lakeland) with the Mecklenburg Lakeland.

• The national scale has areas including links at the level of neighboring countries. These are:

- the Vistula Lagoon;
- the drainage basin of the River Bug; and
- Roztocze.

• The regional scale includes units having links which embrace border regions. These are:

- the Bialowieza Primeval Forest (Puszcza Bialowieska). However, Bialowieza Forest should be considered on the national scale according to the highest value of natural forest ecosystems; and
- the Rominckа Forest (Puszcza Rominckа).

• The delimitation of transboundary ecological areas at the local level requires research along the border belt with depths down to about 20 km. It may be anticipated that this will result in the delineation of transboundary reserves or areas of ecological use.

In the future, geoecological research on various spatial scales may provide a basis for the elaboration within spatial management plans of different scales of a system of transboundary protected areas for countries bordering Poland. It is to this end that natural research modeled on Polish methods has been conducted across the border in Ukraine.

If transboundary ecological areas are classified on the basis of the dominant categories of environmental protection, additional studies must be conducted in some regions. However, as a general rule, the delimited areas may be classified in the following way (Fig. 2) into areas of strict or partial protection.

• Areas with a predominance of strict protection include:

- the Bialowieza Primeval Forest; and
- the Bieszczady Mountains.

• Areas with a predominance of partial protection include:

- the Mazurian/Lithuanian Lakeland;
- the Vistula Lagoon;
- Roztocze;
- the Rominckа Primeval Forest (Puszcza Rominckа);
- the Augustowska Primeval Forest; and
- the Podlasie Gap of the Bug River.

FIGURE 2 Classification of Transboundary Ecological Areas and Protection of the Natural Environment in the Eastern Polish Border Regions

Biosphere Reserves
MAB (a) - International Biosphere Reserve Bialowieza
MAB (b) - International Biosphere Reserve Eastern Carpathian Mountains
MAB (c) - Biosphere Reserve Lœuknajno Lake Wetland reserve of international importance

A-Luknajno Lake

National Parks (according to Denisiuk 1994, status for 1/1/1993)
I - Wigry; II - Bialowieza; III - Polesie; IV - Roztocze; V - Bieszczady.

Landscape Parks (according to Z. Denisiuk 1994, status for 1/1/1993, updated for Olsztyn voivodeship) 1 - Vistula Sand Bar; 2 - Elblag Rise; 3 - Ilawa Lakeland; 4 - Dylewskie Hills; 5 - Mazurian Landscape; Park; 6 - Suwalki Landscape Park; 7 - Knyszyn Primeval Forest; 8 - Narew Landscape Park; 9 - Leczynsko-Wlodawskie Lakeland; 10 - Sobibor Landscape Park; 11 - Chelm Landscape Park; 12 Strzelce Landscape Park; 13 - Szczebrzeszyn Landscape Park; 14 Krasnobrod Landscape Park; 15 Solska Pimeval Forest; 16 - Southern Roztocze Landscape Park; 17 - Przemysl Foothills; 18 - Slonne Mountains; 19 - San River Valley Landscape Park; 20 - Cisniansko-Wetlinski Landscape Park; 21 Jaslo Landscape Park

In addition, two areas of conflict deserve special attention. The first of these concerns the Vistula Lagoon transboundary ecological area, where the problem of environmental contamination is acutely manifested. Both valuable biocenoses and environmental features around which tourism could develop lie in need of protection. This region has been selected by the State Environmental Protection Inspectorate as one of Poland's 27 areas which are threatened ecologically (GUS, 1993).

The second conflict area is the drainage basin of the Bug River. The greatest water pollution occurs here because of multiple sources of contamination located in Ukraine, Belarus, and Poland. In fact, the area is a protected drainage basin where water quality of Class I or II is demanded.

Efforts should be made to raise the water quality in the border river and in the entire drainage basin of the Bug as well as in the Vistula Lagoon through the construction of sewage treatment plants within the boundaries of their catchment basins. It will probably be difficult to solve the ecological problems in these regions because of huge expenses and the need for international solutions.

The synthetic interpretation above has been prepared on the basis of this author's study of the ecological problems along Poland's eastern border (Degorska, 1992; 1993a; 1993b). The greatest difficulties were encountered in the compilation of material on the pollution of the environment in the areas bordering Poland and in cataloging an up-to-date inventory of protected areas.

This paper is part of an extensive program of research entitled, "A Basis for the Development of Poland's Western and Eastern Border Areas." This research is


RUSSIA
LITHUANIA
BELARUS
UKRAINE
SLOVAKIA
ELBLAG
OLSZTYN
SUWALKI
MAB(c)
BIAŁYSTOK
Narew
MAB(a)
BIALA PODL.
HELM
ZAMOSC
PRZEMYSL
KROSNO
MAB(b)
Wolosate
wetland reserve of international importance
proposed international ecological institutes
national parks
landscape parks
Transboundary areas of special significance for natural conservation and tourism
with exceptional natural and landscape qualities
with relatively high natural and landscape qualities
conflict zones

based at the Institute of Geography and Spatial Organization of the Polish Academy of Sciences, located in Warsaw, and is supervised by Professor A. Stasiak. The research embraces the nine most eastern voivodeships (provinces) of Poland (the voivodeships of Elblag, Olsztyn, Suwalki, Bialystok, Biala Podlaska, Chelm, Zamosc, Przemysl and Krosno) as well as four voivodeships in western Poland (Szczecin, Gorzow Wielkopolski, Zielona Gora, and Jelenia Gora). In total, these voivodeships cover approximately 96,700 km^2. Within the scope of the work being carried out are issues relating to demography, settlement, transport, agriculture, ecology, trade, and tourism. Scientific cooperation with Germany, Ukraine, Belarus, and the Russian Federation has prompted international seminars and a number of field excursions which have enabled researchers to familiarize themselves with international factors of these issues. The results of the research have been included in bulletins of the Institute of Geography and Spatial Organization of the Polish Academy of Sciences entitled, "A Basis for the Development of Poland's Western and Eastern Border Areas".

REFERENCES

Chorley R., Kennedy B., 1971, Physical Geography: A System Approach, London

Degorska B., 1992, Modele strukturalno-funkcjonalne w transgranicznych systemach przyrodniczych (w:) Edukacja ekologiczna i ochrona srodowiska na pograniczach, red. K. Wojciechowski, TWWP, Lublin

Degorska B., 1993a, Problematyka ekologiczna wschodniego pogranicza Polski (w:) Podstawy rozwoju zachodnich i wschodnich obszarow przygranicznych Polski, Biuletyn Nr 2, IGiPZPAN, Warszawa

Degorska B., 1993b, Problematyka pogranicza polsko-ukrainskiego (w:) Podtswy rozwoju zachodnich i wschodnich obszarow przygranicznych Polski, Biuletyn Nr 3, IGiPZ PAN, Warszawa

Kondracki J., 1978, Geografia fizyczna Polski, PWN, Warszawa, Ochrona Srodowiska, 1992, GUS, Warszawa

NEW MAPS ON THE USE OF AND THREATS TO THE ENVIRONMENT IN CENTRAL AND SOUTHERN EUROPE

Joanna Plit
Institute of Geography and Spatial Organization
Polish Academy of Sciences

New environmental maps of Central and Southern Europe have been created by an international group of cartographers in Vienna. Cartographic considerations have made it necessary to divide the subject of "Use of the Environment and Resultant Problems" into two parts and, hence, into two maps. Map A ("Use of the Environment") shows resource use, while Map B ("Environmental Problems") is devoted to ecological problems.

The map scale of 1:3,000,000 required a high degree of generalization. The density of information required that some characteristics be omitted even though they were well documented and could otherwise have been included.

Problems can be identified according to the impairment of the environment (qualitatively) or of natural resources (qualitatively or quantitatively). Impairment is determined by the extent to which components of the natural world have been changed and by the relative ability of these components to continue to function socio-economically.

An international collective under the auspices of COMECON charted the environmental situation from the Elbe to the Urals and to the south as far as the Balkans. The result was a two-sheet, 1:2,500,000 map. The collective agreed upon all the data, often negotiating the course of divisions. In 1992, the Austrian Institute of East and South-East European Studies in Vienna edited the maps of the Atlas of Eastern and Southeastern Europe.

The Institute of Geography and Spatial Organization of the Polish Academy of Sciences acknowledges the cooperation of a number of scientists. Tatjana Nefedova (Soviet Union), the editor-in-chief for the manuscripts, was responsible for coordinating the various national contributions. Oldrich Mikulik (Czechoslovakia), Laszlo Bassa (Hungary), and Joanna Plit (Poland) formed the editorial team with Tatjana Nefedova. National data and manuscripts were compiled by D. Doncev, M. Ilieva, M. Jordanova ans St. Veley (all three from

Bulgaria), K. Kabelacova, A. Vaishar (both from Czechoslovakia), G. Schonfeleder (Germany), M. Spes (Yugoslavia), L. Bassa (Hungary), E. Tomasi (Austria), J. Plit (Poland), E. Zavoianu (Romania), T. Nefedova and I. Volkova (both from Soviet Union).

On map A, color was used to indicate the intensity of environmental usage. An appropriate key was employed. Factors which were considered in calculating the index of usage included the structure of land use and per-hectare yield of the basic agricultural crops (cereals, potatoes, and hay), the number of adult livestock per hectare, the size of cuts in forests (in cubic meters per hectare), and the consumption of mineral fertilizers per hectare of agricultural land. Larger complexes of forest, marshes, and wilderness were also shown, as were protected areas such as Nature Reserves, Landscape Parks, and National Parks. Symbols indicated mines and nuclear power stations, and original summary bar graphs for each of the larger industrial centers showed environmental danger posed by various industrial branches. A delicate hachure in the background denoted the main tourist areas.

It was accepted from the beginning that the intensity of use would be presented by administrative units, although units could be divided into parts (for example, in the case of the clear dichotomy of the Carpathian voivodeship (provinces) in Poland). Various authors used this principle freely.

Map B illustrates the ecological problems caused by pollution as well as the exploitation and degradation of the natural environment. Different colors indicate where the air has been contaminated with compounds of sulphur, and the hachure reveals the level of soil degradation, groundwater deficits, deforestation, and degradation of forests through air pollution. Finally, lines indicate the pollution level of the main rivers and lakes and of the coastline zone. Points mark the principal polluters and the larger dumps of industrial waste. Ecological disaster areas are shown, as is the area contaminated after the explosion at Chernobyl (although this name is not to be found on the map).

The maps and text describe an environmental situation which reflects the problems between 1985 and 1989. It must be hoped that the political and economic upheaval in the former socialist countries, especially the events of 1989 and 1990, will improve the attitudes of politicians and the general public toward the environment. A focus on the poor environmental situation has already led some countries to take action, while in other countries only discussions are in progress.

The condition of Poland's environment was at its worst in the late 1980s. However, the situation is slowly improving as a result of the systematic steps taken to protect the environment. Some of these protective measures include the installation of sewage works, changes in production technologies, and closures of the most burdensome factories.

The international nature of environmental problems is made clear by the National Parks of the Bieszczady and Tatra Mountains. The fact that the Carpathians are protected by the Slovak, Ukrainian, and Polish people does not prevent threats to the natural environment from pollution. This problem is presented in the extract from Map B (Figure 1).

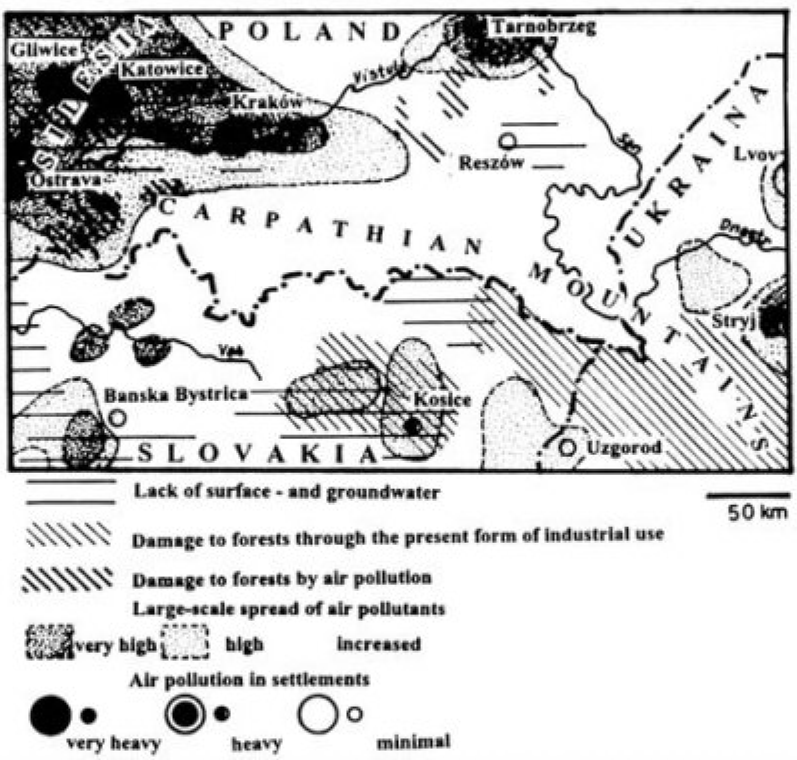


FIGURE 1 Pollution Map of the Carpathian Region

IV

WILDLIFE AND TOURIST MANAGEMENT IN TRANSBOUNDARY PROTECTED AREAS

BIALOWIEZA PRIMEVAL FOREST: HABITAT AND WILDLIFE MANAGEMENT

Henryk Okarma and Wojciech Jedrzejewski
Mammal Research Institute, Polish Academy of Sciences
Boguslawa Jedrzejewska
Workshops for Ecology and Protection of the Natural Environment

INTRODUCTION

Bialowieza Primeval Forest (1451 km^2) is one of the best preserved forest ecosystems in lowland temperate Europe (Falinski 1986). Due to historical changes, the forest complex has been divided between two countries, each of which follow different forest and wildlife management practices.

The aim of this paper is to describe the effects of these practices over the past 50 years on forest structure, ungulate community, and large predators. A further aim is to define the main threats to this unique forest and suggest measures to improve its current status.

HISTORICAL BACKGROUND

The Bialowieza Forest was a royal hunting ground of Polish kings and was strictly protected until the end of the 18th century. After Poland lost its independence in the 19th century, the forest became the czars' game reserve. Several measures were undertaken to promote ungulates, e.g., introduction of alien species (fallow deer, Siberian roe deer), supplementary winter feeding, and persecution of large carnivores. During the two world wars of the 20th century, most game species were decimated and some eradicated. After World War II, the whole forest complex was divided between the Soviet Union (874 km2) and Poland (577 km2), which resulted in two totally different methods of forest and wildlife management. Since 1981, the Polish and Belarusian parts of the forest have been separated from each other by a double wire fence built by the Soviets.

Most of the Polish part of the forest (530 km^2) is a commercial forest (exploited for timber and subject to game management). Only a small part of it (47 km^2) has been strictly protected since 1921 as the Bialowieza National Park (BNP), where neither timber exploitation nor hunting is allowed (see map p. 111). It has been a UNESCO Man and Biosphere Reserve since 1977 and a World Heritage Site since 1979. The entire Belarusian part of the forest has State National Park status, under which several management measures are used. The forests are not exploited for timber, and only dead trees are removed. Ungulates are favored and large carnivores persecuted. In 1993, the entire Belarusian part of the forest was declared a biosphere reserve, with three protection zones (totally protected area, buffer zone, and ecological agriculture zone).

SOURCES OF DATA

Data on species structure and age of tree stands for the Bialowieza Forest were obtained from three sources. For the BNP, data came from the headquarters of Bialowieza National Park (1989 inventory), and for the exploited part from the office of the Bialowieza Forest Administration (1970 inventory). For the Belarusian part, data were provided by the Forestry Department of Belovezhskaya Pushcha State National Park (courtesy of A. Bunevich).

Information on species structure of the ungulate community and density of ungulates also came from three sources. Data for Bialowieza National Park came from a research project on predator community conducted by the Mammal Research Institute (Jedrzejewski et al. 1989, Jedrzejewski et al. 1992), in which snowtracking and driving censuses were used (Jedrzejewska et al. 1994). Data from the exploited part of the forest came from game inventories conducted by game wardens of the Bialowieza Forest Administration, where snowtracking and driving censuses were also used (courtesy of L. Miekowski). For the Belarusian part, the ungulate density data were obtained from the Game Management Department of the Belovezhskaya Pushcha State National Park (courtesy of A. Bunevich). Snowtracking was used for game inventory.

A detailed description of the methodology of forest and game inventory was provided by Jedrzejewska et al. (1994).

FOREST STRUCTURE

The major part of the tree stands in the pristine forest of BNP (72.5%) is dominated by deciduous species: oak (*Quercus robur*), hornbeam (*Carpinus betulus*), alder (*Alnus glutinosa*), lime (*Tilia cordata*), and Norway maple (*Acer platanoides*) (Fig. 1). In spite of the fact that a potential oak-lime-hornbeam forest should have formed in the exploited part of the forest, coniferous stands (54%) with spruce (*Picea abies*) and Scots pine (*Pinus sylvestris*) predominate in nearly 50% of the tree stand. These species have been used for replanting, as they are economically valuable timber species. The practice of clear-cutting has promoted birch (*Betula verrucosa* and *B. pubescens*) and aspen (*Populus tremula*) (13%).

Other deciduous tree species like Norway maple and lime have nearly disappeared as a result of management practices (Fig. 1).

In the Belarusian part of the forest, the natural dominant tree stands are mixed coniferous (mainly Scots pine) with a high proportion of oak. The potential area covered by oak-lime-hornbeam forest is smaller than that in the Polish part of the forest (15%), and the actual area where such tree stands predominate is less than half the size (31%). This decrease was a result of heavy timber exploitation in the 1920s and 1930s. In both the Belarusian part and in the Bialowieza National Park there is the same proportion of tree stands (25%) in which alder, aspen, birch, and ash predominate (Fig. 1).

AGE AND EXPLOITATION OF THE FOREST

The age structure of the tree stands differs in the various areas. Nearly the entire forest of BNP consists of mature stands of natural origin. Stands over 100 years old comprise 67.4% of all tree stands, while young stands less than 40 years old represent only 2.4%. The average age of tree stands is 130 years (Fig. 2).

The majority of the exploited forests are of secondary origin (planted). In 1970, the oldest age classes (over 100 years) constituted 30%, and the youngest (less than 40 years) included 27% of all stands. The average age of tree stands was 72 years (Jedrzejewska et al. 1994). Since data on the age of the exploited forest came from 1970, we can expect that the current average age of tree stands is even lower. However, even comparing data of 20 years' difference for these two parks (Fig. 2), it is evident that management practices have had disastrous effects on the forest and have led to the total degeneration of the natural character of the Bialowieza Forest.

In the protected forest in the Belarusian part, the effect of the heavy cutting of the forest in the 1920s and 1930s is visible in the age structure (Fig. 2). A considerable number of tree stands consist of coniferous replanted tree stands (70 years old on average). Only in younger age classes has the lack of timber exploitation begun to lead to a restoration of the natural age structure of the forest. There is still a large percentage of tree stands older than 100 years, and as a result the average age of all tree stands is 97 years, more than in the Polish exploited part (Fig. 2).

There is an essential difference between the exploitation of the forest in the Polish and Belarusian parts. In the latter, only selective cutting of dead trees takes place, and there have been no clear-cuts or replantations since 1951. The level of timber exploitation per year (1951-1991) was 0.81.7 m^3/ha. In the Polish part, heavy exploitation and large-scale replantation occurs. The level of timber harvest, at 3.04.8 m^3/ha., is on average four times higher.

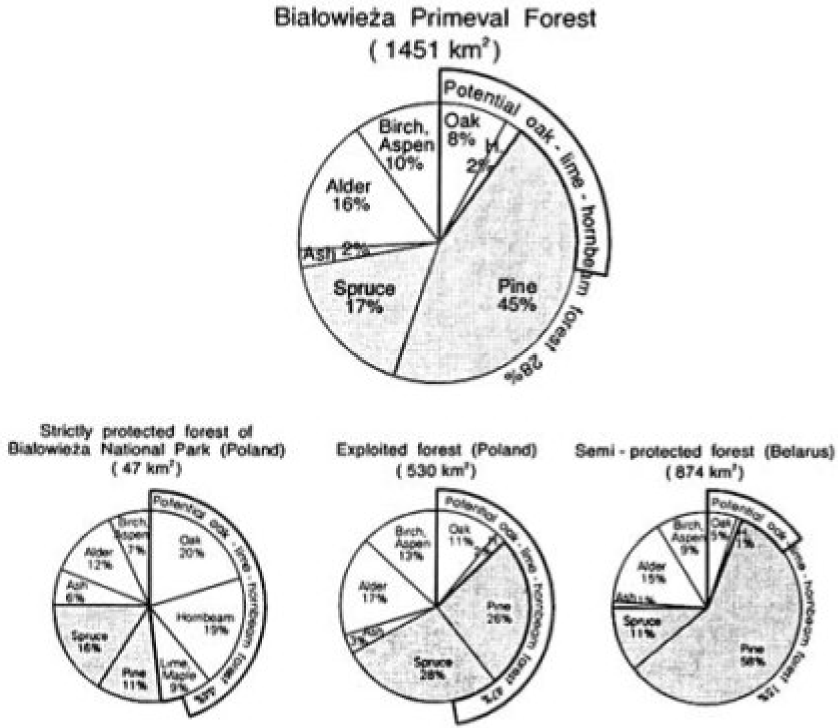


FIGURE 1 Species Composition (shown as percentage area covered by tree stands dominated by a given tree species) of the Strictly Protected Forest of Bialowieza National Park Poland), Semiprotected Part (Belarus) and Exploited Part (Poland) of Bialowieza forest.

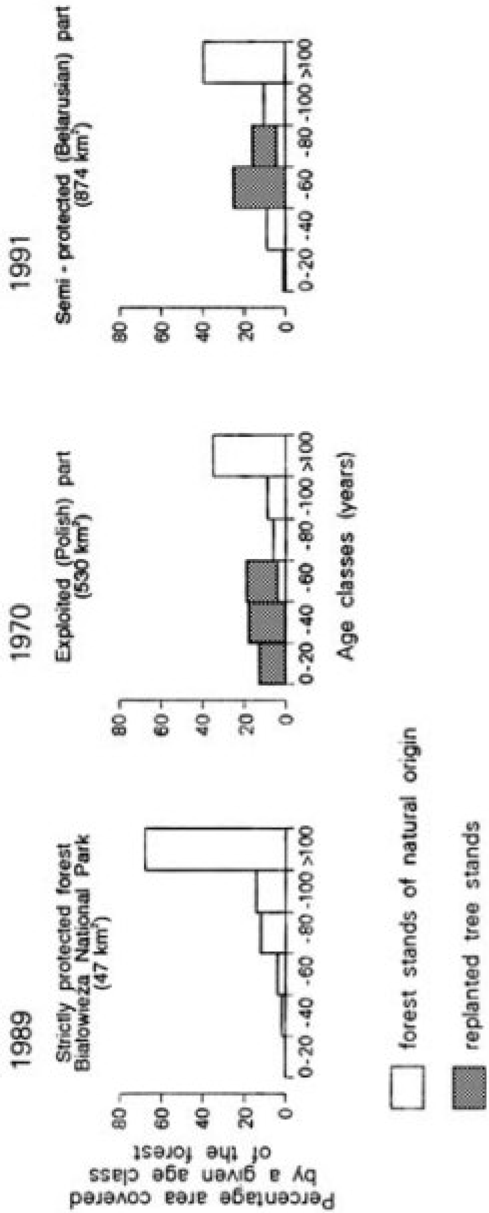


FIGURE 2 Age Structure (shown as percentage area covered by tree stands dominated by a given age class of trees) of the Strictly Protected Forest of Bialowieza National Park (Poland), Semiprotected Part (Belarus) and Exploited Part (Poland) of Bialowieza Forest.

WILDLIFE DENSITY AND MANAGEMENT

Bialowieza Forest harbors a nearly pristine community of ungulates: European bison (*Bison bonasus*), moose (*Alces alces*), red deer (*Cervus elaphus*), roe deer (*Capreolus capreolus*), and wild boar (*Sus scrofa*) (Jedrzejewski et al. 1992). They coexist with two species of large predators: wolf (*Canis lupus*) and lynx (*Lynx lynx*), which are at the westernmost limit of their range in lowland Europe (Okarma 1990, 1993).

There are major differences in ungulate density in the Polish parts of the forest. Within the Bialowieza National Park, ungulate density is very high (Fig. 3). Two species predominate: red deer (12.7 ind/km^2) and wild boar (11.9 ind/km^2). In the exploited forest the density of red deer is two times lower, and wild boar three times lower, while roe deer were more numerous than in the National Park (Fig. 3). These differences in ungulate density could be explained by different species and age structure of the forest (Jedrzejewska et al. 1994). It was found that the total biomass of ungulates-herbivores (European bison, moose, red deer, and roe deer) per unit area was significantly correlated with the percentage of the area covered with tree stands dominated by deciduous trees, while the biomass of ungulates-omnivores (wild boar) correlated with the percentage of the area covered with old tree stands (over 80 years) where production of seeds (primarily acorns) is highest (the average yearly crop was 16.4 tons/km^2 in the Bialowieza Forest). This is why many more ungulates inhabit old-growth deciduous forests in Bialowieza National Park than coniferous-dominated younger forests in the exploited part.

In the Belarusian part of the forest, where coniferous stands predominate, the density of ungulates is much lower (Fig. 3). Red deer and wild boar are dominant species there, but their density is on average six times lower than in Bialowieza National Park.

In the Polish part, all ungulates except European bison are hunted under an annual harvest plan. European bison is a protected species and is excluded from regular game management; its population size is kept stable (recently at a level of about 230-250 individuals) by the National Park authorities by culling several individuals per year (primarily sick and injured ones). Recently there has been a lot of controversy concerning bison management strategy. Foresters have claimed that bison density is too high and that this species causes heavy damage to the forest. Despite the fact that most of this damage is probably caused by red deer (Pucek 1993), the forest authorities still required the number of bison to be reduced.

Until 1990, the harvest of ungulates was on a moderate level in comparison to estimated population size (Table 1). Relatively more wild boar were harvested, but this species also exhibits the fastest potential reproduction rate. During the last two years, the harvest increased drastically (for wild boar up to 50% of the estimated population size). Such a management tendency clearly reflects the attitude of forest authorities toward ungulates (the case of the bison was already mentioned), which they also believe cause excessive damage to replantations.

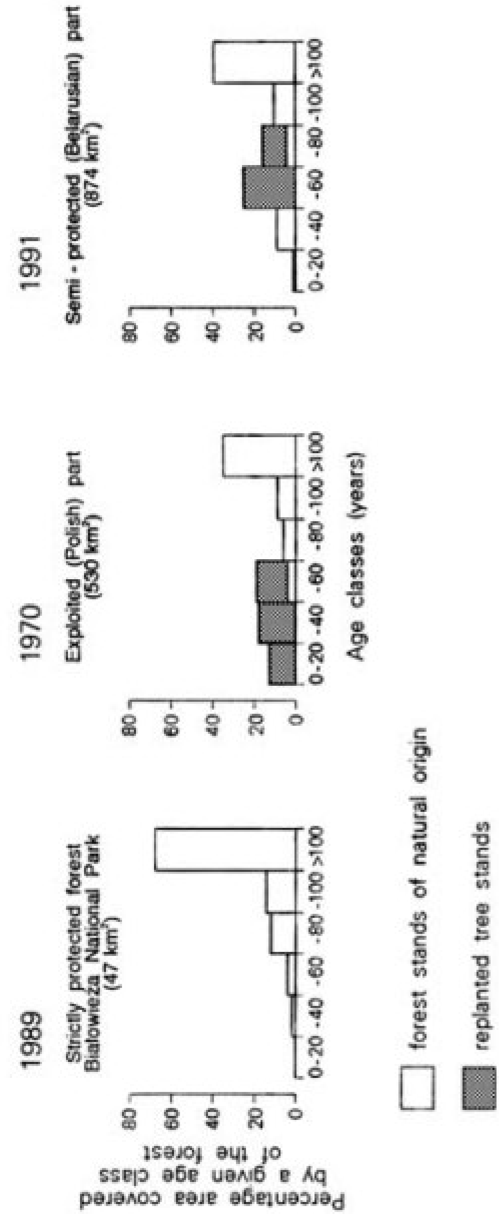


FIGURE 3 Density of Ungulates (N ind/1 km^2) in the Strictly Protected Forest of Bialowieza National Park (Poland), Semiprotected Part (Belarus) and Exploited Part (Poland) of Bialowieza Forest.

TABLE 1 Harvest of Ungulates from the Polish and the Belarusian Part of the Bialowieza Forest in 1988-92. Estimated population Size N (average yearly values), harvest (average yearly values), a

	1988-90			1991-92		
	N[1]	Harvest		N[2]	Harvest	
		N	%		N	%
POLAND						
Red deer	2000	289	14%	286	700	25%
Roe deer	1900	230	12%	2590	540	21%
Wild boar	1200	340	28%	1850	930	50%
BELARUS[3] (1988-92)						
Red deer	1550	156	10%			
Roe deer	900	54	6%			
Wild boar	1590	350	22%			

[1] Since officially reported numbers of ungulates were heavily underestimated (only snowtracking over a grid of 100 ha), estimated numbers of ungulates were taken as to be somewhat lower than an accurate 1991 estimates. Number of ungulates estimated on the basis of driving censuses conducted in winter 1991.

[2] Number of ungulates estimated on the basis of snowtracking censuses. These censuses were conducted over a

[3] grid of 25 ha, which gives an estimate of ungulate density similar to the driving census (Z. Pucek, unpubl. data).

In the Belarusian part of the forest, the bison is also a protected species (about 300 individuals). Only sick individuals are culled, and there is very limited hunting by Western hunters. Red deer, roe deer, and wild boar are harvested under an annual harvest plan, and the harvest is at a similar levels as in the 1970s (Table 1). The level of harvest there was comparable to the harvest in the Polish part up to the late 1980s (Table 1).

Wolf and lynx were persecuted both in the Soviet Union and in Poland in the 1950s. During this period, more than 30 wolves were reported to have been killed in the entire complex of the forest, most of them in the Belarusian part (Fig. 4). In the 1960s and 1970s, the numbers of these predators decreased considerably, and as a result only a few of them were killed (Fig. 4, 5). In the 1980s and 1990s there was a sharp increase in the numbers of wolves killed. More lynx were also killed (Fig. 5). It is impossible to give an accurate number of wolf and lynx inhabiting the forest, because methods of estimating the population size of these species are unreliable (Okarma 1989, 1993; Okarma et al. 1992). However, the numbers given (especially the level of harvest) do reflect some population trends.

Since the late 1980s, management of these species has become different in the two parts of Bialowieza Forest (Okarma 1993). In the Polish part, wolf and lynx have been protected since 1989, but in Belarus lynx only became a protected species in 1993 (Sachanka et al. 1993). Wolves are still heavily controlled, with more than 60% of the estimated population being taken (Fig. 4).

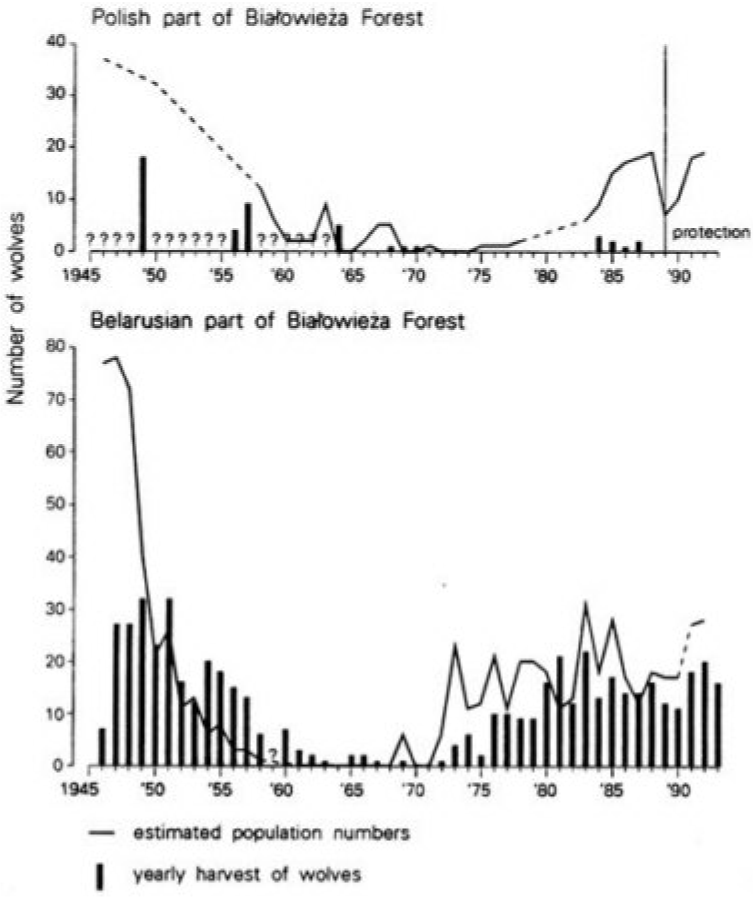


FIGURE 4 Estimated Population Size and Yearly Harvest of Wolves in the Polish and Belarusian Part of Bialowieza Forest in 1948-93

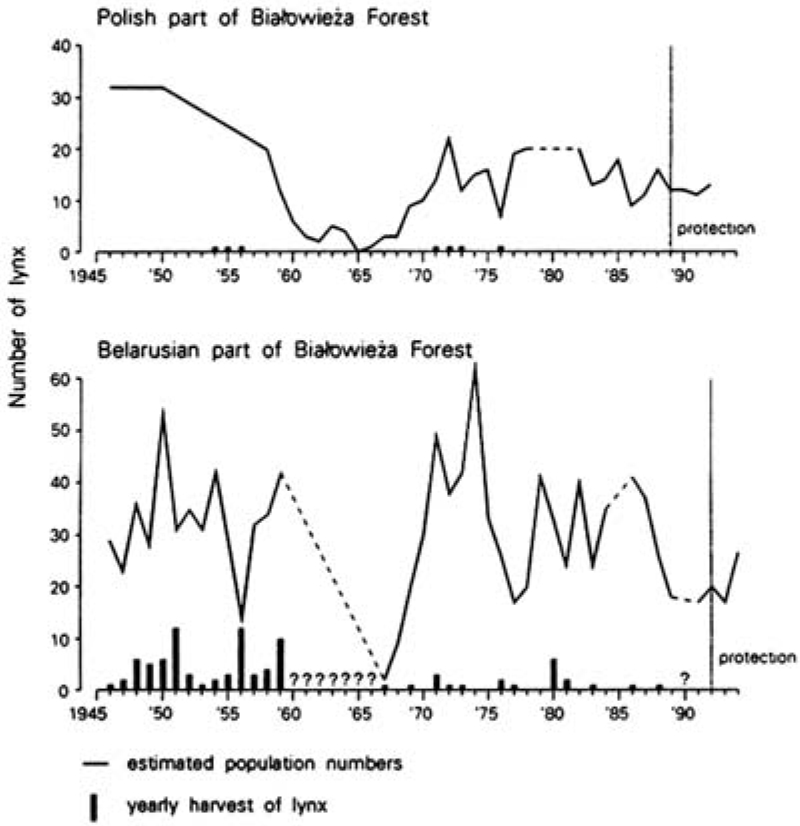


FIGURE 5 Estimated Population Size and Yearly Harvest of Lynx in the Polish and Belarusian Part of Bialowieza Forest in 1948-93.

CONCLUSIONS

- The Bialowieza Forest is still relatively well preserved by European standards; however, it has dramatically lost its primeval character due to forest exploitation. Human intervention has also had a severe effect on the system of ungulates and large carnivores.
- There has been practically no cooperation between the Polish and the Belarusian parts of the forest regarding forest and game management. There is an urgent need for such cooperation, which should include the following:

- stopping the exploitation of the forest and initiating restoration of the natural character of replanted tree stands;

- unifying game management practices in both parks (comparable methods to be employed for the game number inventory, protection of large carnivores in the Belarusian part, and termination of the excessive killing of ungulates in the Polish part of the forest).

- European bison should be considered a priority species in the ungulate community of Bialowieza Forest. This species should be protected, with its number kept approximately at the present level. Accordingly, the density of other ungulates should be limited so that their numbers do not exceed the carrying capacity of the forest. Several measures should be taken to achieve a balance between the food requirements of ungulates and the food supply (e.g., restoration of meadows which underwent secondary forest succession in forest clearings and along river valleys) (Pucek 1993).
- The Bialowieza National Park should be enlarged to include the entire Polish part of the forest (with the three protection zones). The UNESCOMAN requirements for Biosphere Reserves would then be met.

Acknowledgments: We thank K. Zub for preparing the figures.

REFERENCES

Falinski J. B. 1986. Vegetation Dynamics in Temperate Lowland Primeval Forest. Dr W. Junk Publishers, Dordrecht. Geobotany, 8:15-37.

Jedrzejewska B., Okarma H., Jedrzejewski W, Miekowski L. 1994. Effect of Exploitation and Protection on Forest Structure, Ungulate Density, and Wolf Predation in Bialowieza Primeval Forest, Poland. J. Appl. Ecol. [In press]

Jedrzejewski W. Jedrzejewska B., Okarma H., Ruprecht A. L. 1992. Wolf Predation and Snow Cover as Mortality Factors in the Ungulate Community of Bialowieza National Park, Poland. Oecologia (Berl.) 90: 27-36.

Jedrzejewski W., Jedrzejewska B., Szymura A. 1989. Food Niche Overlaps in a Winter Community of Predators in the Bialowieza Primeval Forest. Acta theriol. 34: 487-496.

Jedrzejewski W., Schmidt K., Minkowski L., Jedrzejewska B., Okarma H. 1993. Foraging by Lynx and its Role in Ungulate Mortality: the Local (Bialowieza Forest) and Palaearctic Viewpoints . Acta theriol. 38: 385-403.

Okarma H. 1989. Distribution and Number of Wolves in Poland. Actatheriol. 34: 497-503.

Okarma H. 1990. Status, Distribution and Numbers of Lynx in Poland. Seminar on the Situation, Conservation Needs and Reintroduction of Lynx in Europe. Switzerland, October 1990.

Okarma H. 1992. Following the Lynx. Lowiec Polski 11: 16-17. [In Polish]

Okarma H. 1993. Status and Management of the Wolf in Poland. Biol. Conserv. 66: 153-158.

Okarma H. 1993. Protection and Management of Large Carnivores (Wolf, Lynx) in the Bialowieza Primeval Forest, Poland. Proc. of the Seminar on the Management of Small Populations of Threatened Mammals. Bulgaria, October 1993.

Pucek Z. 1993. European Bison in the Bialowieza Primeval Forest. Echa Lesne 9: 14. [In Polish]

Sachanka B. I., Kurlovich M. M., Malashevich Y. V., Samuel S P. , Khauratovich I. P. (eds.). 1993. Khyrvonaya Kniga Respubliki Belarus. In: Belarusi, Minsk: 35-36.

THE MANAGEMENT OF LARGE MAMMALS IN THE EASTERN CARPATHIANS BIOSPHERE RESERVE

Kajetan Perzanowski, Boguslaw Bobek, W. Frackowiak,
R. Gula, Beata Kabza, and Doreta Merta
Jagiellonian University

INTRODUCTION

Protected areas in Poland are generally rather small, and their management lacks coordination with such surrounding units as state forests and hunting districts (Kabza 1994). Like other protected units in Europe, they are prone to the loss, isolation, and fragmentation of suitable wildlife habitats (Wallis de Vries 1994). Populations of large mammals are particularly difficult to manage due to the considerable home ranges of individuals, and this task becomes even more difficult in the mountains, because of the vertical gradient of habitat conditions (Bobek et al. 1992c).

This paper uses the results of research projects carried out in the Bieszczady Mountains by the Jagiellonian University Department of Wildlife Research to discuss the status of several mammal species in the Eastern Carpathians Biosphere Reserve and to consider the possible implications for management.

MATERIALS AND METHODS

Four species were surveyed to various extents: red deer (*Cervus elaphus*), wolf (*Canis lupus*), brown bear (*Ursus arctos*), and otter (*Lutra lutra*).

The longest and most thorough study involved red deer and considered the following population parameters:

- sex and age structure (Bobek and Kosobucka 1985, Godawa 1989);
- recruitment rate (Kadziela 1984);
- mortality factors, including hunting (Okarma 1984, Perzanowski 1992);
- spatial distribution (Bobek et al. 1984);

- physiological factors (Kapral 1984, Bobek et al. 1990a);
- predator-prey relationships (Bobek et al. 1987, Lesniewicz and Perzanowski 1989, Bobek et al. 1992d); and
- diet composition, habitat selection, and use (Perzanowski et al. 1986, Pis 1986, Bobek et al. 1992c).

In wolves, studies were conducted on nutritional aspects (diet composition, consumption and digestibility of natural foods, and basic metabolism), the impact on potential prey, and conflicts with man (Okarma 1984, Okarma and Koteja 1987, Lesniewicz and Perzanowski 1989, Bobek et al. 1992d, Bobek et al. 1994, Bobek and Perzanowski 1994).

The study on the brown bear focused on population estimates, composition of the natural diet, and damage to livestock and property (Frackowiak and Gula 1992, Frackowiak 1992, Gula 1992, Bobek and al. 1994, Gula and Frackowiak 1994). The population of otters was studied with regard to seasonal changes in the composition of the diet (Harna 1993).

RESULTS AND DISCUSSION

Analysis and discussion will focus on the following factors considered important for the management of the red deer population: a) population trends and distribution; b) interactions with vegetation; c) habitat selection and use; and d) antler quality.

To assess population trends, it is necessary to develop the least intrusive method of population census possible. The proposed method for protected areas, already tested in Bieszczady, is the Langvatn formula, which is based on direct observations and a count of roaring stags (Langvatn 1977, Bobek et al. 1986). Harvest and losses due to predation are undoubtedly the most important mortality factors (Table 1). The spatial distribution of the red deer population in Bieszczady (which has been studied with traditional methods, but soon it is hoped with radiotelemetry) undergoes considerable seasonal changes. Especially important in management are the vertical movements, which begin from wintering areas of high population density and follow the availability of high-quality forage (Fig. 1). This pattern has altered in the last few years as a result of the bankruptcy of former state farms.

Studies on the interactions of the red deer population with vegetation include estimates of the composition of the red deer diet, especially in winter. It has been found that the most important item in that critical season are the evergreen leaves of blackberry (Lankof 1991). This has direct implications for forest management in terms of the appropriate pattern of timber harvest to ensure the maintenance of optimal basal tree area for the regeneration and growth of blackberry (Bobek et al. 1991).

TABLE 1 Average Population Numbers, Harvest and Reported Losses for Five Big Game Species in the Eight Forest Districts of the Bieszczady Mountains (according to State Forest Administration records)

Species	Season	1989/90	1990/91	1991/92	1992/93	1993/94	Average numbers estimated after season
Red deer	H	810	1170	2040	1422	928	2800
	L	232	241	315	253	294	
Roe deer	H	69	134	292	370	283	1800
	L	63	128	93	123	122	
Wild boar	H	171	128	142	44	92	550
	L	83	87	52	54	38	
Wolf	H	22	13	17	16	17	130
	L	0	0	0	0	1	
Lynx	H	2	1	1	0	0	60
	L	0	0	0	0		

Habitat changes caused by forest management have a direct influence on the growth of deer bodies and antlers. There is an optimal ratio of habitats providing food and cover for the rate of growth of an individual (Bobek et al. 1991). That proportion may be disturbed easily by the common practice of planting spruce on former meadows and farmlands.

A still largely unrecognized opportunity to improve habitat for deer is to increase the length of certain ecotones, which may potentially offer better quality food than neighboring forest stands (Moranda 1993, Bobek et al. 1992, Bobek and Merta 1994). This may not only stimulate the growth of bodies and antlers, but also may help to reduce browsing pressure on young stands in the forest. This problem is closely connected with the need to develop environmentally-friendly methods of preventing undesirable browsing and bark stripping. Quite promising results have been obtained from experiments with repellents based on egg yolks, which have already been carried out in Baligrod Forest District (Kasprowicz 1992).

Deer antlers may not seem like a very important factor to be considered in deer management in protected areas, but it is impossible to overlook the fact that, according to rough estimates, the annual revenue from hunting licenses in Bieszczady is approximately 2.5 million dollars. At present, game management remains the most profitable element of forest management within the area of the Biosphere Reserve, and the future development of ecotourism is likely to allow the famous antlers of Bieszczady stags to bring even more income to the region. In addition to genetic and habitat constraints, antler growth may also be reduced seriously by human-related disturbance (Bobek at al. 1990b). This factor should also be considered and controlled by management.

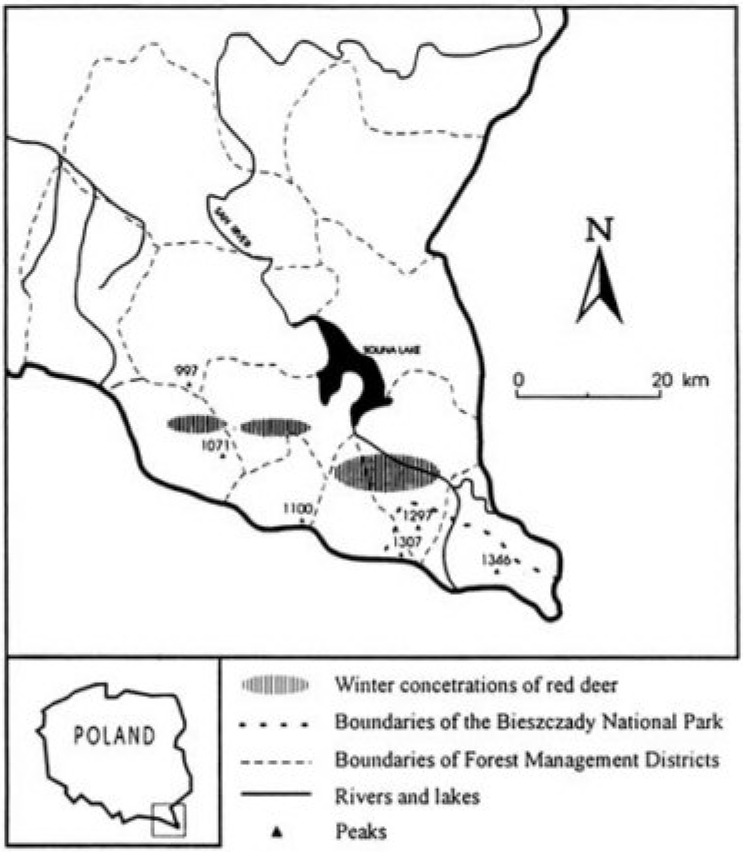


FIGURE 1 Winter Concentrations of Red Deer in Bieszczady National Park

Another crucial component of wildlife in Bieszczady is the wolf. Studies of the diet of wolves in winter (on the basis of stomach contents) and over the entire year (on the basis of scat analyses) reveal that deer are the most important item (Lesniewicz and Perzanowski 1989, Smietana and Klimek 1993). The old questions regarding the influence of wolves on a deer population were answered by a study of the condition, sex, and age of wolf kills, as were suspicions about the possibility of wolves killing prime stags at the end of winter. It was proved that even if some stags, exhausted after the rut, do fall prey to wolves by the spring, the frequency of such cases is low, and the majority of animals killed under normal weather conditions were individuals almost depleted of fat reserves (Bobek et al. 1990, Okarma 1991, Bobek et al. 1992d).

The population of brown bears in Bieszczady has grown considerably since the 1960s. The most visible effect is the seasonal increase in bear activity in the spring, when they feed on carrion laid out by hunters as bait for wolves and wild boar. A study of diet shows quite a high percentage of agricultural crops, and the bear may become one of the most important nuisance species in Bieszczady if its numbers continue to grow (Table 2) (Frackowiak 1992, Gula 1992, Bobek et al. 1994). Implementing a program for monitoring and assessing the population is thus absolutely necessary.

Finally, the otter, considered almost extinct a few years ago, was found to be relatively widely distributed across the range. The diet of this species is more than 60% fish, but the species eaten most frequently are small and unimportant from the recreational or economic viewpoints. However, since the trout (*Salmo trutta*) is the most important item in terms of biomass, otters may potentially compete to some extent for fish with anglers and become a nuisance at fish ponds (Harna 1993).

Since the majority of the area in Bieszczady is either intensively penetrated by people or directly managed and exploited in various ways, relations between wildlife species and human populations are quite important. Wolves and bears occasionally prey on livestock (Table 3). According to the latest findings, the best way to reduce the possibility of such conflicts is to maintain high densities of potential prey in the forest and to continue the harvest of large predators outside protected areas at a stable level (Perzanowski 1992, Bobek et al. 1994).

CONCLUSIONS

High densities of deer are desirable not only for hunters but also from the recreational point of view. This can be achieved if forest management measures are oriented towards improving the habitat for wildlife rather than increasing maximal

TABLE 2 Damages Done by Bears to Livestock and Beehives in the Bieszczady Mountains in the Period 1988-92 (Kwiatkowski 1993)

Year	1988	1989	1990	1991	1992
Item					
Bee-hives	16	90	138	56	27
Cattle	11	20	15	4	—
Sheep	79	92	29	69	—
Other	1	3	2	7	—

TABLE 3 The Numbers (A) and the Percentage of Total Number of Sheep Grazing in the Bieszczady Mountains (B) Killed by Wolves in the Period 1988-92 (Lesniak 1993)

Years	1988	1989	1990	1991	1992
A	295	315	243	296	307
B	0.36	0.30	0.32	0.49	1.06

timber yields. Since the size of the average protected area is generally too small to encompass viable populations of large herbivores, let alone large predators, it is absolutely necessary to have a management plan for game species which is coordinated with the State Forest Administration. It is also essential to carry out management of the entire Bieszczady range instead of continuing with today's ineffective and unrealistic attempts to treat protected areas as isolated units. A future approach to the management of large mammals should follow the basic principles of ecology and should thus take the natural trends and requirements of these animals into account.

Finally, there is an unavoidable need to limit to a reasonable level the degree of human interference within the area designed for strict protection. The creation of the Biosphere Reserve in Bieszczady provides at least an opportunity to separate the tasks of wildlife protection and management among the areas belonging to various zones of the Reserve.

REFERENCES

Bobek B., Boyce M.S., Kosobucka M. 1984. Factors Affecting Red Deer (*Cervus elaphus*) Population Density in Southeastern Poland. J. Appl. Ecology 22, 3: 881-891

Bobek B., Perzanowski K., Zielinski J. 1986. Red Deer Population Census in Mountains: Testing of an Alternative Method. Acta theriol. 31: 423-431.

Bobek B., Perzanowski K., Weiner J. 1990a. Energy Expenditure for Reproduction in Male Red Deer. J. Mamm. 70, 2: 230-232.

Bobek B., Kosobucka M., Krzakiewicz A., Perzanowski K., Wolf R. 1990b. Food, Cover and Human Disturbance as the Factors Influencing Antler Weight in Red Deer (*Cervus elaphus L.*). Proc. 19th IUGB Congr., Trondheim, 1989: 27-34.

Bobek B., Perzanowski K., Bielak M. 1991. Analysis of Forest Habitats for Successful Roe and Red Deer Management in Central Europe. In: Wildlife Conservation - Present Trends and Perspectives for the 21th Century. N. Maruyama, B. Bobek, Y. Ono, W. Regelin, L. Bartos, P.R. Ratcliffe (eds.). Proc. Int. Symp. on Wildlife Conservation, Tsukuba and Yokohama, 1990: 244pp.

Bobek B., Kosobucka M., Perzanowski K., Rebisz S. 1992a. Seasonal Changes in the Group Size and Sex Ratio in Various Populations of Red Deer in Southern Poland. In: B. Bobek, K.Perzanowski, W. Regelin (eds.). Global Trends in Wildlife Management. Trans. 18th IUGB Congress. Vol.2. Swiat Press. Cracow-Warsaw: 185-192.

Bobek B., Kossak S., Merta D. 1992b. The Effect of Ecotone Length on Quality of Red Deer Habitat in Mountain Forest. Sylwan 6: 51-58. (in Polish with English summary)

Bobek B., Morow K., Perzanowski K., Kosobucka M. 1992c. Red Deer (*Cervus elaphus L.*) - Its Ecology and Management. Swiat Press, Warsaw: 200pp. (in Polish)

Bobek B., Perzanowski K., Smietana W. 1992d. The Influence of Snow Cover on the Patterns of Selection within Red Deer Population by Wolves in Bieszczady Mountains, Poland. In: B. Bobek, K. Perzanowski, W. Regelin (eds.). Global Trends in Wildlife Management. Trans. 18th IUGB Congress. Vol.2. Swiat Press, Cracow-Warsaw: 341-348.

Bobek B., Perzanowski K., Merta D. 1993. The Workplan for Eastern Carpathians Biosphere Reserve. Msc. presented as a poster at 4th EURO MAB Conference. Zakopane, 1993: 6pp.

Bobek B., Merta D. 1994. The Effects of Ecotones on the Weight of Red Deer Antlers in Southeastern Poland. Proc. 1st Int. Wildlife Manage. Congr. Wildlife Society. San Jose, Costa Rica, 1993. (in print)

Bobek B., Perzanowski K. 1994. Intake and Digestibility of Various Natural Diets by Wolves. J. Wildl. Res. (in print)

Bobek B., Perzanowski K., Kwiatkowski Z., Lesniak A., Seremet B. 1994. The Economic Aspects of Brown Bear and Wolf Predation in Southeastern Poland. Proc. 1st Int. Wildlife Manage. Congr. Wildlife Society. San Jose, Costa Rica, 1993. (in print)

Frackowiak W. 1992. The Seasonal Changes in the Diet Composition of Brown Bear (*Ursus arctos*) in the Bieszczady Mountains. Ninth International Conference on Bear Research and Management, Grenoble, France. Abstract 3.6.

Frackowiak W., Gula R. 1992. The Autumn and Spring Diet of Brown Bear (*Ursus arctos*) in the Bieszczady Mountains of Poland. Acta theriol. 37,4: 339-344.

Godawa J. 1989. Age Determination in the Red Deer (*Cervus elaphus*). Acta theriol. 34, 28: 381-384

Gula R. 1992. The Density and the Age Structure of the Population of Brown Bear (*Ursus arctos*) in the Bieszczady Mountains, Poland. Ninth International Conference on Bear Research and Management, Grenoble, France. Abstract 2.7.

Gula R., Frackowiak W. 1994. Size and Age Structure of the Brown Bear (*Ursus arctos*) Population in the Bieszczady Mountains, Poland. J. Wildl. Res. 1: 000-000. (in print)

Harna G. 1993. Diet Composition of the Otter (*Lutra lutra*) in the Bieszczady Mountains, Southeast Poland. Acta theriol. 38,2: 167-174.

Kabza B. 1994. Biosphere Reserves in Poland: Expectation, Realization and Projection. J. Wildl. Res. 1: 000-000. (in print)

Kadziela M. 1984. The Analysis of Fecundity in Red Deer Hinds. Msc. Jagiellonian University, Krakow. (in Polish).

Kapral M. 1984. Seasonal Dynamics of Body Weight in Red Deer in Southeastern Poland. M.Sc. Thesis. Jagiellonian University, Krakow. (in Polish).

Kasprowicz A. 1992. Estimation of Damage Caused by Red Deer in Fir Plantations and Efficiency of "Emol" Repellents. Sylwan 11: 19-33. (in Polish with English summary)

Kwiatkowski Z. 1993. The Evaluation of Damages Caused by Brown Bears in Southeastern Poland. M.Sc. Thesis, Jagiellonian University. Krakow, Poland. (in Polish).

Langvatn R. 1977. Social Behavior and Population Structure as a Basis for Censusing Red Deer Population. Proc. 13th IUGB Congr., Atlanta: 77-89.

Lankof 1991. The Diet of Red Deer in Bieszczady Mountains. M.Sc. Thesis, Jagiellonian University, Krakow. (in Polish).

Lesniak A. 1993. The Evaluation of Damages Due to Wolf Predation in Southeastern Poland. M.Sc. Thesis, Jagiellonian University, Krakow, Poland. (in Polish).

Lesniewicz K., Perzanowski K. 1989. The Winter Diet of Wolves in Bieszczady Mountains. Acta theriol. 34,27: 373-380.

Moranda J. 1994. The Evaluation of Ecotone Length in Selected Forest Habitats of Bieszczady. M.Sc. Thesis, Jagiellonian University, Krakow, Poland. (in Polish).

Okarma H., Koteja P. 1987. Basal Metabolic Rate in the Gray Wolf in Poland. J. Wildl. Manage. 51,4: 800-801.

Okarma H. 1984. The Physical Condition of Red Deer Falling Prey to the Wolf and Lynx and Harvested in the Carpathian Mountains. Acta theriol. 29,23: 283-290

Okarma H. 1991. Marrow Fat Content, Sex and Age of Red Deer Killed by Wolves in Winter in the Carpathian Mountains. Holarctic Ecology 14: 169-172.

Perzanowski K., Pucek T., Podyma W. 1986. Browse Supply and its Utilization by Deer in Carpathian Beechwood (*Fagetum carpaticum*). Acta theriol., 31,8: 107-118.

Perzanowski K. 1992. The Economic Aspects of Wolf Predation in Bieszczady Mountains. Proc. Conf. "Wolf in Europe: Current Status and Prospects" Wildbiologische Gesellschaft, Munchen: 126-129

Pis M. 1986. Debarking of Fir (*Abies alba*) in Cisna Forest District. M.Sc. Theses, Jagiellonian University, Krakow. (in Polish)

Smietana W., Klimek A. 1993. Diet of Wolves in the Bieszczady Mountains, Poland. Acta theriol. 38,3: 245-251.

Wallis se Vries M.F. 1994. Foraging in a Landscape Mosaic. Cip- Gegevens Koninklijke Bibliotheek, Den Haag. 161pp.

OLYMPIC ELK: PARALLELS TO RED DEER MANAGEMENT IN TRANSBOUNDARY PROTECTED AREAS OF CENTRAL EUROPE

David M. Leslie, Jr.
U.S. National Biological Service

INTRODUCTION

Biological diversity in any protected area is affected, in part, by the manner in which populations of large herbivores are managed. Any management activities that influence densities of large herbivore populations, such as harvesting or feeding, will in turn affect qualitative and quantitative aspects of biological diversity in a given area. Those management activities that foster high-density populations of large herbivores are likely to have the greatest impact on biological diversity, although a conclusion that high densities will always reduce diversity is not clearly defensible (Denisiuk et al. 1992). In contrast, the complete absence of large herbivores, or their occurrence at very low densities, may result in a reduction of floral diversity (Happe 1993). Clearly, large herbivores—whether endemic or domestic—have the potential to play a key role in the conservation of biological diversity because of their trophic influence on vegetative composition and structure (Leslie 1983, 1986; Leslie et al. 1984, Happe 1993).

In the United States, large herbivores typically are not managed in national parks (i.e., our highest level of protected areas), which has resulted in high-density populations of a variety of ungulate species. Densities that are apparently in excess of some acceptable carrying capacity (Caughley 1976) have caused considerable debate in the United States for decades (e.g., Houston 1982, Wright 1992). Lack of hunting, the loss of major predators at primeval densities (often they were deliberately extirpated), ill-advised feeding programs that can artificially inflate carrying capacity, and refuging of individuals from altered landscapes or human activities outside a protected area can exacerbate problems associated with high density.

On several occasions during this workshop, the advantages and disadvantages of feeding programs for large wild herbivores, particularly red deer (*Cervus elaphus*; i.e., elk in North America) and European wisant (*Bison bonasus*) were discussed. Such programs are common and socially rooted throughout Europe and currently practiced in the transboundary biosphere reserves that were the focus of the workshop; they are uncommon in the United States (but see Boyce 1989, Smith and Robbins 1994). Feeding programs theoretically can be used to enhance winter survival and increase population levels of common game species beyond the existing carrying capacity of local habitats, so as to provide the public with more hunting opportunities. Alternately, feeding programs can be used to improve habitat conditions for and enhance recovery of endangered species such as the European wisant.

The population of Roosevelt elk (*C. e. roosevelti*) in Olympic National Park (Moorhead 1994) is a North American example of an ungulate population that is unregulated by man. The lack of human-induced regulation of this population and the extirpation of predators, particularly wolves (*Canis lupus*), have caused ongoing concern over the condition of the forage base and the elk themselves. Both conditions have permitted various elk herds in the Park to persist at high densities for over 60 years (Houston et al. 1978, 1990). Elk in Olympic National Park have not been fed by man. The overview that follows permits a general comparison to red deer management in transboundary protected areas of Central Europe, particularly the comparison of unfed and fed ungulate populations and their subsequent impact on biological diversity.

STUDY AREA

Olympic National Park encompasses 3,600 sq. km of pristine old-growth coniferous temperate rainforest in the center of the Olympic Peninsula, Washington, in the extreme northwestern corner of the United States. Copious rainfall typifies much of the Park, particularly on its western side; for example, precipitation at the Hoh Ranger Station on the west side of the Park averages about 350 cm annually. Most of the precipitation below 600 m is rain, but sporadic and ephemeral snowfall usually occurs each winter below this elevation. Temperatures are mild and reflect the maritime influence of the Pacific Ocean.

Vegetation in old-growth forests on the Olympic Peninsula is very heterogeneous. Dominant overstory species include Sitka spruce (*Picea sitchensis*), western hemlock (*Tsuga heterophylla*), and Douglas fir (*Pseudotsuga menziesii*). Forests of red alder (*Alnus rubra*) and willow (*Salix* spp.) occur in valley bottoms near glacial rivers, and big-leaf maple (*Acer macrophyllum*) stands dominate certain edaphic sites. Fonda (1974) associated forest development with a seral chronosequence along river terraces in valley bottoms and argued that given enough time, each would progress toward a western hemlock climax. Others have concluded that much of the Park is a Sitka spruce-western hemlock disclimax (Franklin 1982), perhaps due in part to herbivory by a high-density collective population of elk and Columbian black-tailed deer (*Odocoileus hemionus columbianus*) (Leslie 1983). Because of the moderate and moist climate, many individual trees have a copious cover of cryptogams and other epiphytes; drapes of mosses about 1 m are common on big-leaf maple branches.

As many as 44 species of mammals have been documented in the Hoh Valley on the western side of Olympic National Park. Elk and black-tailed deer are the most conspicuous herbivores, but slugs (*Ariolimax* spp.), snowshoe hare (*Lepus americanus*), and mountain beaver (*Aplodontia rufa*) no doubt contribute significantly to the overall consumption of the flora, and thus influence biological diversity. Populations of predators in the Park were reduced greatly in the early 1900s, and little is known of their specific ecologies today. Extant predators include cougar (*Felis concolor*), black bear (*Ursus americanus*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*). Cougar sightings have increased substantially in the Park during the past 10 years, which suggests that their populations are increasing.

HISTORY OF ELK IN OLYMPIC NATIONAL PARK

The 3,600 sq. km at the center of the Olympic Peninsula was set aside as a national monument under the initial jurisdiction of the U.S. Forest Service, primarily to protect populations of Roosevelt elk, which were decreasing at an alarming rate due to unregulated market hunting at the turn of the century (Moorhead 1994). Authority over the area was transferred to the U.S. National Park Service in the 1930s, and it became a national park in 1938. Concern over low numbers of elk helped establish Olympic National Park, originally proposed to be named Elk National Park, but concern over high numbers of elk, now protected with hunting prohibited, has dominated many of the subsequent years of the Park's history.

Happe (1993:9-12) recently provided a historical overview of research on the Roosevelt elk population in Olympic National Park, with specific reference to concern over elk densities. The relationship between elk and deer (referred to as cervids below) densities and the apparent overused condition of the vegetation in the Park have been of perennial concern to Park managers since at least the 1920s. Prior to settlement of the Olympic Peninsula in the late 19th century, cervids were plentiful. Within 10 years of settlement, however, cervid numbers were decimated due to market and subsistence hunting. With protection and deliberate predator extermination, cervid numbers (particularly elk) increased to the point that Park managers were concerned that the population had surpassed the ability of the habitat to support it.

Although thorough censuses of the Park's cervid population were not conducted in the 1920s and 1930s, it is possible (in my opinion, likely) that elk populations in particular exceeded carrying capacity during the period, which led to range or forage deterioration as described in early reports (Bailey 1918, Riley 1918, Murie 1935, Sumner 1938, Schwartz 1943, Schwartz and Mitchell 1945).

During several severe winters in the first third of the 20th century (1915-1916, 1917-1918, and two winters between 1933-1937), large winter kills of elk were reported, which suggested that the population was above carrying capacity and that the forage base had been negatively affected by a high-density cervid population. Population estimates of elk ranged from 5,000 to 8,000 during the period. Notable North American wildlife biologists of the time (e.g., A. Muire) expressed concern that elk were overpopulated in the Park. Interestingly, these were exactly the conditions that have prompted wildlife managers to begin feeding programs elsewhere in the United States, perhaps the most notable being the Jackson Hole elk herd in Wyoming, a population that is still fed in winter today largely because of socio-political rather than resource considerations (Boyce 1989, Smith and Robbins 1994). Feeding programs were never undertaken in Olympic National Park, perhaps because the very low-density human population in the area did not cause much public outcry over winter die-offs.

Because of concerns of overpopulation of elk, the prohibition on hunting in the Park was lifted in 1933, but hunting again ceased after the Park's establishment in 1938 (following legislative mandate, hunting generally is not permitted in national parks in the United States). Little attention was directed toward cervid numbers in the Park until the severe winter of 1949 and the associated large die-off of elk. Once again, park personnel focused on the population densities of elk and their apparent negative effect on forage resources. Newman (1954, 1958) concluded, however, that although (1) densities were high, (2) the potential for large winter kills existed, and (3) the forage base was heavily used, the situation appeared to be self-regulating and "natural," despite the lack of predators.

More recently, studies of elk in Olympic National Park have attempted to quantify the complex relationships between habitat and forage use (Jenkins 1980, 1981, Jenkins and Starkey 1982, 1984; Leslie 1983, 1986; Leslie and Jenkins 1985; Leslie et al. 1984, 1985, 1987; Schroer 1986; Happe et al. 1990; Happe 1993; Schroer et al. 1993) and ultimately test the hypothesis that cervid numbers in the Park are self-regulating around ecological carrying capacity, as determined by a dynamic equilibrium between herbivore numbers and availability of useable plant biomass (Caughley 1976). Herbivores at ecological carrying capacity are by definition at high density, have low reproductive output, increased longevity, and may not be in the best physical condition (i.e., just the opposite of the conditions we hope to see in actively managed game populations or domestic herds—a condition referred by Caughley [1976] as economic carrying capacity). Most of this research supports the notion that the collective cervid population in the Park, which is clearly dominated by Roosevelt elk (Leslie 1983), is at equilibrium with its forage base, as hypothesized by Leslie et al. (1984) and recently supported by Happe (1993).

DISCUSSION AND SUMMARY

Maintenance of large herbivore populations at ecological carrying capacity brings a number of consequences that, on the surface, may appear detrimental to objectives focused on the conservation of biological diversity. For example, numerous biologists working over the years in Olympic National Park have noted the impact of herbivory on the shrub layer; browsing maintains an open, park-like understory in many habitats in Olympic's old-growth forests by restricting growth of common shrub layer species. Several preferred shrubs (e.g., elderberry [*Sambucus racemosa*], thimbleberry [*Rubus parviflorus*], and Devil's club [*Oplopanax horridum*]) only grow out of reach of cervids or in areas of restricted access (e.g., on root wads of fallen trees, in steep ravines, or in areas of intense human activities) (Leslie 1983, Leslie et al. 1984). Similarly, growth of salmonberry (*Rubus spectabilis*) and ladyfern (*Athyrium filix-femina*) is retarded dramatically by cervid herbivory (Happe 1993). Selective consumption of tree seedlings by high-density cervids may have influenced the present species composition of some of Olympic's old-growth forests (Leslie 1986).

Herbivory by high-density cervids in Olympic National Park perhaps has its most important impact on the herbaceous and shrub layers by creating and perpetuating grass-dominated patches in what would otherwise be fern- and shrub-dominated forest understories (Happe 1993). Exclosure studies to exclude cervid grazing and browsing at various locations throughout the Park have shown that the shrub layer of some forest types would be dominated by a near monoculture of salmonberry or ladyfern (Leslie 1983, Happe 1993), obviously resulting in a reduction of floral diversity at that site, due to the shading out of various herbaceous species. Happe (1993) concluded that herbivory in the Park created a "more favorable foraging environment" for cervids than would exist if their densities were low or if they were eliminated (as illustrated by exclosure studies). With regard to floral diversity, Happe (1993) documented increased floral species richness on small spatial scales, and long-term, cervid herbivory enhanced the diversity of plant associations in old-growth forest matrix. Grazing by both endemic and domestic ungulates enhances floral diversity in Karkonosze Biosphere Reserve (F. Krahulec, pers. commun.). Similarly, empirical observations in Polish protected areas indicate that grazed areas support higher floral diversity than ungrazed areas (see Denisiuk et al. 1992).

Alteration of the vegetative structure by high-density herbivores, as described above, likely has a pronounced impact on invertebrate and vertebrate taxa that are dependent on particular plant species and structure for food, shelter, etc. Clearly, complete removal of the shrub layer by herbivores in a forested ecosystem would eliminate, for example, shrub-dependent nesting birds, which may be the case in Bialowieza Biosphere Reserve in Poland (L. Tomialojc, pers. commun.) as a result of red deer and wisant herbivory. Alternately, such herbivory could enhance nesting or feeding opportunities for ground-dwelling species. Unfortunately, such effects have not been quantified or investigated in detail in Olympic National Park, or in other protected areas to my knowledge. Typically, high rates of herbivory by large ungulates have been viewed as negative or destabilizing, but specific impacts to floral and faunal diversity are obscure or not available.

Clearly, herbivores can have an impact on the biological diversity of localized areas in which they occur, and the nature of that impact will vary depending on their densities. It seems plausible to conclude that if a feeding program had been established in Olympic National Park such that cervid densities were even higher, impacts to the flora would be even greater than those described above. Theoretically, winter feeding of cervids can elevate population levels (by increasing winter survival, normally a period of high mortality [Peek 1986]) beyond the capacity of the habitat to sustain the population at other times of the year, or at least force animals to depend on parts of the forage base not normally used due to low palatability and nutrition (e.g., bark or species of low preference, such as spruce [*Picea* spp.]). Under such conditions, pernicious impacts to biological diversity—first floral and in turn faunal—would be expected.

Clearly, more research is needed to refine the generalizations briefly outlined above. Much of the early work in Olympic National Park did not directly address the issue of herbivore impacts to biological diversity; one can only speculate from narrative accounts. Even contemporary work in the Park has not been designed with the particular intent to evaluate this timely issue. Similarly, effects of feeding programs in Central Europe to elevate herbivore population levels, or maintain artificially high levels, and the subsequent impact on biological diversity needs to be evaluated in detail. At this time, it is theoretically clear that overt manipulation of herbivore numbers, through programs such as feeding and habitat alterations to benefit a few species, affects our ability to conserve biological diversity. Further investigation is needed to quantify these interrelationships fully and to insure adequate conservation of the biological diversity of transboundary protected areas.

ACKNOWLEDGMENTS

I am grateful to the U.S. National Park Service for funding my research and that of others in Olympic National Park over the years and to K. J. Jenkins and E. E. Starkey, who continually advise me on technical aspects of elk research in temperate rainforests. My participation in this workshop was made possible by the National Research Council, Office for Central Europe and Eurasia; the Polish Academy of Sciences; and the U.S. National Biological Survey.

REFERENCES

Bailey, V. 1918. Report on Investigation of Elk Herds in the Olympic Mountains, Washington. Unpublished report, Olympic National Park files, Port Angeles, Washington, USA.

Boyce, M. S. 1989. The Jackson Elk Herd: Intensive Management in North America. Cambridge University Press, Cambridge, England.

Caughley, G. 1976. Wildlife Management and the Dynamics of Ungulate Populations. Pages 183-246. In: T. H. Croaker, editor. Applied Ecology, Volume I. Academic Press, London, England.

Denisiuk, Z., A. Kalemba, T. Zajac, A. Ostrowska, S. Gawlinski, J. Sienkiewicz, and M. Rejman-Czajkowska. 1992. Interactions Between Agriculture and Nature Conservation in Poland. Environmental Research Series 6, International Union for Conservation of Nature and Natural Resources, East European Program, Gland, Switzerland.

Fonda, R. W. 1974. Forest Succession in Relation to River Terrace Development in Olympic National Park, Washington. Ecology 55: 927-942.

Franklin, J. F. 1982. Ecosystem Studies in the Hoh River Drainage, Olympic National Park. Pages 1-8. In: E. E. Starkey, J. F. Franklin, J. W. Matthews, editors. Ecological Research in the Parks of the Pacific Northwest. Forest Research Laboratory, Oregon State University, Corvallis, Oregon, USA.

Happe, P. J. 1993. Ecological Relationships Between Cervid Herbivory and Understory Vegetation in Old-Growth Sitka Spruce-Western Hemlock Forests in Western Washington. Ph.D. Dissertation, Oregon State University, Corvallis, Oregon, USA.

Happe, P. J., K. J. Jenkins, E. E. Starkey, and S. H. Sharrow. 1990. Nutritional Quality and Tannin Astringency of Browse in Clearcuts and Old-Growth Forests. Journal of Wildlife Management 54: 557-566.

Houston, D. B. 1982. The Northern Yellowstone Elk: Ecology and Management. MacMillan Publishing Company, New York, New York, USA.

Houston, D. B., B. B. Moorhead, and R. W. Olson. 1987. Roosevelt Elk Density in Old-Growth Forests in Olympic National Park. Northwest Science 61: 220-225.

Houston, D. B., E. G. Schreiner, B. B. Moorhead, and K. A. Krueger. 1990. Elk in Olympic National Park: Will They Persist Over Time? Natural Areas Journal 10: 6-11.

Jenkins, K. J. 1980. Home Range and Habitat Use by Roosevelt Elk in Olympic National Park, Washington. M.S. Thesis, Oregon State University, Corvallis, Oregon, USA.

Jenkins, K. J. 1981. Status of Elk Populations and Lowland Habitats in Western Olympic National Park. Unpublished report, Oregon Cooperative Park Studies Unit, Oregon State University, Corvallis, Oregon, USA.

Jenkins, K. J., and E. E. Starkey. 1982. Social Organization of Roosevelt Elk in an Old-Growth Forest. Journal of Mammalogy 63: 331-334.

Jenkins, K. J., and E. E. Starkey. 1984. Habitat Use by Roosevelt Elk in Unmanaged Forests on the Hoh Valley, Washington. Journal of Wildlife Management 48: 642-626.

Leslie, D. M., Jr. 1983. Nutritional Ecology of Cervids in Old-Growth Forests in Olympic National Park, Washington. Ph.D. Dissertation, Oregon State University, Corvallis, Oregon, USA.

Leslie, D. M., Jr. 1986. How Animals Shape an Old-Growth Forest. American Forests 92(9): 42-44, 50.

Leslie, D. M., Jr., and K. J. Jenkins. 1985. Rutting Mortality among Male Roosevelt Elk. Journal of Mammalogy 66: 163-164.

Leslie, D. M., Jr., and E. E. Starkey. 1985. Fecal Indices to Dietary Quality of Cervids in Old-Growth Forests. Journal of Wildlife Management 49: 142-146.

Leslie, D. M., Jr., E. E. Starkey, and B. G. Smith. 1987. Forage Acquisition by Sympatric Cervids along an Old-Growth Sere. Journal of Mammalogy 68: 430-434.

Leslie, D. M., Jr., E. E. Starkey, and M. Vavra. 1984. Elk and Deer Diets in Old-Growth Forests in Western Washington. Journal of Wildlife Management 48: 762-775.

Moorhead, B. B. 1994. The Forest Elk: Roosevelt Elk in Olympic National Park. Northwest Interpretive Association, Seattle, Washington, USA.

Murie, O. J. 1935. Wildlife of the Olympics. Unpublished report, Olympic National Park files, Port Angeles, Washington, USA.

Newman, C. C. 1954. Special Report on the Roosevelt Elk of Olympic National Park. Unpublished report, Olympic National Park files, Port Angeles, Washington, USA.

Newman, C. C. 1958. Final Report on the Roosevelt Elk of Olympic National Park. Unpublished report, Olympic National Park files, Port Angeles, Washington, USA.

Peek, J. M. 1986. A Review of Wildlife Management. Prentice Hall Publishers, Englewood Cliffs, New Jersey, USA.

Riley, S. 1918. Memorandum to Washington Department of Fish and Game. Unpublished memorandum, Olympic National Park files, Port Angeles, Washington, USA.

Schroer, G. L. 1986. Seasonal Distribution and Movements of Migratory Roosevelt Elk in the Olympic Mountains, Washington. M.S. Thesis, Oregon State University, Corvallis, Oregon, USA.

Schroer, G. L., K. J. Jenkins, and B. B. Moorhead. 1993. Roosevelt Elk Selection of Temperate Rain Forest Seral Stages in Western Washington. Northwest Science 67: 23-29.

Schwartz, J. E. 1943. Range Conditions and Management of the Roosevelt Elk on the Olympic Peninsula. U.S. Forest Service files, Olympia, Washington, USA.

Schwartz, J. E., and G. E. Mitchell. 1945. The Roosevelt Elk on the Olympic Peninsula, Washington. Journal of Wildlife Management 9: 295-319.

Smith, B. L., and R. L. Robbins. 1994. Migrations and Management of the Jackson Elk Herd. U.S. National Biological Survey Resource Publication 199, Washington, DC, USA.

Sumner, L. 1938. Special Report on Elk in Olympic National Park. Unpublished report, Olympic National Park, Port Angeles, Washington, USA.

Wright, R. G. 1992. Wildlife Research and Management in the National Parks. University of Illinois Press, Urbana, Illinois, USA.

A PROPOSED SYSTEM OF CROSS-BORDER PROTECTED AREAS IN THE EASTERN BORDER REGION OF POLAND

Grzegorz Rakowski
Institute of Environmental Protection

INTRODUCTION

For many years, there has been insufficient investment in the areas along the eastern border of Poland (the "eastern wall"), and consequently these areas now suffer from depopulation. This condition is also the result of the remoteness of these areas from economic centers and the almost total lack of cross-border traffic and local cross-border trade until 1989. Although it has had an obvious negative impact on the economy, this situation, which has lasted for over 45 years, has contributed to the retention of many relatively little-modified areas of high natural and landscape value. Devoid of industry, these sparsely-populated border regions were only rarely visited by tourists because of strict rules relating to stays and travel within the border zone. Similar areas have been retained on the other side of the border in the states which emerged after the disintegration of the USSR, where until recently the border rules were even more rigorous. A considerable portion of these areas on both sides of the border have lacked proper protection up to now.

The change in the political situation in 1989, and in particular the disintegration of the USSR in 1991, has encouraged a spontaneous and explosive development in the traffic of people and goods at the ever-increasing number of border crossings. Extensive areas near border crossings and along routes leading to them are undergoing systematic and rapid degradation, which poses a serious threat to nature. It is therefore essential that the most valuable border areas be brought under legal protection as quickly as possible. However, for this protection to be fully effective, similar steps also must be taken by Poland's eastern neighbors, who are facing similar problems.

The highly valuable natural and landscape features of border regions could also be a basis for promoting tourism in these areas. Currently, traffic at the Polish border crossings is dominated by visitors from neighboring countries who tend not to be involved in tourism. However, it may be supposed that genuine tourists and citizens of western European countries will constitute an ever greater part of this traffic. Many tourists in transit may be attracted if border areas are protected and managed properly, if the infrastructure is developed (obviously while ensuring the protection of the most valuable natural features), and if the area is appropriately advertised. The enjoyment of the most valuable and attractive border areas, such as the Romincka, Augustowska, and Bialowieska Forests (Puszczas) or the Bieszczady Mountains, could become the main reason for Polish and foreign guests to visit. The attractiveness of these areas would be enhanced considerably were it possible for tourists to visit the entire area of an integral ecological complex regardless of state borders. Moreover, staking the future on tourism would provide an opportunity for the economic development of border regions in Poland and neighboring countries.

All those aspects are included in the concept of a system of Cross-Border Protected Areas (TOChs, a Polish abbreviation standing for Transgraniczne Obszary Chronione), the principles for which were established in 1992 at the Institute of Environmental Protection in Warsaw and the Institute of Tourism in Warsaw. In the first phase of preparation, data were collected on protected areas, valuable natural features, and the tourist economy of border areas of eastern Poland, Russia's Kaliningrad District, southwestern Lithuania, western Belarus, western Ukraine, and northeastern Slovakia. On the basis of the data, eight areas have been nominated as qualifying for protection as cross-border protected areas (TOCh), and a preliminary scheme has been produced. This plan includes the principles by which TOCh areas would function and by which tourism would develop in them.

CREATION OF CROSS-BORDER PROTECTED AREAS

Following are the main aims of the scheme for the system of Cross-Border Protected Areas (TOCh):

- Protecting those areas in Poland's eastern border region that are most valuable from the standpoints of nature and landscape;
- Intensifying cooperation between Poland and her eastern neighbors in environmental protection and tourism; and
- Developing tourism in border areas, thus furnishing an opportunity for the voivodeships and gminas (provinces and civil parishes) of the "eastern wall" and the border regions of neighboring countries to emerge from economic stagnation.

The main principles of the scheme include:

- Creating a system of Cross-Border Protected Areas along Poland's eastern border at sites selected as the most valuable in terms of nature and landscape. These areas can and should include currently-existing protected areas: national parks, landscape parks, nature reserves, zapovedniks and zakazniks (nature protection areas in the former USSR referred to as nature reserves), as well as other areas which are environmentally valuable but not yet protected.
- Developing common nature protection regulations for the neighboring countries and establishing principles of tourist traffic within Cross-Border Protected Areas to allow for the possibility of visits to some areas lying either side of the border (e.g., by means of a special tourist zone or special border crossings for tourists).
- Designating special zones with a primarily touristic function around, at the edges of, and within these areas (in cooperation with the authorities of neighboring countries), and constructing or enhancing the infrastructure in these areas while preserving valuable natural features.
- Jointly organizing tourism in these areas (guides, specialist groups, ecotourism) and conducting advertising and promotional campaigns (e.g., by producing brochures, tourist maps, books, press advertisements, and offers for travel agencies).

Following is a proposal on the operating principles and status of Cross-Border Protected Areas:

- Cross-Border Protected Areas are to be ecological corridors connecting Poland's Extensive System of Protected Areas (WSOCh) with the systems of protected areas of our eastern neighbors. These areas should have a status similar to that of Polish Landscape Parks. Independent of the international status of the protected area, individual parts of a given TOCh should be under the protection of a given state in a form typical of that state, e.g., as national parks, landscape parks, nature reserves, zakazniks, zapovedniks, etc.
- The parts of a TOCh on the territories of each of the neighboring countries should be composed of designated functional areas. For the Polish parts, the most appropriate form would seem to be a union of gminas (civil parishes). Such gminas making up a TOCh should acquire the status of ecological gminas.
- In the course of drawing up spatial management plans, several zones of different status must be distinguished within the TOCh:

- A zone of strict protection, including the areas most valuable for nature: strict reserves and national parks, or parts of them. Economic activity should be completely banned in these areas, and only tourism of a specialized nature should be permitted, such as hikes along designated scientific or didactic trails, guided groups of specialists, and visits by individual tourist-naturalists who have obtained suitable permit-passes.

- A zone of landscape protection, including the areas most valuable in terms of landscape. Forestry management should be permitted in these areas, along with traditional forms of management (agricultural production without fertilizers, health foods, beekeeping, etc.). This zone would be earmarked for qualified tourism, including hiking, boating, bicycling, and skiing, as well as more sedentary forms based on stays in guesthouses or private accommodations.
- A recreational and economic zone, including the edges of the areas most valuable in terms of nature and landscape, as well as some settlement enclaves in the interior. Various forms of economic activity would be permitted here, provided they are in accord with the principles of sustainable development (harmonious coexistence between human activities and the functioning of nature). Industry and intensive agriculture would be excluded. Sedentary forms of tourism would develop primarily in this zone, with small hotels and lodges, centers for tourist services and information, and tourist equipment rental establishments.

- The appropriate implementation of the protective aims of individual TOCh areas should be overseen by an international scientific board. Such boards should be composed of scientists from the neighboring countries who know the area and its problems very well, directors of smaller autonomous protected areas (e.g., national parks, landscape parks and zapovedniks) within the TOCh, and environmental protection officials of the local governments.
- In order to fulfill the assumption that tourism in TOCh areas is to be one of the economic bases sustaining the local population, it would be useful if special tourist bureau-agencies could be created to organize, promote, and advertise ecotourism in the areas of a TOCh on both sides of the border. Among other things, these agencies would handle hotel bookings; organize the rental of private accommodations; develop a network of guesthouses and tourist equipment rental centers; organize services for specialized groups; train guides; publish brochures, maps, guidebooks, and other materials; draw appropriate attention to the region's greatest natural and landscape attractions capable of attracting foreign tourists; and promote concepts of sustainable development and ecotourism among the local population. By regulating the scale of tourist traffic within a TOCh, these agencies would ensure that the number of tourists staying in a given place at a given time would not exceed the maximum permissible number. The income from these bureau-agencies would augment the finances of the union of gminas making up the TOCh areas.

The most important problems associated with the creation of a TOCh are:

- Differences in nature protection regulations between Poland and neighboring countries;
- Different forms and systems of protected areas in individual countries, as well as different principles by which they function;
- Differences in the system of administrative divisions, in the legal status of individual administrative units, and in the rights of local governments;
- Border crossings within a TOCh and the principles by which they would function, as well as international tourist traffic in these areas;
- Acceptance by the local population and local government of the idea of the TOCh and of the principles by which such areas function (sustainable development, eco- and agrotourism); and
- Threats to the valuable natural features of cross-border areas posed by mass traffic in transit, uncontrolled tourist traffic, and the contamination of waters air.

Eight Cross-Border Protected Areas have been preliminarily designated and are shown on the map:

Zalew Wislany (Vistula Lagoon) TOCh

Located on the border between Poland and the Kaliningrad District of Russia, this area will include the Vistula Spit (of which the Polish part is at present a landscape park, while the Russian part is a nature reserve) and almost the entire Vistula Lagoon and its western edges (which includes the Elblag Elevation Landscape Park in the Polish part and the Balga Reserve in the Russian part).

This area has exceptionally favorable conditions for the development of sailing tourism in summer and ice-boating in winter with a large marine basin sheltered from the sea and the proximity of the urban cluster of The Triple City (Gdansk-Gdynia-Sopot), Elblag, and Kaliningrad. There are very good conditions here for sedentary tourism associated with sunbathing and swimming. Almost devoid of people, the Vistula Spit is ideal for ecotourism. Furthermore, the leeward shore of the Vistula Lagoon is characterized by exceptionally valuable landscape as well as by the presence of valuable groupings of historic buildings.

The Suwalsko-Wisztyniecki (Suwalki-Vistytis) TOCh

This area lies on the borders of three countries: Poland, Russia (Kaliningrad District), and Lithuania. On the Polish side, it would comprise the southern part of Puszcza Romincka (the Romincka Forest), as well as Suwalki Landscape Park. On the Russian side, this TOCh would include the northern part of Puszcza Romincka with two areas enjoying landscape protection: the Krasnaya (Bledzianka) River

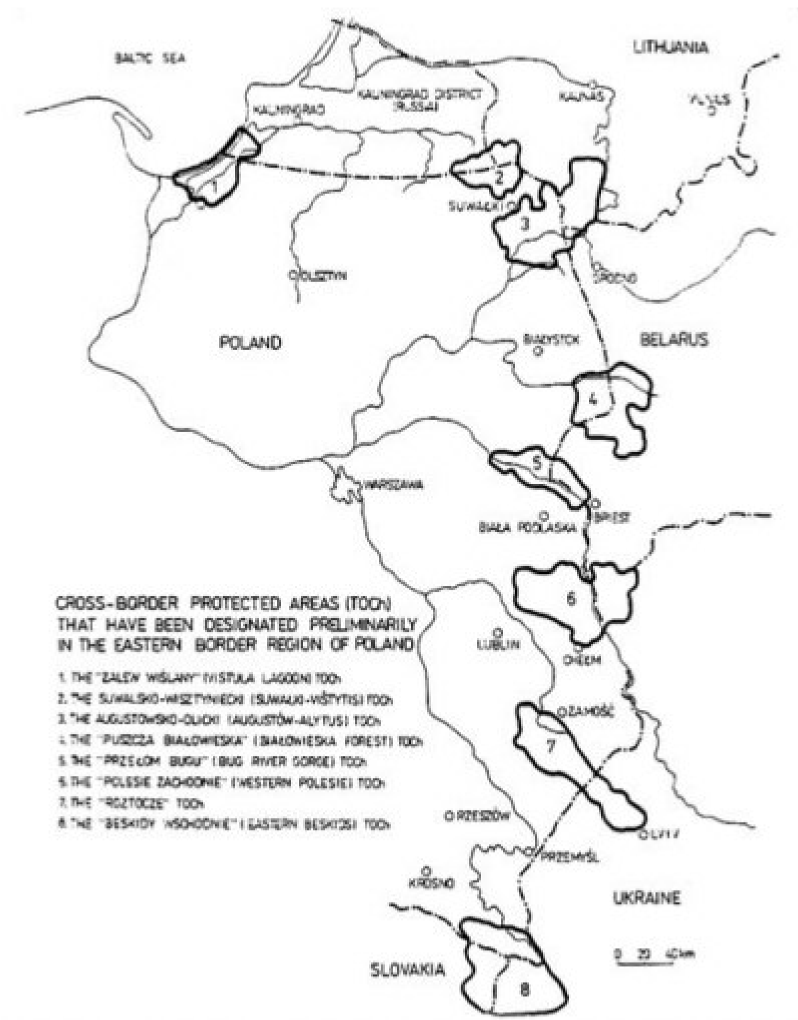


FIGURE 1 Transboundary Protected Areas on Poland's Eastern Border

valley and Lake Vistytis, situated on the border with Lithuania. On the Lithuanian side, this area would encompass Vistytis Regional Park, which is situated east of Lake Vistytis near the border with Poland and Kaliningrad District.

The Romincka Forest area is of outstanding natural value. For several centuries it has been a hunting area famous throughout Europe, a favorite of the rulers of Prussia and later of Germany, and it enjoyed strict protection prior to World War II. The natural and historical value of the Romincka Forest can be compared to that assigned to the Bialowieza Forest, and the opening up of this area for sightseeing and exploration will certainly attract many tourists, especially from Germany. In turn, Suwalski Landscape Park and Vistytis Regional Park in Lithuania are areas of particularly valuable landscape with post-glacial landforms. The attractive landscape and suitable climatic conditions (allowing for winter skiing) create favorable conditions for the development of varied forms of tourism here all year round.

The Augustowsko-Olicki (Augustow-Alytus) TOCh

This area is situated on the borders of three countries: Poland, Lithuania, and Belarus. On the Polish side, it would include Wigierski National Park, as well as Puszcza Augustowska (the Augustow Forest) and parts of the Sejny Lakeland east of Sejny. On the Lithuanian side, this area would encompass the northeastern edge of Puszcza Augustowska, as well as Meteliai and Veisiejai Regional Parks and the adjacent part of the Neman River Valley. On the Belarusian side, this area would include the southeastern edge of Puszcza Augustowska along with Sopockinskij Reserve and part of the adjacent Neman River Valley.

The huge forested area of Puszcza Augustowska combines with lakelands of outstanding landscape value to create perfect conditions for the development of ecotourism. An additional attraction is the prospect of bringing the cross-border section of the Augustow Canal back into use. A European-scale tourist attraction would be created by setting up canoe routes joining the Augustow Lakes, or Lake Wigry, with the Neman River, and by establishing tourist passenger transport from Augustow (Poland) to Grodno (Belarus) or Druskininkai (Lithuania).

In the future, it would be possible to increase the area of the TOCh considerably by adding environmentally valuable areas on the border between Lithuania and Belarus. The TOCh would then include a large, compact area of forest stretching from Augustow almost as far as Vilnius.

The Puszcza Bialowieska (Bialowieska Forest) TOCh

An area straddling the border between Poland and Belarus, this TOCh would embrace the whole of Puszcza Bialowieska, including Belovezhskaya Pushcha National Park and Dikoye Reserve on the Belarus side, as well as Poland's Bialowieski National Park. The creation of an international Polish-Belarusian Biosphere Reserve is also proposed for the whole of the Bialowieska Forest.

The Bialowieska Forest has an established international reputation as an area of outstanding natural value and as a natural refuge of the European bison. The chance to visit both parts of the forest will certainly encourage increase interest in this area and will attract many tourist-naturalists.

The Przelom Bugu (Bug River Gorge) TOCh

This area is situated on the border between Poland and Belarus. It would include the part of the Bug River Valley between Brest and Drohiczyn, as well as adjacent areas on both sides of the border. Plans call for creating a landscape park in the Polish part.

This valuable landscape has a the gorge-like river valley and high morainic hills. This area also has features of sightseeing and cultural interest due to the large number of historic buildings preserved there. In the future, the TOCh should come to encompass the entire border section of the Bug River Valley. It is a phenomenon unique in Europe that the valley of such a large river has a landscape which, as a result of its border location, has changed so little.

The Zachodnie Polesie (Western Polesie) TOCh

Situated on the border between Poland and Ukraine, this area includes on the Polish side Poleski National and Landscape Parks, Leczna Lakeland Landscape Park, Bubnow Marsh Nature Reserve, and Sobiborski, Chelmski, and Strzelecki Landscape Parks. On the Ukrainian side, the area would include Satsk National Park and adjacent areas, as well as the proposed Liubomelskij, Lukivskij, and Pribuzskij Landscape Parks and a fragment of the Bug River Valley forming the national border.

The proposed TOCh is an area of outstanding natural value, protecting the Polesie landscape with its marshes, lakes, forests and numerous sites for rare flora. This landscape is ideal for ecotourism. The area could possibly be enlarged considerably by including large, naturally-valuable marshes on the border between Ukraine and Belarus.

The Roztocze TOCh

This area lies on the border between Poland and Ukraine. On the Polish side, it would embrace Roztoczanski National Park, Szczebrzeszynski Landscape Park, Puszcza Solska Landscape Park, and Krasnobrodzki and Poludniowo-roztoczanski (South Roztocze) Landscape Parks. On the Ukrainian side, it would include Roztocze Zapovednik, the proposed Roztocze National Park, the proposed Potielieckij and Niemirivskij Landscape Parks, and adjacent areas.

Featuring outstanding terrain both in terms of nature and landscape, its attractiveness is increased by the proximity of valuable groups of historic buildings (Zamosc, Zovkva, Lviv), which make it possible for various forms of qualified and sedentary tourism to be enjoyed here.

The Wschodnie Beskidy (Eastern Beskid Mountains) TOCh

This area is located on the borders of Poland, Ukraine, and Slovakia. Included on the Polish side are Bieszczadzki National Park, Cisniansko-Wetlinski Landscape Park, and Dolina Sanu (San River Valley) and Jasliski Landscape Parks. Included on the Slovak side will be the Vychodne Karpaty Protected Area (Chranena Krainna Oblast). Included on the Ukrainian side will be Stuzica Zapovednik, the proposed Skolivski Beskidy National Park, the proposed Orivskij and Sianskij Landscape Parks, and adjacent areas. The central part of the proposed TOCh was brought under protection in 1993 as East Carpathian International Biosphere Reserve.

The Bieszczady Mountains and the Eastern Carpathians have long been exceptionally popular with tourists. After the creation of an international protected area here, this area of valuable landscape and natural features will become a great attraction for tourists, including those from Western Europe. The assets of this area are gorgeous landscapes which cannot be encountered in other mountain ranges, fragments of natural montane forest, sites for rare flora, animal refuges, and partly-preserved folk culture and historic buildings. Among the basic forms of tourism which may develop in this area are hiking, "survival school"-type tourism, and winter recreation associated with the snow.

In the future there are possibilities for this TOCh to be enlarged considerably. It could ultimately include the entire range of the Carpathians on the borders of Poland, Slovakia, Ukraine, and Romania. In this range, there are already numerous extensively protected areas of various rank.

The final number, sizes, and boundaries of cross-border protected areas will be defined in successive stages of the program's implementation expected in the coming years. In the course of further work, detailed projects for each of these areas should be worked on by teams of specialists from Poland and the neighboring countries.

INTERNATIONAL COOPERATION

The TOCh idea was presented at a conference called at the initiative of Poland and held in Brest (Belarus) in October 1992. Participants included representatives from the governments, nature protection services, and scientific institutions of Belarus, Lithuania, Kaliningrad District, Poland, and Ukraine. In the final signed communique, participants approved the TOCh idea and obligated themselves to take steps to implement it. The Institute of Environmental Protection in Warsaw, in close cooperation with scientists from the above mentioned countries, is continuing to work on implementation of the TOCh concept.

RECREATION AND TOURISM MANAGEMENT IN PROTECTED AREAS

Thomas A. Heberlein
University of Wisconsin - Madison

INTRODUCTION

Dealing with recreation and tourism is one of the most difficult aspects of natural area management. Tourists are both a potential resource and a problem. Managers have little training in recreation management and often have a biocentric orientation. Because of this focus on protection, recreation management seems different than and less important than natural system management. Addressing recreation management in this context, this paper makes three points. First, tourism and recreation in the parks and preserves should be approached from a scientific perspective. Recreation management should be based on sound scientific methods and data rather than on intuition and windshield judgment. Second, tourists should be viewed as an asset for preserves and protected areas. Finally, the paper discusses some of the potential and problems for ecotourism.

SCIENCE AND RECREATION MANAGEMENT

We all believe in the important role of science in managing natural systems. One would not try to manage preserves without adequate inventories of the species as well as a knowledge of their locations and functions. Ecosystem management relies heavily on the use of science. The resource manager is required to base resource management decisions on scientific information.

But what about visitors? What about the large two-legged mammals that are seasonal migrants to parks and preserves (i.e., tourists)? I suggest that we know much more about red deer and bear than we know about humans in the preserves. Simply because a manager is a member of the species homo sapiens, that does not mean that he or she has any special knowledge about the patterns of visitor use and the social trends affecting these patterns. Like any large species, humans can impact the ecosystem. Their visitation patterns can cause other species to change their behavior, they can affect plants by trampling, and their behavior can affect the behavior and experiences of other visitors. But such judgments about the human impact on the ecosystem should be made on the basis of strong scientific data, rather than on intuition and guesses. Yes, humans might have an impact, but they should not be assumed to have an impact in the absence of data; and if they do have an impact, it should be compared carefully to the impacts of other animals and practices, including management practices and biological scientific inquiry. In short, human behavior in the parks should be the subject of careful scientific study.

There are a variety of ways to go about such studies. The first step, however, is to involve trained social scientists as part of the research process. Just as sociologists would not be likely to conduct an adequate study of beaver ecology, we should not expect a mammalogist or forester to be able to design and analyze credible studies of human behavior in preserves. When the independent variables are characteristics of the humans and when the dependent variables are characteristics of the ecosystems, then both social and natural scientists should be involved. This kind of interdisciplinary research is often complicated, but with enough commitment on both sides it can be done (See Heberlein, 1988 for a discussion of the difficulties of involving social science and natural science research).

Because humans are verbal, unlike other mammals in ecosystems, there is a strong tendency to interview them and to conduct some sort of survey. While surveys are common in the sociologist's kit bag of tools, much can be learned about human behavior by using techniques that biological scientists use to understand nonhuman animals in preserves, namely observation.

Working at Crater Lake National Park in the United States, Bo Shelby and his associates learned a good deal about visitors and the visitor experience from observation. They randomly selected automobiles headed for the main parking area in Crater Lake. They then randomly selected a visitor leaving the car and followed him or her, recording the length of time that he or she participated in recreational activities. They discovered that the central parking lot, which resembled the large parking lot in a shopping center, actually attracted people to the shops and stores. Often a visit to Crater Lake began with a stop at the store rather than a look at the lake. Visitors often spent as much or more time in the store or the rest rooms than they spent actually looking at the lake. Shelby and his associates hypothesized that this was because of the location of the parking lot. They asked the managers if they could randomly close off the parking lot for several hours or days as an experiment to determine how the parking lot configuration might influence visitation patterns. There was an alternative parking lot nearby and closer to the prime resource that visitors could use instead. The managers were uncooperative with the scientists and refused permission. Fortunately, a maintenance person contacted Professor Shelby and notified him that the parking lot would be closed the next day for resurfacing. This served as a natural experiment. Shelby and his colleagues found that when the main parking lot was unavailable, people parked farther away from the lot and spent more time observing the lake and less time in the shops. [These data are unpublished, but are available from Bo Shelby at Oregon State University, USA]. Heberlein and Dunwiddie (1978) also discovered an interaction between experience level and camping patterns simply by observing campers at a high mountain lake.

The experience at Crater Lake National Park illustrates that:

- One can learn useful things about the visitor experience from observation.
- It is possible to take advantage of naturally occurring changes as experimental manipulations.
- Park managers are not always very cooperative with social scientists.

Social scientists have also taken advantage of natural variation at Grand Canyon National Park to study the effects of crowding on the Colorado River, which flows through the bottom of the canyon in the park. Observers were placed on boats to count the number of contacts between parties in periods of low usage and high usage. These data provided the basic information to establish a social carrying capacity on the river (Shelby and Heberlein, 1986). Shelby also conducted a planned field experiment to determine the difference between an oar and motor experience on the river. Visitor surveys showed that both types of visitors enjoyed their trips. But the vast majority of visitors made only one trip, so they did not have both experiences. Shelby set up a situation where visitors, when half the way on an oar- or motor-powered trip, changed to the other type of trip halfway along the trip (Shelby, 1980). The visitors were surveyed after their oar and motor experience. The data showed that when they had both experiences, the visitors preferred the oar-powered experience and that the experiences were quite different.

These examples show how both observation and experiment, two basic tools of science, can be used to provide information about the large mammals (i.e., human beings) in parks. In addition to this kind of on-site management, the human research agenda should include systematic data collection on visitor numbers and activities. This can be done using various procedures. These would include the analysis of registrations and other statistics, counts along trails and at campgrounds at randomly selected periods, intercept surveys of visitors, and mailed or telephone surveys of past visitors. It is also important to gather data on people who do not visit preserves. The question of who is not coming is necessary to determine who is being served by the reserves themselves. To truly understand the function these preserves in the current social system, non-visitors should be the subject of at least some scientific inquiry.

Our focus on tourists here should not obscure the need to understand scientifically the other homo sapiens in parks. These include those who live there, often called managers and workers. Scientists also represent another migratory group that visits parks, and they engage in different behaviors than tourists. Sometimes their behaviors involve catching and tagging or collaring and tracking animals, digging up plants, etc., something the typical tourist would never be allowed to do. Why are some homo sapiens permitted to engage in certain behaviors and not others? In many cases their numbers and behaviors should be documented and the causes and effects on the park be carefully measured. Another group that deserves scientific attention are the residents who live in or around the parks. Management often has great effects on their well-being. Conversely, their behaviors can have great effects on the parks. The point is simply that if we are truly going to understand preserves and protected areas as part of the social system, as they really are, then all groups must be studied, and there must be a blending of social, biological, and physical science in the preserves.

A recent report of an American tourist in Poland might be useful here. The report indicated that he had to wait three days to get into the preserve and then could only do so with a guide (Wolff, 1994). How much data about the tourist experience is available to the manager? Do we know what the average waiting time is for visitors? Are data available on the distribution of waiting times? How many visitors wait, and does this vary by the time of year and by type of visitor? These are all scientific questions that can be answered by careful analysis. Knowing this information can help provide better experiences. The second issue is the need for a guide. Is there scientific evidence that visitors without guides do more damage to the forest than those with guides? Or are we simply requiring guides on the basis of hunch and tradition? This could be answered by experimental design. Some visitors could be allowed in the forest without a guide, and biologists could determine the impact of these visitors. There is also an effect on the social economy. What local benefits do the guides provide, and what affects the supply of guides so that visitors have to wait as long as three days? Finally, the report suggests that the preserves are being run by the "scientific mafia." Is this true? Sociologists could study decision-making in the preserves to better document which human groups, scientists, tourists, local landowners, environmentalists, etc. are having the most influence.

TOURISTS AS AN ASSET

Since many managers complain about problems with tourists and recreationists, I think it is important to point out that these groups of humans can be an asset to parks and preserves. Managers seldom doubt that managers are beneficial to parks. They often, but not always, think that scientists are an asset to parks. But they often see tourists as a problem. Tourists take staff time, are difficult to control, and frequently need assistance.

To place this question in perspective, we might ask why we have parks and preserves in the first place. At the most general level, they exist to provide benefits to humankind. One of these benefits is for science. These sites are necessary to conduct scientific inquiry. But who benefits from this inquiry? Most often it is the scientist him or herself. One gets the joy of discovery, the opportunity to be in the field, and the scientific recognition for work well done. The scientific community perpetuates the ideology that the entire society benefits from their research. To a certain extent this is true, but it is more definite and certain that the scientist benefits more than the society benefits. The science done in a preserve represents only one use value for humans from the preserve.

The human who visits a preserve when he or she is not working (thus a manager or a scientist can sometimes be a park visitor) is a recreationist. He or she gets recreational benefits from the park. Sometimes the person may be "collecting data" much like the scientist, such as the birder who is adding to his or her "life list." The recreationist could be a hunter who is taking game. He or she could also be someone who is looking for solitude, or trying to see new species. These are all personal benefits and are appropriate uses of preserves. Thus, if one wishes to increase the total benefits to society from preserves, one should be interested in recreation and tourism just as one is interested in science and preservation.

Second, tourists are an asset because they provide economic support for preserves. Tourists bring money. This can help the local communities and people around the preserves. There is often conflict between rural people who live near preserves and the preserves themselves. The rural people are concerned that the preserve, which "locks up" resources for consumptive uses, will take away their livelihood. If the recreational visitors to a park or preserve provide local jobs (such as guides, park rangers, or housing), then the tourists can help the local economy. This is not to imply that large influxes of tourists are ALWAYS beneficial, but with the right controls and limitations they may be very beneficial. To establish such controls it is again necessary to have good data on the human populations. Tourists can also provide resources for the preserves. Fees and contributions are the obvious direct factors. In addition, some tourists are eager to work on research projects and donate some of their skills to park maintenance and management.

Third, tourists and recreationists provide political support for preserves and parks. This is increasingly important in a democratic society. In pluralistic debates one has to demonstrate social support for a variety of activities. It is clear that managers and scientists will support preserves, but the public increasingly demands more direct benefits. The recreationists themselves become an important political force in supporting preserves. They also generate secondary support from those who benefit from tourism, such as people in the local communities.

In short, the clever park or preserve manager should want a healthy recreation population (homo sapiens) just as he or she wants a healthy population of other plants and animals in parks.

ECOTOURISM

Ecotourism is a new concept that directly applies to many of the transboundary preserves in Central Europe. Ecotourism as a concept tries to mold an unlikely alliance between environmental preservation, the marketing emphasis of tourism planning, and rural economic development. Ziffer (1989) quotes a Mexican journalist who states that ecotourism is a "pragmatic new concept…[where] capitalism and conservation join together to fight for the same cause: wildlife preservation at a profit." Nature tourism is leisure travel to natural wildlands that have been preserved for their unusual flora, fauna, or aesthetic qualities, and it provides an experience of authentic and intimate contact with outdoor phenomena (Ingram and Durst, 1987). Ecotourism adds to this concept a concern for the well-being of the local communities and culture surrounding the wildland resource. It envisions tourism as a means for local people to diversify their economies and improve their standard of living by developing locally-owned businesses to serve a growing ecotourism market. In partnership with local economic development, ecotourism aspires to preserve wild areas and local cultures. Ziffer (1989) states, "The ecotourist practices non-consumptive use of wildlife and natural resources and contributes to the visited area through labor or financial means aimed at directly benefiting the conservation of the site and economic well-being of the local residents."

Ecotourism provides potential for many of the preserves in the transboundary area. Tourism is a large and growing industry worldwide. The World Tourism Organization claims that tourism is the second largest industry (behind oil) in the world, producing between $195 billion in annual receipts (Whelan, 1991) and $2 trillion in annual receipts (Ziffer, 1989). This same organization predicts that tourism will be the world's largest industry by the year 2000. Nature tourism as a subset of the entire industry also appears to be growing. Tourism experts suggest that as much as 10% of the leisure-related travel among Americans and Europeans is nature-based tourism. Ziffer (1989) presents information that suggests ecotourists may be a rather select group. She cites one adventure travel survey indicating that half of all of the ecotourism participants made more than $39,000 per year in 1987. Further, 10 percent of those surveyed made more than $100,000 per year. Whelan (1991) cites another market survey of ecotourists to Ecuador showing that 25% of this clientel made more than $90,000 per year.

Community impact assessment in the ecotourism literature tends to be generally positive. Ecotourism around nature preserves implies minimal infrastructure with minimal capital investment (Johnson, 1990). Ecotourism thus provides a potentially favorable cost/benefit ratio to areas that may have few other relative advantages. In sluggish rural economies, ecotourism is seen as having great potential. A substantial literature warns of environmental impacts of ecotourism, where increased use of an area can cause soil erosion, litter, wildlife disruption, extensive firewood cutting, and poor water quality (see Ziffer, 1989; May, 1991; Romeril, 1989; and Farrell and Runyon, 1991 for a review of this literature). In the United States, tourism development has been associated with physical disruptions in the community, such as noise, congestion, transience, and crime (Pizam, 1978; Getz, 1986); economic disruption, such as higher commodity prices and increased taxes to support expanded tourist-oriented infrastructure; family disruption as people employed in the tourist sector may have less time to spend with other family members; and a dislocated sense of community as people feel more isolated and have less control over community development (Allen et al., 1988). This literature treats these negative impacts as limiting factors to effective tourism development that must be addressed through comprehensive planning.

Ecotourism is not well defined, but it appears to be growing and represents a potential opportunity for transboundary protected areas. It would be useful for these areas to take cautious advantage of this movement. Doing so requires active planning, however.

CONCLUSIONS

The goal of this paper has been to note the importance of scientifically studying the tourists and recreationists who visit transboundary parks and preserves. If human use is to be understood and managed, it must be approached with the same kind of scientific attention and precision which we apply in studying other fauna. The concluding sections argued that tourists should be treated as assets and that there was considerable promise in the growing ecotourism movement as a potential for providing economic and political resources for preservation. Because of this potential and its growing importance, preserves should actively plan for and manage ecotourism.

REFERENCES

Farrell, B.H. and D. Runyon, 1991. "Ecology and Tourism," Annals of Tourism Research, vol. 18, pp. 26-40.

Getz, D., 1986. "Models on Tourism Planning: Towards Integration of Theory and Practice," Tourism Management, vol. 7, pp. 21-32.

Heberlein, Thomas A., 1988. "Improving Interdisciplinary Research: Integrating the Social and the Natural Sciences," Society and Natural Resources, vol. 1, pp. 5-16.

Heberlein, Thomas A. and Peter Dunwiddie, 1978. "Systematic Observation of Visitors to a High Mountain Lake, Leisure Sciences.

Ingram, C. D. and P. B. Durst, 1987. "Nature-Oriented Travel to Developing Countries," Southeastern Center for Forest Economics Research, Research Triangle Park, NC. FPEI Working Paper No. 28.

May, V., 1991. "Tourism, Environment, and Development: Values, Sustainability and Stewardship," Tourism Management, vol. 12, pp. 112-118.

Pizam, A., 1978. "Tourism's Impact: The Social Cost to the Destination Community as Perceived by its Residents," Journal of Travel Research, vol. 16, pp. 8-12

Romerril, M., 1989. "Tourism and the Environment—Accord or Discord?" Tourism Management, vol. 10, pp. 204-208.

Shelby, Bo and Thomas A. Heberlein, 1986. Social Carrying Capacity in Recreation Settings. University of Oregon Press.

Shelby, Bo, 1980. "Contrasting Recreational Experiences. Motors and Oars in the Grand Canyon," Journal of Soil and Water Conservation, vol. 35 (3), pp. 129-131.

Whelan, T., 1991. Nature Tourism: Managing for the Environment. Washington, DC: Island Press.

Wolff, Jeremy, 1994. "Poland's Bialowieza Forest, The Last Wilderness in Europe," Travel and Leisure, April, pp. 48-53.

Ziffer, K. A., 1989. Ecotourism: The Uneasy Alliance. Conservation International and Ernst and Young. Working paper on Ecotourism, No. 1.

TOURISM'S IMPACT ON THE GEOGRAPHICAL ENVIRONMENT AROUND KASPROWY WIERCH

Anna B. Kozlowska, Zofia Raczkowska, Marek Degorski
Institute of Geography and Spatial Organization

The area around Kasprowy Wierch is currently the part of the Polish Tatra Mountains most impacted by hiking in the summer and by skiing in the winter (Skawinski 1993). The intensification of tourist pressure began in 1936, the year in which the cable car from Kuznice to Kasprowy Wierch came into use. Prior to that time, the area had mainly been visited by skiers (Oppenheim 1936), while at present heavy ski traffic combines with equally intensive traffic in summer. Despite restrictions resulting from capacity limits, it is still possible for between 2000 and 2200 people to make the ascent by cable car each day (Bogucka and Marchlewski 1982; Skawinski 1993). In addition, several hundred tourists reach the summit each day on foot from the Myslenickie Turnie side (60-70 people), from Goryczkowa Czuba (80-90 people), and from Hala Gasiennicowa. Data from the Polish Cable Railways for average daily attendance in recent years may be combined with data from earlier estimations to suggest that some 8 million people visited Kasprowy Wierch between the years 1936 and 1989 (Skawinski 1993). It is for these reasons that there is enormous pressure for even greater development of this area for skiing.

The severe anthropogenic pressure has resulted in a steady transformation of the natural environment in this area: the slopes are becoming increasingly denuded, and the erosion and degradation of soils and vegetation are under way. Furthermore, an increase in the impact of skiing is to be expected as a consequence of the frequently submitted projects for the construction of new ski lifts in the area. It is thus necessary for the area's present state to be diagnosed, especially prior to the onset of possible further development. In addition, it is also necessary to determine the direction and rate of the changes taking place and to propose protective measures.

This paper represents an attempt at an empirical definition of the changes in selected characteristics of the geographical environment which are occurring in the Kasprowy Wierch area as a result of human activities. The research is being conducted by our team under a grant from the Scientific Research Committee for a three-year research program entitled "The Transformations of the Natural

Environment in the Area around Kasprowy Wierch under the Influence of Natural Factors and Touristic Use." The research focuses on two sites which are comparable in terms of their geological structure, type of slope cover, type of slope, range of altitudes, and vegetation. The main difference between the sites lies in the degree of anthropogenic pressure, with Kociol Kasprowy and Beskid being places influenced strongly by tourism, while Swinska Dolina is a strict nature reserve.

Adopted as the most constant elements in this research were relief (which conditions the development of the remaining components of the geographical environment) and vegetation (which is the resultant feature shaped by all habitat processes, including those which create soil, and which can at the same time serve as an indicator of those processes).

The main aims of the study include:

- Diagnosing the current state of the natural environment of selected sites in Tatra Mountains National Park which represent environments that are natural or experiencing strong anthropogenic influence;
- Summarizing the differences between these areas and evaluating the degree to which different parts have been transformed;
- Monitoring changes occurring over time in areas under different kinds of human influence (hiking and ski runs), and comparing these changes with those occurring naturally over time in the strict nature reserve; and
- Drawing practical conclusions and preparing guidelines for actions intended to provide proper protection for the area around Kasprowy Wierch.

The research project includes the following tasks:

- Production of a series of 1:2500-scale sketches and detailed 1:500-scale maps:

  - a geomorphological map of selected areas, including forms and contemporary geomorphological processes;
  - maps of the disappearance of snow cover in the areas studied; and
  - maps of the vegetation in the areas studied.

- Determination of the relationship between the length of time for which snow cover persists and the plant communities present. This relationship, along with the determination of plant communities and plant indicator species, will constitute the basis for evaluating the length of time for which snow cover persists. It will also be used practically in setting limits on ski runs in the area.
- Investigation of the processes and directions of the changes regarded as indicative of relief and plant cover. The sites for these studies were selected on the basis of the maps drawn.

- the establishment of a series of trial plots on selected slope fragments modeled by different processes in order to measure the rate and directions of action of these processes in both of the areas studied.
- the establishment of a series of trial plots with selected types of vegetation in areas experiencing various kinds of anthropogenic and natural influences and having an appropriate degree of replication. the following studies will be carried out using these plots:
- determination of plant species composition and cover and the numerical levels of selected populations;
- determination of the physical and chemical properties of the substratum, including changes in soil structure, air capacity, reactions, and basic chemical characteristics;
- study of the thermal conditions for the occurrence of plants, especially at the start of the growing season, including the influence of snow cover; and
- examination of the population biology of selected species from the standpoint of their reaction to increasing anthropogenic pressure (trampling near hiking trails, the limitation of access to air due to compression of snow by vehicles preparing ski runs, etc.).

• Evaluation of management practices in the areas of Tatra Mountains National Park which were studied, including conclusions on possible changes and appropriate protective measures. This may take place at two stages:

- preliminary, on the basis of the maps drawn; and
- after a sufficiently-long period of study, on the basis of the synthesis of data collected over a period of some years.

Studies carried out in this way will make it possible to:

• Draw general conclusions about the direction, rate, and course of morphogenetic and pedogenic processes and changes in the relief and vegetation of natural or anthropogenically-transformed systems;
• Describe the relationships between various natural factors and to express these in the form of correlative tables; and
• Formulate practical conclusions and proposals on the appropriate management of areas within national parks which attract such a high intensity of tourism in both summer and winter.

The studies have a cognitive aspect in that they broaden knowledge of individual elements of the high mountains and the links between them, and they provide information on the natural and anthropogenic transformations which are occurring. It is assumed that these studies will be carried out by teams from various fields of science and that the final result will be a summary of the relationships existing between elements and factors within biogeocenoses.

These studies also have a clear practical aspect. On the basis of them it will be possible to draw conclusions on the state of preservation of, transformations in, and threats to an area of Tatra Mountains National Park that is one of the most important from the standpoint of nature conservation and touristic use. The results of the research may also find practical application in the possible creation of a spatial management plan to meet the needs of winter tourism in the Kasprowy Wierch area.

REFERENCES

Bogucka, A., and A. Marchlewski, 1982. Studium pojemnoxci turystycznej Tatrzanskiego Parku Narodowego. Studia Naturae, Ser. A., 22: 17-66.

Oppenheim, J., 1936. Szlaki narciarskie Tatr Polskich i glowne przejscia na poludniowa strone. Polski Zwiazek Narciarski. Krakow.

Skawinski, P., 1993. Oddzialywanie czlowieka na przyrodu kopuly Kasprowego Wierchu oraz Doliny Goryczkowej w Tatrach. In: (ed. W. Cichocki) Ochrona Tatr w obliczu zagrozen. Wydawn. Muzeum Tatrzanskiego, pp. 197-226. Zakopane.

ENVIRONMENTAL PROBLEMS OF TATRA NATIONAL PARK AND THE TOWN OF ZAKOPANE

Marek Peksa
Tatra National Park

Zakopane, a town of 30,000 inhabitants, is situated at the foot of the Tatras in southern Poland. It has the highest mountain range in the Carpathians and the only one between the Alps and the Caucasus with alpine flora, fauna, and climate. The town is 800 to 1000 m above sea level.

Zakopane is an important tourist center and a starting point for 245 km of hiking trails into the Polish Tatras. It has been a mecca for mountaineers for nearly a century and is also famous for excellent skiing conditions, owing to both the natural configuration of the land and local skiing facilities.

Tourist development in Zakopane began at the end of the 19th century, as part of an increasing interest in the Tatras generated by the Polish Tatra Society established in 1873. During this period, Zakopane received special government recognition as a health resort, and at this time the number of inhabitants reached 3000.

The railway line to Zakopane was opened in 1900, and this made it possible for numerous tourists to arrive quickly and in comfort at the foot of Tatras. The railway line had a great effect in increasing the number of inhabitants and tourists, which numbered about 8000 a year at that time. The most intense development of Zakopane occurred in the 1930's, with the largest health spas being built in 1933. The last decade of the 19th century saw Zakopane become a center of Polish skiing. The oldest Polish ski club, the Skiing Section of the Polish Tatra Society, was set up in 1907 and is still active today. Additionally, the Polish Skiing Union was established in 1919.

In a short time Zakopane took the lead among Polish skiing centers and became "the winter capital of Poland." It gained international renown during the time between the two world wars, although the first international ski competition was held there in 1910. This was followed by two FIS World Ski Championships. The first was held on February 5-10, 1929, with the participation of more than 200 sportsmen from 15 countries. The organization of the second was awarded to

Zakopane unanimously by the FIS Congress in Helsinki in February 1938. The event attracted 500 contestants and some 200 press correspondents, and the competitions were broadcast by seven European radio stations. At that time, Zakopane was one of the best-equipped and most popular skiing centers in Europe. The cable car to the summit of Kasprowy Wierch was built in 1936, and the funicular railway on Gubalowka and the sledge lift on Kociol Gasienicowy in 1938. The Wielka Krokiew ski jump, one of the most beautiful jumping hills in the world, was first constructed in 1925 and later modernized many times. In 1956, the Academic World Ski Championship was held at the foot of Tatras, and the third FIS World Championships in Zakopane were organized in 1962. A record 110,000 spectators watched the ski jumping competition on Wielka Krokiew. In 1969, Zakopane hosted the Biathlon World Championship, and World and European Cups in alpine and cross-country skiing and ski jumping were held here many times. Most recently, the Winter Universiade was held here in 1993.

A very attractive aspect of the Zakopane region is its folklore, which is rich and very well preserved. It has a great influence on the unique and picturesque everyday life here, which has a special charm of its own. Highlanders in traditional costume are to be seen every day, folk art still flourishes, and the unique sound of highland music is to be heard everywhere. The typical culture of the Highlanders is particularly visible outside the town, where many live in beautiful hand-crafted wooden houses. There are many folk ensembles in which Highlanders dance, sing, and play regional music. Zakopane also has numerous folk artists who paint glass, carve wood, and work iron. The studios and workshops of these artists are open to the public. There are also many professional artists in Zakopane, some of which are world famous. Each year the town hosts numerous international shows, including (most importantly) the International Festival of Mountain Folklore and the Festival of the Music of Karol Szymanowski. Exhibitions and sporting events of various types are held here year round, as are meetings and gatherings of different kinds.

Very interesting for all visitors is Koscieliska Street and adjoining sidestreets, which form the oldest center of the town. For the past hundred years the old Highland houses have been admired as open-air museums displaying the material culture of the Podhale region. One attraction is Villa Koliba, the first Zakopane-style building designed by Stanislaw Witkiewicz. Zakopane's old town also has a wooden church from 1847. The road through the stone gate was designed by Stanislaw Witkiewicz and leads to the historic Old Cemetery, which is the resting place of many cultural, scientific, and mountaineer personalities. The Tytus Chalubinski Tatra Museum, Poland's first regional museum, was founded in 1888 and is a good starting place for sightseeing in the region. The exhibits consist of ethnographic collections from the Podhale, Spisz, and Orawa regions, as well as specimens of the material culture of the Tatra foothills district and interesting natural and geological samples.

At present, the area of Zakopane covers about 350 km^2 and has nearly 50,000 inhabitants. The magnificent environment, climate, monuments, and many

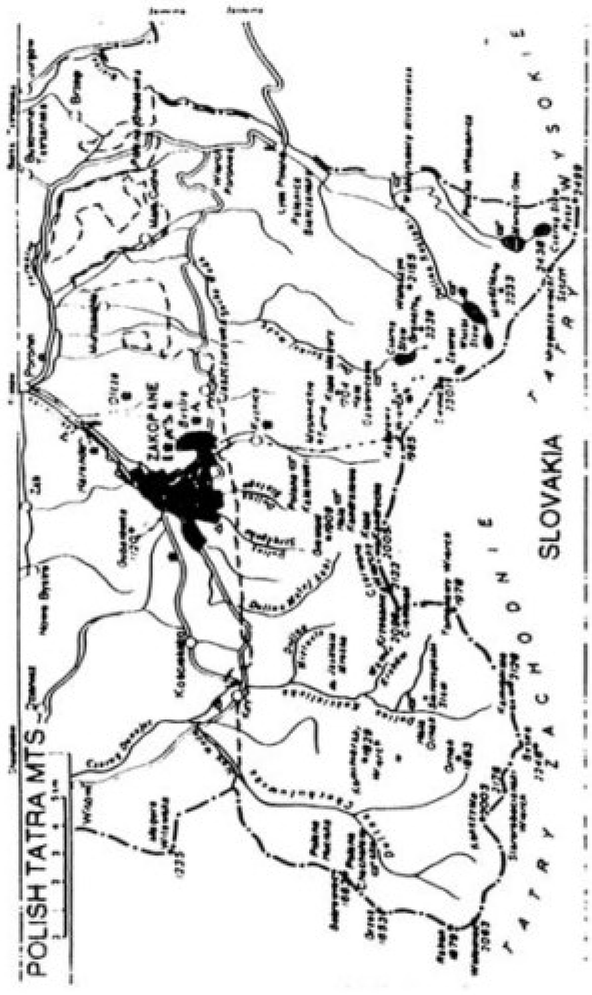


FIGURE 1 The Town of Zakopane (Shadowed) and Tatra National Park (—Park Border, - • - State Border)

attractive events draw millions of tourists annually to Zakopane. The number of inhabitants increases to 100,000 persons a day. Tourists have come here since 1850, but the present tourists differ from those of previous times in that they do not want to live in ordinary cottages and eat simple meals. For this reason, we must think about building a better infrastructure, especially since the number of tourists has increased more than the suitable infrastructure in the past few years, and numerous threats are thus being posed to both the town's natural environment and the Tatra Mountains.

Mass tourism was very popular in socialist times, with many establishments, institutions, and factories organizing trips for their workers. It was during this period that the greatest environmental damage occurred in the town. Plans to manage the area focused on the enlargement of hotels and flats and the enhancement of consumer services. The town authorities gave a lot of agricultural and forest land for hotels and tourist centers to be built.

Zakopane has about 300 large coke furnaces which consume nearly 300,000 tons of coke and coal each year. Most houses, flats, and households are also heated by coke and coal. Each day, Zakopane produces about 300 m^3 of trash, and only 40% of its buildings are connected to sewers.

Poland's political and economic changes of the 1980's led to restrictions on tourist traffic. For example, it was calculated that the number of tourists declined from a peak of 3.5 million a year in the late 1970's to around 2.5 million a year. In the meantime, the requirements of tourists changed, and the town authorities began to look at the issue in a different way than in past years. A new "wastewater" system was opened some years ago, and the local authorities put in a gas pipeline to Zakopane. People are now paying more attention to plans for the management of the area. They want to protect the natural environment and the resources of Tatra National Park. In many cases, the policies of Tatra National Park have contributed to such a position among the local authorities.

The research contributed by scientists from the scientific research center in Tatra National Park illustrates the threat to the areas surrounding Zakopane.

The policy of Tatra National Park has not suited many businessmen. Environmental protection laws enacted in 1991 strictly defined the role to be played by the national parks. It has been assumed that there will be a protective zone which will secure the Tatra Mountains from negative influences originating outside of the area. At this time, the total size of this zone is under discussion. Tatra National Park creates natural recreational and sporting areas for inhabitants and tourists. Zakopane also draws numerous benefits from the area. Every day, the town takes in many thousands of cubic meters of water and employs many thousands of people. The Tatra forests are the lungs of Zakopane, and they also supply timber for the local people. We believe that everything that happens in Zakopane and everything that draws tourism should be arranged in the course of cooperation between the authorities of Zakopane and of Tatra National Park. Such cooperation is therefore imperative, and both authorities should aspire to create a policy that will be satisfactory in protecting the Tatra environment as well as in meeting the needs of inhabitants and tourists alike.

V

MONITORING AND MEASURING THE DIVERSITY OF LIFE IN BORDER AREAS

PLANT DIVERSITY IN TATRA NATIONAL PARK (SLOVAKIA)

Rudolf Soltes, Anna Soltesova, Zuzana Kyselova

Research Station of Tatra National Park

A database including hundreds of thousands of records has provided objective information on a habitat's environmental factors to help pinpoint priorities for plant conservation. Although the results are only approximate, they have integrated long-term environmental conditions and can give information presentable on a spatial projection. Unlike other time-consuming and technically-advanced methods, this method offers a prompt ecological foundation which can be expressed quantitatively. We have found that the creation of a database information system offers the most convenient method for storing data on biodiversity mapping in Tatra National Park. However, the database is only as good as the data that is fed into it. The structure of the file is as follows: species, subspecies, chassis, inventory number of the specimen, date, orographic unit, location, substratum, altitude, community, density, cover of respective layer, notes (memo field), collector, determinator, and square.

We have found that the methods recommended by Jurko (1990) are most convenient for our purpose. We have decided to use more index types because each is specific and renders information of a different type. The following selected indices will be calculated by sub-programs:

The scale diversity index Dsc (equation 1)

$$Dsc = \frac{\Sigma xi + \Sigma yi + \Sigma zij}{2}$$

xi - values for mean number of species

yi - values for mean cover of respective layer

ziy - mean cover of sublayer

The advantage of this index is the considerable stability of the values entered and the corresponding relative constancy of the communities as well.

McNaughton's dominance index Cn (equation 2)

$$Cn = 100 \sum_{i=1}^{n} \frac{Nd}{N}$$

Nd - values for cover of the dominants

N - total cover

This index expresses the sum of values of dominants compared to total cover, where dominants are considered to be those species with more than 40% dominance. The function of dominants is very important, and so index Cn is especially valuable in succession studies.

Hill's diversity index (equation 3)

$$N2 = \frac{(\Sigma xi)^2}{\Sigma xi^2}$$

xi - the value of species significance

This index is transparent and gives a wide spectrum of values along the scale of 1 - 100. However, even highly-diversified communities do not have values higher than 50.

Shannon's index (equation 4)

$$H = \sum_{i=1}^{s} \frac{xi}{N} \log2 \frac{xi}{N}$$

S - number of species

N - the sum of significances

Shannon's index is the function of relative cover and species significance and is logarithmically related to the number of species (xi). So, index H' is especially sensitive to the total number of species and to their coefficients of significance.

Pielouov's equitability index (equation 5)

$$e = \frac{H'}{\log2s}$$

H' - Shannon's index
s - number of species

The real diversity is compared to the maximum possible, i.e., the ideal distribution of species. This index is useful in some specific investigations.

The values of these indices will be Version 2 projected on a network consisting of 90×150 m oblongs using the ARCVIEW program. The scales will be settled later and distinguished by color or pattern. To date, we have stored nearly 12,000 records, and the number is increasing constantly.

ENDANGERED SPECIES OR HABITATS OF SPECIAL IMPORTANCE

Peatland Habitats

Peatland habitats were lost in the past as a result of land reclamation, the intensification of agricultural practices, the construction of communications infrastructures, river straightening, turf cutting, etc. These habitats are suitable for many endangered and precious species and communities of vascular plants and mosses. Peatland habitats include acid bog peats, fen peats enriched by base compounds, and intermediate peats. The number and extent of peatland habitats have been greatly reduced, and protection of the remainder is thus a matter of concern. The majority already enjoy protection in protected areas covering 227 hectares. But they are still endangered by air pollution, and the extent of the harmful influence of the atmospheric deposition of acidifying agents is still unclear. Another human influence, especially in forest ecosystems, is groundwater extraction for drinking water.

The critically-endangered species *Pedicularis sceptrum-carolinum* is restricted to this ecotope. Despite intensive searches, this species has been confirmed at only 21 locations. The species occurs abundantly at only one location, with the others being endangered by the natural seeding of trees.

Most endangered of all is *Carex chordorrhiza*, which had declined in its location to one very depauperate population of some 13 sterile plants in 1993. Most likely this decline is caused by natural succession as the site is becoming dry.

Andromeda polifolia appears to be restricted in Tatra National Park to two locations. The best site, close to the major tourist resort of Strbske Pleso, is endangered by human activities, including garbage accumulation and trampling.

Ledum palustre has been confirmed at four sites, of which only one has a large enough population to survive. The others are only remnants of the previous, more extensive distribution, and two populations consist of less than five plants each.

Scheuchzeria palustris was noted in three locations, but is more abundant in only one. In the 1980's, a new species for the Tatra Mountains, *Calla palustris* , was found. The population is large enough to survive, and the main danger is thus the competition of other populations.

Worthy of mention are other critically-endangered vascular plants like *Carex limosa, Carex lasiocarpa, Baeothryon alpinum*, and *Baeothryon caespitosum*. Rare and endangered mosses include *Paludella squarrosa, Meesia triquetra, Hypnum pratense*, and *Sphagnum platyphyllum*. The peatland habitats represent a valuable natural heritage of Tatra National Park, and their adequate protection is an essential part of the Park's function.

Freshwater Habitats

The main features of this ecosystem are the generally low diversity and the marked vulnerability to acid rain and anthropogenic contamination.

Sparganium angustifolium is found in still water at only one site, and *Ranunculus reptans* is found in its splash zone. *Drepanocladus trichophyllus* is a submerged moss found at three locations.

Running water is the habitat of the critically-endangered species *Juncus castaneus*. Only three small, isolated sites are known for this species, which needs special attention to prevent its decline and disappearance from the Tatra Mountains. Some rare moss species restricted to this habitat include *Racomitrium aciculare, Racomitrium aquaticum*, and *Fontinalis antipyretica*.

Epiphytic Lichens and Mosses

Epiphytic moss and lichen species are rarely afforded any special conservation efforts because of the lack of experts. The bark of coniferous and deciduous trees is a convenient substratum for some mosses and lichens which are declining on the European scale and some species which must presently be considered extinct (the lichen *Usnea longissima* and the mosses *Ulota rehmanii* and *Antitrichia curtipendula*). Some important epiphytes are restricted to deep, constantly-humid, and shaded forest stands which are protected from pollution inputs and strong winds. Such phorophytes were found on the broadleaved trees *Populus tremula, Salix caprea, Alnus incana*, and *Betula carpatica* . Important phorophytes also occur on some trees managed on parkland or trees in avenues, for example, *Fraxinus excelsior, Tilia cordata, Populus tremula, Populus alba, Ulmus glabra, Betula pendula, Sorbus aucuparia*, and *Acer pseudoplatanus*.

The frequency histogram of IUCN categories (Fig. 1) shows the apparently greater sensitivity of cryptogamic plants to environmental conditions (1.66% of moss species extinct and 1.86% of lichens, but only 0.6% of higher plant species).

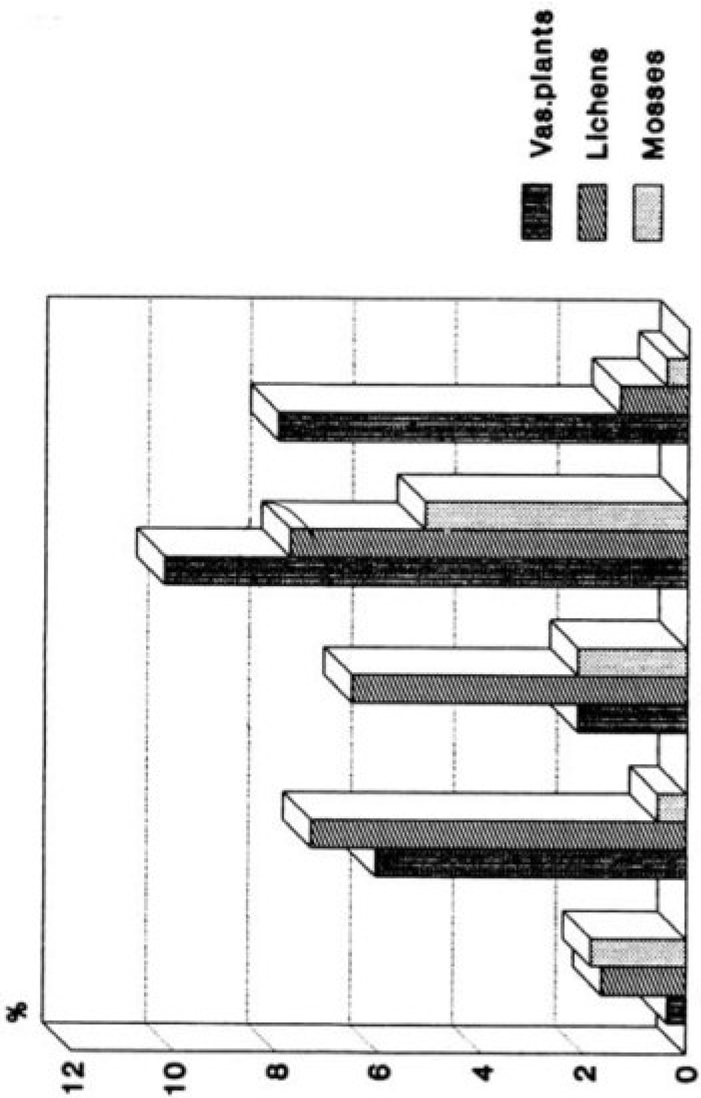


FIGURE 1 Frequency Histogram of IUCN Categories in Accordance with the Total Number of Plant Species

The frequency histogram of IUCN categories (Fig. 1) shows the apparently greater sensitivity of cryptogamic plants to environmental conditions (1.66% of moss species extinct and 1.86% of lichens, but only 0.6% of higher plant species).

It can be assumed that changes in the vegetation of Tatra National Park will continue as long as habitat quality continues to be affected.

The nomenclature of mosses follows Corley et al. (1981), while that of vascular plants is after Dostal and Cervenka (1992), and that of lichens mainly after Wirth (1987) and occasionally Santensson (1984).

REFERENCES

Corley, M.F.C., A.C. Crundwell, R. Dull, M.O. Hill and A.J.E. Smith, 1981. "Mosses of Europe and the Azores; an Annotated List of Species, ith Synonyms from the Recent Literature," J. Bryol., vol. 11, pp. 609-689.

Dostal, J. and M. Cervenka, 1992. Velky kluc na urcovanie vyssich rastlin. Bratislava.

Jurko, A., 1990. Ekologicke a socioekonomicke hodnotenie vegetacie. Bratislava.

Santensson, R., 1984. The Lichens of Sweden and Norway. Stockholm and Uppsala.

Wirth, V., 1987. Die Flechten Baden-Wurtembergs. Stuttgart.

FLORISTIC DIVERSITY IN THE UKRAINIAN EASTERN CARPATHIANS AND THE UKRAINIAN PART OF THE BIOSPHERE RESERVE

Lydia Tasenkevich
State Museum of Natural History
Ukrainian Academy of Sciences

The significance of the Carpathians as a European center of floristic diversity has not yet been recognized. Only recently (particularly in the East and South) have studies begun to focus on this mountain system's influence as a floristic barrier on the one hand and a linking bridge on the other.

The Ukrainian part of the Eastern Carpathians is a typical medium-sized mountain system with mainly dome-shaped summits which are frequently united into long ranges or massifs and dissected by the deep river valleys. Only in the southeastern part of the Ukrainian Eastern Carpathians do altitudes increase, reaching 2061 m a.s.l. at Hoverla, the highest peak in the Ukrainian Carpathians. Such smoothness of relief is caused by the easily-destroyed flysch deposits that are the prevailing geological bedrocks in the Ukrainian Eastern Carpathians. Only in the southeastern part are some massifs, like the Chornohora and Marmarosh Mountains, built of the weathering-resistant sandstones and crystalline and metamorphic rocks whose relief is characterized by more severe forms. Here, peaks frequently have the form of inaccessible rocks, and the bases of the rock faces develop extensive fields of scree. Traces of former Pleistocene glacier activity (glacial cirques, valley-steps, moraines) are also particularly distinct.

The diversified geology and relief influences the richness and diversity of the vegetation cover. A number of phytogeographical units can be distinguished within the territory of the Ukrainian Eastern Carpathians. Putting aside a detailed consideration of the correctness or correspondence of the different systems of floristic and geobotanical divisions (Domin 1928, 1930; Soo 1933; Pawlowski 1948; Fodor 1960; Chopyk 1976, 1977), we accept here the system used most frequently in Ukrainian botanical literature: the one proposed by V. Chopyk (1977) and subsequently modified slightly by Tasenkevich (1986).

CURRENT STATE OF KNOWLEDGE ON THE FLORISTIC DIVERSITY OF THE UKRAINIAN EASTERN CARPATHIANS

The flora of the Ukrainian Eastern Carpathians has been studied for nearly 200 years by generations of Austrian, Polish, Ukrainian, Slovak, Czech, Hungarian, and Romanian botanists. The Flora of the Ukrainian SSR (1935 - 1965) and the vascular plant species of the Manual of the Ukrainian Carpathians (1977) may be considered unique reviews of these investigations. According to the data within them, 2012 species of vascular plants occur in the territory of the Ukrainian Carpathians (Manual 1977). They belong to 135 families and more than 600 genera. The richest families include Compositae, Rosaceae, Gramineae, Cyperaceae, Ranunculaceae and Caryophyllaceae. Also well represented are genera whose centers of diversity are the European mountains. Examples here are Astragalus, Gentiana, Potentilla, Primula, Ranunculus, and Saxifraga.

More than 150 vascular plant species are included in the second edition of the Red Data Book of Ukraine (in press). The latest data indicate that 331 species of vascular plants are rare, vulnerable, or endangered in the flora of the Ukrainian Eastern Carpathians (Tasenkevich, manuscript). It must be noted that the aforementioned Manual includes foothills as well as genuine mountain territory. It therefore lists more species than actually occur. Similarly, adequate knowledge of the native floral diversity is still lacking, with the Manual including all groups of synanthropic plants, including exotic ones.

By the time of the publication of the last volume of the Flora of Ukraine, the concept of the species as a biological system consisting of population combinations had gained a foothold in the biological world (the change from the monotypical species standard to the polytypical one had been accomplished). However, even after the completion of Flora Europaea (1968 - 1980), attempts are still being made to qualitatively and quantitatively re-estimate the flora of the Eastern Carpathians of Ukraine by the equal species standard. In contrast, the floras of our neighbors are either well advanced (Flora Slovenska, v. 1 - 4, 1966 - 1992; Flora Polski, v. 4, 5, 1985, 1987) or even completed (Beldie, 1972; Dostal, 1989).

The results of one of the first attempts at a modern approach to the floral diversity of the Ukrainian Eastern Carpathians were presented in a single, recently-published article on the endemism of vascular plants (Stoyko, Tasenkevich, 1993). On the basis of critical taxonomic and chorological study, some 95 species and subspecies were considered to be endemic to the Ukrainian Carpathians.

Various authors take up diverse positions regarding the number, taxonomy, chorology, and other aspects of endemic taxa. Thus, different results have been obtained. V. Chopyk (1976) considered only 76 species to be endemic to the Ukrainian Eastern Carpathians, while B. Pawlowski (1970) gave only 102 endemic taxa for the entire Carpathian flora.

Lists of Carpathian "endemics" have often included what are actually subendemic taxa with wider geographical ranges. This group comprises taxa with Carpathian-Balkan distributions (for example, *Rhododendron myrtifolium,* Schott et Kotschy; *Verbascum glabratum,* Friv.; *Veronica baumgartenii,* Roem. et Schult.; *Viola ideclinata,* Waldst. et Kit.) as well as East Alpine-Carpathian-Balkan species like *Cardamine opizii* , Presl.; *C. glanduligera*, O. Schwarz; and *Cirsium waldsteinii*, Rouy.

All the above-mentioned facts give a striking illustration of the necessity for a critical treatment of the Ukrainian Eastern Carpathian flora on the basis of unified taxonomic and chorological foundations. A primary task in such an effort is the study of the flora of the Ukrainian Carpathians as part of the Eastern Carpathian flora linking the West and South Carpathians. The task should thus be of interest to botanists in both Ukraine and Central Europe.

Such research is expected to provide a great deal of different botanical data, and it is for the recording, storage, processing, and analysis of this information that the "Carpathians Flora" informational system was created.

This system is built on a database that contains species characteristics as follows: species name; family; genus; subspecies; occurrence in the West, East, and South Carpathians; biomorphology; ecological demands; caryotaxonomy; ecotopes; phytogeographical characteristics; economic importance; and protection status.

The foundation of the database is a species composition block, so the taxonomy and nomenclature of species from the volumes of Flora Europaea was selected as the uniting and unifying base.

THE STATE OF EXPLORATION OF THE FLORISTIC DIVERSITY OF THE UKRAINIAN PART OF THE EASTERN CARPATHIANS BIOSPHERE RESERVE

A considerable proportion of the vascular plant species grow in protected areas of several types in the Ukrainian Eastern Carpathians. Most of these protected areas have been described in general outline only (Stoyko et al. 1980). But even the main ones (Carpathian Biosphere Reserve, Carpathian National Park, and Synevir National Park) which are described in special monographs (Stoyko et al. 1982, 1993) will not be explored completely due to their recent establishment or expansion. As a result, there are no clear data on the composition and status of protected plant species in the Ukrainian Eastern Carpathians.

The most representative protected area in the Ukrainian Eastern Carpathians is Carpathian Biosphere Reserve. The main part of it was protected in 1968 as Carpathian Reserve (zapovidnyk), but it was only after numerous organizational difficulties that 32,000 ha of it was incorporated into the international network of Biosphere Reserves in 1992.

The principal part of the reserve, consisting of six separate areas, is representative of all the vegetational belts of the Ukrainian Eastern Carpathians, from the meadows of the Transcarpathian plain to the low alpine grasses of the Marmarosh and Chornohora Mountains. The western massif in the Eastern Beskydy Mountains, situated away from the main part of the reserve, is territorially a constituent part of the Polish-Slovak Eastern Carpathians Biosphere Reserve. With the change in its legal status, the protected area on this western massif was enlarged from the original 2542 ha of Stuzhytsia Protected Forest to 14,665 ha.

Floristic and phytocenotic data from the Slovak and Polish parts of the Biosphere Reserve have been published recently (Dostal 1988, 1989; Hadac 1988, 1989, 1991; Hadac et al. 1986, 1988; Hadac and Soltan 1989; Hadac and Terray 1988; Krahulec 1987; Majovsky et al. 1987; Sojak 1959; Vazur 1988). However, no such data from Ukraine have been forthcoming because the area on the Slovak-Ukrainian border was guarded by Soviet army forces and was not accessible to scientists.

During the first growing season after the collapse of the Soviet Union, a group of Czech, Slovak, and Ukrainian botanists initiated observations of the flora and vegetation of the now-accessible Eastern Beskydy.

Interesting finds were made from the very beginning of the floristic exploration. These included *Conioselinum tataricum* Firch (reported previously in a single site in the Ukrainian Carpathians in the Chyvchyny Mountains by Pawlowski 1948); *Aconitum anthora* L., 1A. *firmum* Reichenb. subsp. *baumgartenii* (Schur) Gayer; *Poa nemoralis* L. subsp. *carpatica* Jirasek; *Cotoneaster niger* (Thunb.) Fries subsp. *slavicus* Hrab. Uhr. had not been known previously from the territory of the Ukrainian Eastern Carpathians.

The western part of Carpathian Biosphere Reserve is transected by the western delimitation boundary of Eastern-Carpathian endemics and the Central-Carpathian phytogeographical disjunction. Prolongation of this delimitation line is observed to the north in the Polish part of the Eastern Carpathians (Zemanek 1990) and to the northwest and south in the Slovakian part (Hadac 1989).

Although our collections are incomplete and fragmentary, about 560 vascular plant species were still collected in this floristic terra incognita of the Ukrainian part of the Biosphere Reserve.

Besides ensuring possibilities for much more effective protection of individual natural objects, transboundary areas may serve the important goal of transboundary integration of the efforts of scientists and nature managers. Transboundary areas in general, and the Eastern Carpathians area in particular, can be used as training grounds for the testing and unification of research methods. For example, Ukrainian botanists have an interest in the mapping methodology that is applied in the Bieszczady (Polish) part of the Biosphere Reserve. This may help to integrate Ukrainian floristics into the Europe-wide chorological programs and to form a unified database for the further floristic monitoring of the Biosphere Reserve.

The need to explore and protect floristic diversity throughout the entire territory of the Ukrainian Eastern Carpathians and in transboundary areas both protected and unprotected means that the following principal tasks must be addressed:

- Unification of the methodological base and methods by floristic diversity is studied;
- Elaboration, pluralization, and coordination of a database on floristic diversity;
- Inventorying of plant species diversity in the Ukrainian Eastern Carpathians, in transboundary areas, and in protected areas in the Ukrainian Eastern Carpathians; and
- Chorological investigation of rare, endemic, and endangered plant species and the preparation of a chorological atlas and an Endangered Species Data List for the Carpathians as a whole.

REFERENCES

Beldie, A., 1972. Flora Romaniei. Determinator ilustrat al plantelor vasculare. Edit. Academiei Republici Socialiste Romania. Bucuresti, vv. 1 - 2. (in Romanian)

Chopyk, V., 1976. The High Mountain Flora of the Ukrainian Carpathians. 267 p. Naukova Dumka Press, Kyiv (in Ukrainian)

Chopyk, V., 1977. Scheme of the Floristic Regionalization of the Ukrainian Carpathians. In: Manual of the Ukrainian Carpathians Vascular Plant Species. p. 12. Naukova Dumka Press, Kyiv (in Ukrainian).

Domin, K., 1928. Introductory Remarks to the Fifth International Phytogeographic Excursion (I.P.E.) through Czechoslovakia. Acta Bot. Bohemica 6 - 7, pp. 3-76.

Domin, K., 1930. A New Division of Czechoslovakia into Natural Geobotanical Districts. Acta Bot. Bohemica, 9, pp. 55-58.

Dostal, J., 1988. Vascular Plants. In: The Eastern Carpathians. Protected Landscape Area. Priroda. Bratislava, pp. 81-90 (in Slovak)

Dostal, J., 1989. New Flora of the CSR. Academia, Praha, vv. 1 2, 1548 p. (in Czech).

Flora Europaea. 1968 - 1980. (Eds. T.G. Tutin, V.H. Heywood, N.A. Burges et al.) vv. 1 - 5, Cambridge University Press. Flora Polski. 1985 - 1987. (Ed. A. Jasiewicz) vv. 4, 5. Polskie Wydawnictwo Naukowe. Warszawa. (in Polish) Flora Slovenska. 1966 - 1992. (Ed. L. Bertova) vv. 1 - 4. Veda, Bratislava. (in Slovakian) Flora of the Ukrainian SSR. 1935 - 1965. (Ed. K. Zerov). vv. 1 -12. Academy of Sciences of the Ukrainian SSR Press, Kyiv. (in Ukrainian).

Fodor, S., 1960. Botanical and Geographical Regionalization of the Altimontane Vegetation of the Transcarpathians. In: Flora and Fauna of the Carpathians. pp. 85-96. Academy of Sciences of the USSR Press. Moscow - Leningrad (in Russian)

Hadac, E., 1988. Unforested Plant Communities. In: The Eastern Carpathians. Protected Landscape Area. Priroda, Bratislava. pp. 90-96 (in Slovak)

Hadac, E., 1989. Pflanzengeographische Bemerkungen uber die Berggruppe Bukovske vrchy in der NO - Slowakei. Flora. - VEB Gustav Fischer Verlag, Jena. pp. 481-486.

Hadac, E., 1991. Distribution of Some Vascular Plants Species in the Bukovske Vrchy Hills, NE Slovakia. Preslia. v. 63. pp. 205226.

Hadac, E., J. Andresova, J. Paukertova, V. Klescht, 1986. Four Wetland Plant Communities of the Bukovske Vrchy Hills in the NE of Slovakia. Preslia, v. 58, pp. 339-347 (in Czech)

Hadac, E., V. Hadacova, V. Potocek, 1988. Vegetation of the Bukovske Vrchy Hills on the NE of Slovakia and Soils Reaction. Preslia, v. 60. pp. 157-165 (in Czech)

Hadac, E., Z. Soltan, 1989. Plant Communities of Springs and Mountain Streamsides of the Bukovske Vrchy Hills in the NE of Slovakia. Preslia. v. 61. pp. 343-353 (in Czech)

Hadac, E., J. Terray, 1988. Notes on the Flora of Bukovske Vrchy Hills. Zpravozdania CS. Botan. Spolecn., Praha, v. 23 pp. 66-68 (in Czech).

Krahulec, F., 1987. Festuca Saxatilis - a New Species of the Czechoslovak Flora. Preslia. v. 59. pp. 273-278.

Majovsky, J., A. Murin, a kolektiv, 1987. Karyotaxonomy of Slovakian Flora. Veda, Bratislava, 436 p. (in Slovak)

Manual of the Ukrainian Carpathians Vascular Plant Species, 1977. Naukova Dumka Press, Kyiv. 434 p. (in Ukrainian).

Pawlowski, B., 1947. Characteristique Geobotanique Generale des Monts de Czywczyn. Extrait du Bulletin de l'Academie Polonaise des Sciences et des Lettres. Classe des Sciences Mathemat. et Naturel. -Ser B: Scienc. Naturelles (1) 1946 . Imprimerie de l'Universite, Cracovie, pp. 71-108.

Pawlowski, B., 1970. Remarques sur l'Endemisme dans la Flora des Alpes et des Carpates. Vegetatio, 21, pp. 181-243.

Sojak, J., 1959. Notes on the Flora of Nizke Poloniny. Preslia, v. 31, pp. 307-317.

Soo, R. Analyse der Flora des Historischen Ungarns (Elemente, Endemismen, Relikte). Arb. 1. Abt. Ungar. Biol. Forschunginst. v. 4, pp. 173 -192.

Stoyko, S., L. Milkina, et al., 1980. Nature Protection in the Ukrainian Carpathians and Adjacent Territories. Naukova Dumka Press, Kyiv, 262 p. (in Ukrainian)

Stoyko, S., L. Milkina, L. Tasenkevich, et al., 1993. Nature of the Carpathian National Park. Naukova Dumka Press, Kyiv, 212 p. (in Ukrainian)

Stoyko, S., L. Tasenkevich, 1993. Some Aspects of Endemism in the Ukrainian Carpathians. Fragmenta Floristica et Geobotanica, Suppl. 2 (1), pp. 345-353.

Stoyko, S., L. Tasenkevich, L. Milkina, et al., 1982. Flora and Vegetation of Carpathian Reserve. Naukova Dumka Press, Kyiv, 218 p. (in Ukrainian).

Tasenkevich, L., 1986. Place of the Rika-Teresva Interfluve in the Floristic Division of the Ukrainian Carpathians. Ukr. Bot. Zhurn. 43, n. 2, pp. 30-33 (in Ukrainian with English summary)

Vazur, M., 1988. Forest Plant Communities. In: The Eastern Carpathians. Protected Landscape Area. Priroda. Bratislava. pp. 97-106.

Zemanek, B., 1991. The Phytogeographical Boundary between the East and West Carpathians - past and present. Thaiszia, 1, pp. 59-67. Fig. Floristic division of the Ukrainian Carpathians (Chopyk, V., 1977, modified by Tasenkevich, 1986) I - the Eastern Beskydy Mountains, II - Gorgany, III - Krasna, IV - Svydovets, V - Chornohora, VI - Marmarosh, VII - Chyvchyny.

GRASSLANDS OF THE EAST CARPATHIAN BIOSPHERE RESERVE IN SLOVAKIA

Helena Ruzickova and Miroslav Bural
Institute of Landscape Ecology

INTRODUCTION

Since forests previously dominated the temperate zones, the grasslands are mainly of secondary origin. Nevertheless, grasslands are important sources of biodiversity in the East Carpathians Biosphere Reserve in Slovakia. Entire groups of vegetation communities, plants, and animals, which have only limited conditions for existence in forests, survive in the grasslands. Grassland ecosystems can support a stable composition of species communities, provided that there is some regularly repeated energy input and output (mowing, pasturing, fertilizing). Compensation mechanisms ensure a resilient level of stability. Both human influence over time and site conditions impact the stability. Such grasslands can be considered seminatural. However, artificial grasslands arise if the intensity of economic activity is high enough to change the site conditions, and therefore change the species composition (through reclamation, drainage, the heavy use of fertilizer, the additional sowing of grass cultivars, or large flocks). These unnatural grasslands have many non-productive functions. However, they are not subjects for nature conservation because they have no meaning as biotopes and biodiversity sources.

Transitional meadows and pastures arise through the self-seeding of former fields. This phenomenon is common in mountainous areas of Slovakia, where extreme areas and terraced fields are no longer cultivated. In the East Carpathians, these fields were managed in the double-field system of economy in which cultivated soil and meadows were alternated for periods of 10 to 12 years each. However, these fields are rarely replowed.

In a conservation program for the grasslands, one must consider the enrichment of a territory's species diversity as well as which species to include. Forests predominate the East Carpathians Reserve, while meadows comprise only about 15 percent of the area. However, meadows deserve special attention since they not only have natural, scientific significance, but they also have also cultural and historical value. They bear witness to the original and current ways of farming in the area. The grasslands of the area can be divided into two large groups: mountain "poloniny" grasslands and grasslands of lower areas. Each group has different vegetation and different requirements for biodiversity conservation.

MOUNTAIN "POLONINY" GRASSLANDS

The mountain "poloniny" grasslands, occurring at altitudes above 1000 m, are found in the ridges of the East Carpathians. The traditional farming system, which continued until the 1940s, consisted of mowing and grazing in alternate years. Although the hay and grass were of lower quality than that grown in lower sites, the system enabled farmers to breed animals economically. Sheep, and later oxen and horses, used to graze in the meadows, but the meadows have been abandoned and left unknown since the middle of the 1960s.

The "poloniny" meadows are primarily inhabited by types of vegetation which grow in the upper boundary of the forest in the Carpathians. These meadows include the alliances Calamagrostidion arundinaceae, Nardo-Agrostion tenuis, and Vaccinion vitis-idaeae (E. Hada et al., 1988). The meadows of the alliance Polygono-Trisetion, which are typical of mountain areas in Central Europe, do not occur here. The "poloniny" are special because East Carpathian species which are often at the limits of their ranges inhabit them. Some of these species are associated only with ridge areas and are not found in lower grasslands (examples include *Viola dacica, Campanula abietina, Melampyrum herbichii, Senecio papposus, Tithymalus sojakii*, and *Dianthus compactus*).

Bla'kov conducted the first extensive phytocoenological research on "poloniny" meadows in 1969, when farming activity was gradually ceasing (D. Bla'kov, 1991). Bla'kov revisited the areas 15 to 20 years later and recorded the successional trends following the cessation of farming. After 3 to 8 (10) years, the copses were found to be dominated by *Vaccinium myrtyllus*, vitis-idea, *Poa chaixii*, and *Achillea stricta*. After 15 to 20 years, the dominants were *Calamagrostis arundinacea, Gentiana asclepiadea*, species of the genus Rubus, and more forest species. Today, copses with *Calamagrostis arundinacea* occupy large areas and have relatively poor species composition.

Preserving the species diversity of mountain grasslands is a difficult problem. Usually, the primary issue is not the preservation of the grasslands with their original species diversity, but rather their re-succession. Internal conditions have completely changed in places where groups of grasses predominate which previously constituted only a small part of the original vegetation. We have seen examples of grasslands' reactions to regular long-term interference which is inevitable for the preservation or renewal of meadows. Permanent plots can be marked out within grasslands so that changes in species composition can be monitored and evaluated. Cooperation between Slovakia, Poland, and Ukraine would be valuable since the "poloniny" meadows occur primarilly on frontier ridges.

GRASSLANDS AT LOWER LEVELS

Away from the mountain ridges, usage of land as permanent meadows or pastures has affected areas whose soils were not arable. Such soils were too wet or dry, on slopes, or too shallow or acidic. These seminatural meadows and pastures often have specific species compositions. They are single- or double-mowing meadows (utilized for fodder or litter) or extensive pastures which supplemented fodder obtained from temporarily-grassed areas and meadows near houses. Today, many of them have been abandoned as a result of collectivization or the evacuation for the construction of the Starina reservoir. Farmers lost interest in mowing and grazing extensive grasslands when no livestock remained.

The group of seminatural meadows at lower elevations includes moor and peaty meadows, wet and mesophytic meadows, subxerophyll meadows and pastures, and acidic pastures. Although they are restricted to small areas around springs, the moor and peaty meadows deserve special attention. They belong to the alliances Caricion fuscae, Caricion lasiocarpae, and, in one locality, Sphagnion medii.

The moist meadows of the alliances Calthion and Molinion caerulae are located beside water courses and springs. The species composition of these meadows depends on the water regime, on the nutrient content of the soil, and on the soil reaction (pH). Meadows of the alliances Calthion and Molinion caerulae create interesting landscapes with relatively varied mixture of plant communities, and they are the biggest sources of biodiversity at lower levels. As only a few species are utilized by the local inhabitants, these meadows require directed care with a particular frequency of mowing. Without mowing, they rapidly become poor, tall herb communities of the alliance Filipenduleion.

Extensive pastures can be found in sloping, inaccessible sites with shallow soils. Like the moist meadows, these sites lost their economic importance after collectivization. Depending on the nutrient and lime content of the soil, these communities range from subxerophyllous herb communities with many species to poor pastures with *Nardus stricta* belonging to the alliances Cynosurion, Arrhenatherion, and Cirsio-Brachypodion. These pastures are probably among the oldest grassland types in the region and possess a large variety of animal species, especially entomofauna. To preserve selected areas, directed farming must be ensured.

The original mesophillous meadows of the alliance Arrhenatherion occur only in meadows near houses and in old fruit orchards. These are mostly secondary communities established on fields. They are often not farmed (in the area of the Starina reservoir), and the natural seeding of pioneer tree species indicates the direction of the succession. These fallows are often secondary sites with many species from the Red List of Slovak Flora, especially from the family Orchidaceae. As nature conservation alone is not able to keep grasslands open, permanent areas need to be selected so that the process of succession can be monitored and the possibilities for arresting it sought.

CONCLUSIONS

The grasslands of the East Carpathians Biosphere Reserve are vital in the preservation of biodiversity in the area. Their management should consist of the following steps:

- The inventory of the grasslands and the evaluation of their uniqueness, species diversity, and rarity as well as natural, cultural/historical, and aesthetic value;
- The selection of representative areas, the determination of the optimal way in which they may be utilized, and the search for ways to ensure the maintenance of the stated regime; and
- The establishment and regulation of permanent areas.

When selecting areas, preference should be given to those with a mosaic of different kinds of grassland, along with traditionally utilized arable soil. Such biotope complexes would guarantee the preservation of species diversity and the character of the landscape.

REFERENCES

Bla'kov, D., 1991. Succession in Abandoned Mountain Meadows in the Stu'ica Nature Reserve (The Bukovsk Vrchy Mts., East Slovakia). Preslia, Praha, 63: 177-188 (in Czech).

Hada, E., Andresov, J., Kleschtt, V., 1988. The Vegetation of the "Poloniny" in the Bukovsk Vrchy Hills NE Slovakia.

FLORISTIC DIVERSITY IN THE LATORITSA RIVER BASIN (UKRAINIAN CARP A THIANS)

Bogdan Prots
Institute of Ecology of the Carpathians
Ukrainian Academy of Sciences

The natural and anthropogenically transformed areas of the Latoritsa river basin have long attracted the attention of botanists, and the history of their investigations is intimately linked with the historical fate of the Transcarpathians. Three periods of exploration may be distinguished. The first period, from the end of the 19th century to the beginning of the 20th century, involved the gathering of data on the distribution of separate plant species (Pax, 1895; Thasiz, 1909, 1912). The second period, from the beginning of the 20th century to the mid 1940s, saw new approaches taken in floristic research (geobotany, chorology, and nature protection). This interest took the form of a number of publications (Margittai, 1923, 1929; Nadvornik, 1929; Maloch, 1931, 1932; Zlatnik, 1934; Klastersky, 1936 and many others). The third period, from the mid 1940s to the present, is characterized by attempts at systematic and critical approaches to floristic study (Popov, 1949; Rudenko, Fodor, Riznychenko, 1956; Chopyk, 1958; Fodor, 1974; Malynovsky, 1980; and many others).

Floristic investigations in the area of the Mukachevsky Gory Mts. (west flank of the Vulcanychny Carpathy Mts.) were begun by the present author in 1988 (Zahulsky, Prots, 1991). Detailed floristic investigation began from 1991 onwards. The aim of this study was to show the floristic diversity and some aspects of the anthropogenic transformation of the flora in the Latoritsa river basin (Ukrainian Carpathians). The results of these investigations have been published in a series of papers (Kozak, Prots, 1993; Prots, 1994 and others).

The Latoritsa river basin is located in the western part of the Ukrainian Carpathians on the border of four geographic regions: the Verchovynsky Mts., the Polonynsky Mts., the Vulcanychny Mts., and the Zakarpatska Rivnyna Plain (Figure 1).

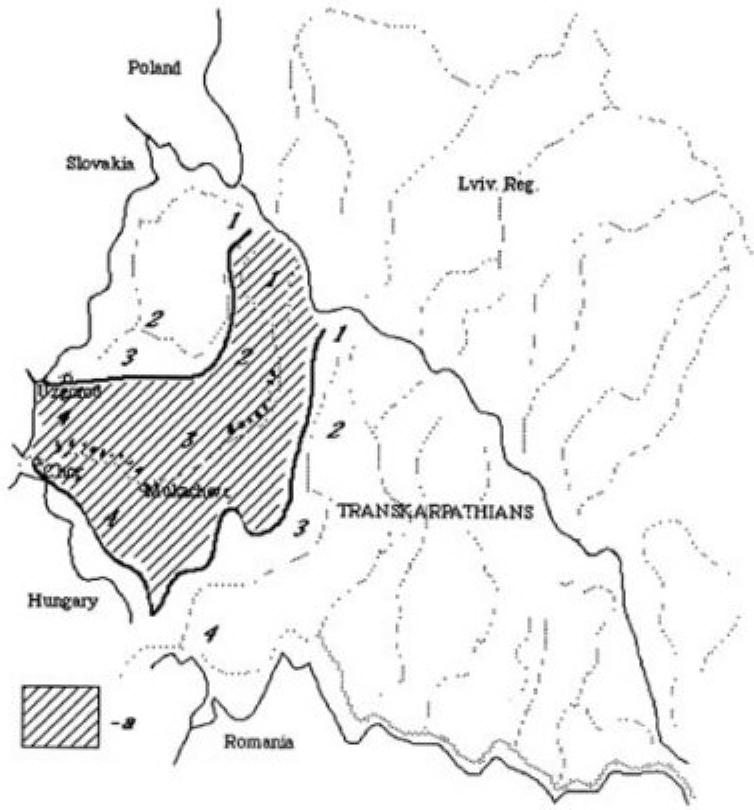


FIGURE 1 Location of the Latoritsa River Basin in the Transcarpathians (the Ukrainian Carpathians). a - extent of the Latoritsa basin, 1 - Verchovynski Mts. (Schidni Beskydy Mts.), 2 - Polonynski Mts., 3 - Vulcanychni Mts., 4 - Zakarpatska Rivnyna Plain

There are 7 vertical climatic zones which are of basic importance to the vegetation (Holubets et others, 1988). In the mountain part of the basin there are 4 altitudinal floristical belts of the Ukrainian Carpathians (Tkachyk, Prots, 1993): xerothermic - mountain, nemoral - mountain, submountain, and mountain. Two zones and 4 vegetational belts are to be found in the Latoritsa river basin (Holubets, 1978).

The Latoritsa river basin is a very heterogenic system not only in terms of its geographical, climatic, and floristic relations, but also from the hydrological, soil, and landscape points of view (Holubets et al. 1988).

The Latoritsa basin is on the border of two floristic provinces (the Central European and the Pannonian). It is included in at least three floristic districts (the Zakarpatska Rivnyna Plaine, the Vulcanychny Carpathy Mts. and the Schydny Beskydy Mts.). The basin covers about 3000 km^2.

Wild (ahemerobic and oligohemerobic) areas cover about 40 percent of the basin area, while antropogenically transformed (mezohemerobic, euhemerobic, poly- and metahemerobic) areas cover about 60 percent (Blume, Sukopp, 1976). The population of the Latoritsa river basin area is 250,000, encompassing the greatest industrial centres of the Transcarpathians (such as Mukatchevo and Svaljava). The most important industries involve timber, television and mining, and many people also work in agricultural production. The Latoritsa basin is crossed by the Chop - Mukatchevo - Strij - Lviv roads and railways, though railway and road infrastructure is very weakly developed. There are many devastated areas (dust-heaps, quarries, and railway stations) which make up more than 5 percent of the basin area.

Floristic research was carried out on the basis of detailed-itinerary, half-stationary, and stationary methods (Yurtsev, Kamelin, 1987).

The flora of the Latoritsa basin includes 1146 indigenous plant species (from 137 families and 560 genera). The total number of plant species is 1502. Quantitative data on the flora of the Latoritsa Basin are given in Table 1.

The richest in species are the following 10 families: Asteraceae (149), Rosaceae (69), Poaceae (65), Brassicaceae (58), Fabaceae (51), Cyperaceae (50), Scrophulariaceae (50), Lamiaceae (49), Ranunculaceae (41), and Caryophyllaceae (40). The 10 principal families accounted for 54.3 percent of the total number of species. The analogical arrangement of families in the main part of the spectrum is

TABLE 1 Taxonomic Structure of the Flora of the Latoritsa River Basin

TAXA	Number of species	% of total number of species	Number of genera	% of total number	Number of families	% of total number of families
Lycopodiophyta	5	0.4	4	0.7	4	2.9
Equisetophyta	8	0.75	1	0.2	1	0.7
Polypodiophyta	29	2.5	19	3.4	11	8.0
Pinophyta	8	0.75	6	1.1	3	2.3
Magnoliophyta,	1096	95.6	530	94.6	118	86.1
incl. Liliopsida	235	20.5	103	18.4	20	14.6
Magnoliopsida	861	75.1	427	76.2	98	71.5
Total number	1146	100%	560	100%	137	100%

characteristic for the Holarctic flora (Tolmachev, 1974). The predominance of the Rosaceae, Brassicaceae, and Fabaceae also attest to the influence of the ancient Mediterranean flora or formation on the present one.

Indices of the number of species in different pairs of families may be use to give a qualitative characterization of a flora. Thus the ratio of Asteraceae species to Fabaceae species, at 2.9, is characteristic of a boreal flora, while the Asteraceae Cyperaceae (ratio of 3.0), is intermediate between the boreal and Mediterranean floristic regions.

Meanwhile, three large families (Asteraceae, Poaceae and Cyperaceae) had 23 percent of the total number of species, a feature characteristic for the flora of temperate latitudes (Tolmachev, 1974). The most important genera were: Carex (36 species), Hieracium (31), Veronica (21), Rosa (17), Galium and Ranunculus (15), Euphorbia, Viola, Campanula (13), and Rumex (12). The large numbers of Rosa and Rubus species (8) are characteristic of Central European floras as opposed to East European floras.

Consequently, the flora of the Latoritsa river basin (within Ukraine) is part of the Middle European Region (Carpathian subregion) flora. This is a result of the geographical location of the region under investigation, as well as by its florogenetic connections.

Ecotypical classification is characterized by groups as follows: by degree of moisture, such as mesophytes (684 species; i.e., 59.7 percent of total number of basin flora), xerophytes (259; 22.6 percent), hydrophytes (141; 12.3 percent), and hygrophytes (62; 5.4 percent); and by soil fertility, including mesotrophs (548 species; 47.8 percent), eutrophs (528; 46.1 percent), and oligotrophs (70; 6,1 percent).

Vital forms were distinguished in the following way using the Raunkiaer system: hemicryptophytes (562 species; i.e.; 49 percent of total number of basin flora), cryptophytes (241; 21.0 percent), therophytes (216; 19.0 percent), phanerophytes (83; 7.2 percent), and chamaeophytes (44; 3.8 percent).

Nine zonal geographical elements (Malynovsky, 1980) are to be distinguished in the flora Latoritsa basin: nemoral (369 species; i.e., 32.1 percent of total number of flora's investigated territory); boreal (251; 21.9 percent); arid (222; 19.4 percent); azonal (127; 11.1 percent); mountain (87; 7.6 percent); nemoral mountain (55; 4.8 percent); boreal mountain (17; 1.5 percent); alpine (10; 0.9 percent); and arctic alpine (8; 0.7 percent).

The following endemics and subendemics may be noted: endemic to the Carpathians as a whole (6 species); endemic to the Southern and Eastern Carpathians (8); Carpathian-Balkan subendemics (2); and East Carpathian-Balkan subendemics (4).

Comparison of the numbers of plain and mountain species shows that plain species are in the majority.

The Latoritsa river basin is notable for a flora with a high degree of floristic diversity. This is due to the basin location on the boundary of several macrophytochorions.

The anthropogenic transformation (Burda, 1991) or synanthropization s.l. (Kornas, 1978; Malyshev, 1981 and others) of the flora of the Latoritsa basin is characterized by:

- The impoverishment of the genepool of the native;
- The invasion, expansion and naturalization of anthropophytes;
- Disturbances to the flora (Burda, 1991);
- Teratogenic phenomena; and
- The appearance of floristic complexes that have no analogues in nature.

The process of impoverishment of the genepool of the native flora was investigated on the Orchidaceae, the best represented family in the Ukrainian Red Data Book. Twenty-eight species have been discovered by different investigators over the last hundred years, i.e., 75.7 percent of the orchid flora of the Transcarpathians and 70.0 percent of that of the Ukrainian Carpathians. According to the results obtained, 14 orchid species have 154 localities, and in 60 of these localities, 22 of 25 known species are found to have become extinct.

The impoverishment of the genepool of the native flora in the Latoritsa basin is leading to the isolation of populations or plant species in all areas as well as to reduced cover, loss of species, and reduced population vitality (Zahulsky, Prots, 1991, Prots, 1994).

Among the plant species which have disappeared from the Latoritsa basin are: *Drosera rotundifolia* L., *Beckmannia eruciformis* (L.) Host., *Salix incubaceae* L., *Scheuchzeria palustris* L., and *Rhododendron myrtifolium* Schott et Kotschy. In total, the genepool of the native species of the basin has so far been impoverished by 0.5 percent.

Geographical-historical analysis of synanthropic plant species (Thellung, 1918; Holub, Jirasek, 1968; Schroeder, 1969; Kornas, 1977) found 122 anthropophytes of 41 families and 83 genera (i.e., 23 percent of the synanthropic flora). Anthropophytes may be distinguished: by the way of migration (acolutophytes, 57 species; ergasiophygophtes, 39; and xenophytes, 26); by the time of migration (archeophytes, 47 species; and kenophytes, 75); and by the degree of naturalization (epecophytes, 73 species; ergasiophytes, 57; hemiagriophytes, 31; and holoagriophytes, 14).

Anthropophytes provide a model for microevolutionary processes (including flora perturbation). *Ambrosia artemisifilia* var. atropurpurea Priszter. was found in the lower part of the spruce belt (730m above sea level).

Teratogenic phenomena have been discovered among synanthropic plants. This is the result of technogenic influences on phenotypes.

TABLE 2 List of Plant Species in the Latoritsa River Basin with Abnormal Structures (terats).

	Types of terats					
SPECIES	fasciation	prolification	branching of floscule	corolla turning green	"cones"	destruction on the leaflets
Acer negundo L.						#
A. platanoides L.						#
Ambrosia artemisifolia L.	#				#	
Cardaria draba (L.) Desv.				#		
Cichorium intybus L.				#	#	
Echium vulgare L.	#					
Matricaria perfoliata M.	#		#			
Plantago major L.						#
P.lanceolata L.						#
Tanacetum vulgare L.	#					
Taraxacum officinale W.	#	#				#

A total of 6 types of terat were found in 11 species (Table 2). Such abnormal structures as fasciation and destruction of leaflets are most frequent. *Taraxacum officinale* has been found to have 50 percent of the total number of terat types.

Anthropoflorocomplexes in forming aspects were considered in three groups: accidental, forming, and formed. The first group included a large number of complexes (more than 80, including dominants *Vitis vinifera* + *Triticum aestivum* L. + *Papaver somniferum* L.). The second group had 27 complexes (dominants: *Lepidium latifolium* + *Urtica dioica* L. + *Leonurus quinquelobatus* Gilib.). The third group had 12 (*Quercus robur* L. + *Rudbeckia laciniata* L. or *Robinia pseudoacacia* L. + *Fagus sylvatica* L.).

A flora's anthropogenic transformation takes place in time and in space. Hemerobicity is the result of the action of all types of anthropogenic influence on ecosystem (Blume, Sukopp, 1976). In the Latoritsa river basin, the following degrees of hemerobicity may be noted: ahemerobic (0-2 percent of total number of the hemerobic species); oligohemerobic (5-11 percent); mesohemerobic (14-22 percent); euhemerobic (26-68 percent); polyhemerobic (58-83 percent); and metahemerobic (74-100 percent). The correlation between hemerobicity and flora diversity showed unity between the processes of flora transformation and the degradation of the ecosystem as a whole. The Quantitative characteristics of biodiversity are not as important as the qualitative one. The high degree of hemerobicity points to a flora becoming increasingly cosmopolitan, xerophytic, and unified in structure. This is a basis for unstable floras. The direction of flora's transformation necessary to regulate of reconstruction of the primary communities.

Research on the processes of synanthropization on the Laritosa river basin showed a high level of degradation of plant cover, especially in the western part.

The number of protected areas must be increased and rare species safeguarded from the processes of anthropogenic transformation. We propose 16 protected areas where rare and endangered species grow in the Latositsa river basin. These include: on the Zakarpatska Rivnyna Plain, small lakes near Chop, the forest near the Dachna railway station, and the forest near the Klucharky railway station; in the Vulcanichni Carpathy Mts., hill slopes near Beregovo, the old beech forest between Synjak and Chynadijevo, the forest near Chynadijevo, the slopes of Pohar hill, and the forest near Carpathy village, Lovachka hill, and Monument hill (Mukachevski Mts.); and within Verchovynski Carpathy, the Bokjuska Polonyna Range, Hostra hill, the beech forest near the Pereval railway station, the slopes of the Velyka Hranka Range, the valley of the Pynja River near Solochyn, and the valley of the Mala Pynja River near Uklyn.

With regards to Polish and Ukrainian scientific collaboration, the investigation of the floristic corridor between Tarnitsa, in the Halich hills of the Polish Carpathians and Pikuj hill in the Ukrainian Carpathians are very interesting.

The results in this paper are provide the basis for continued floristic monitoring.

REFERENCES

Blume H.P., and Sukopp H., 1976. Okologische Bedeitung Anthropogener Bodenveranderungen, Schriftenr. Vegetationskunde, 10, 75-90.

Burda R.I. 1990. Flora's Antropogenic Transformation. Naukova Dumka Press, Kyjiv (in Russian).

Chopyk V.I. 1958, Flora and Vegetation of the Western Part of the Ukrainian Carpathians. An URSR Press, Kyjiv (in Ukrainian).

Fodor S.S. 1974. Flora of the Transcarpathians. State University Press, Lviv (in Ukrainian).

Holub J. and Jirasek V. 1967. Zur Vereinheitlichung der Terminologie in der Phytogeographie. Fol. Geobotan. et phytotaxon. Bochemsol. - 2, N1.

Holubets M.A. 1978. Spruce Forests of the Ukrainian Carpathians. Naukova Dumka Press, Kijev (in Russian).

Holubets M.A. and Others. 1988. The Ukrainian Carpathians Nature. Naukova Dumka Press, Kijev (in Russian).

Klasterky I. 1936. Ochranarsko-botanicke Studie na Podkarpatske Rusi. III. Penisnik karpatsky (Rhododendron Kotschyi Simk). a jeho spolecenstva. Krasa neseho Domova, 28: 49-51

Kornas J. 1977. Analiza Flor Synantropijnych. Wiadomosci botaniczne. XXI, N2-P. 385-393

Kornas J. 1978 Remarks on the Analysis of a Synanthropic flora. Acta Bot. sl.-3, -P. 385-393

Kozak I. & Prots B. The Interpenetration of Plant Species between Forest and Meadow Associations in the Ukrainian Carpathians. Ukr. Botan. Journal. Vol. 50, N1 (in Ukrainian).

Maloch M. 1931. Borzavske Poloniny v Podkarpatske Rusi. Sborn. vyzk. Ustavu zemed. 67: 1-200, Praha.

Malynovskyi K. 1980. Vegetation of High Mountain Part of the Ukrainian Carpahians. Naukova Dumka Press, Kyjiv (in Ukrainian).

Malyshev L. 1981. Flora's Change of the Earth under Anthropogenic Influence. Biol. scien. -N3.-P. 5-20 (in Russian).

Margittai A. 1923. Contributions to Flora of the Podkarpatska Rus. Kvartalnyj, Pannonia (in Russian).

Nadvornik J. 1929. Reboik Kostkovany (Fritillaria meleagris L.) Vesmir 8: 18, 19.

Pax F. 1895. Einige Neue Pflanzenarten aus den Karpathen. Oest. bot. Z. 45: 26, 27, 41-45.

Popov M. 1949. Essays on the Carpathian Vegetation and Flora. MOIP press, Moscow (in Rusiian)

Prots B. 1994. Orchidaceae Species Spreading in the Latoritsa Basin (The Transcarpathians). Materials of International conference, Rahiv (in Ukrainian).

Schroeder F.-G. 1969. Zur Klassifizierrung der Anthropochoren. Vegetatio 16 (5-6): 225-238.

Thaisz L. 1909. Adatok Beregvarmegye Florajahoz. Magyar Bot. Lapok, Budapest, N8.

Thaisz L. 1912. Syringa Josikaea Jacq. fil. Ujabb Termohelyei. Magyar Bot. Lapok, Budapest, NII.

Thellung A., 1918/19. Zur Terminologie der Adventiv- und Ruderalflora. Allg. Bot. Z. Syst. 24: 36-42.

Tolmachev A. 1974. Introduction in to the Plant Geography. Leningrad University Press, Leningrad (in Russian).

Yurtsev B. and Kamelin R. 1987. Program of the Floristical Investogations of Different Degrees of Dataility. Theoretical and metodological problems of comparative floristics. Nauka Press, Leningrad (in Russian).

Zahulskyj M. and Prots B. 1991. Some Data about Orchidaceae Species Cenopopulations in the Industrial Territories. Theses of conference, Lviv (in Ukrainian).

Zlatnik A. 1934. Studie o statnich lesich na Podkarpatske Rusi. Dil prvni. Prispevky k dejinam statnich lesu a lesnictvi na Podkarpatske Rusi. Sborn. Vyzk. Ust. Zemed. 126/8: 1-109.

ECOEDAPHIC CONDITIONS OF TRANSBOUNDARY FOREST ECOSYSTEMS AND THE IMPACTS OF AIR POLLUTION

Milan Kodrík and Eduard Bublinec
The Institute of Forest Ecology
Slovak Academy of Sciences

The stability of forest growth is threatened, particularly in the most valuable natural sectors which various countries have proclaimed their national parks. A network of monitoring areas on vertical transects within the Tatra National Park (TANAP) was established for the purpose of long-term ecoedaphic research and the monitoring of environmental factors. Research on the transects is at present aimed at investigating changes in the health condition and stability of forest ecosystems. Every monitoring area has 100 trees under investigation and evidenced in detail (by reference to biometric characteristics, tree classification, the nature of regeneration, and the diagnostics of changes in health). Also considered are bioclimatic changes and characteristics, ecoedaphic changes, changes to biocenoses and their components, etc.

This paper interprets the results of a special investigation of the soil and vegetation qualities of transects I. (Zadne Med'odoly) and III. (Skalnata dolina). The upper area of the transect I is at an altitude of 1520 m above sea-level, and it has an unsaturated brown forest carbonate soil with the Sorbi aucupariae-Piceeta association (nutritious order B) and with the mull form of surface humus. The weight of this averages 18 t.ha-1, the pH in water is 4.85, and there is limited proton loading (0.052 kmol.ha-1). The middle area of the transect has a brown gley-podzol of the average degree at an altitude 1380 m above sea-level. It has an acid association of the order A (Piceeta sorbina) with greater acidity (pH 3.45) and raw humus at 75 t.ha-1. The actual proton (H^+ ion) loading is 102.5 times greater than in the preceding monitoring area (MP) and reaches a value of 5.312 kmol. The lowest area (1280 m above sea-level) has brown rendzina with an organic horizon of the rendzina moder type weighing about 5 5 t.ha-1. Acidity is least marked in this horizon (pH 5.45 in H_2O), a fact that is influenced by a soil rich in two-power bases, which also distinguishes the group of forest types Sorbi ariaePiceeta from the transient order B/D. The actual horizon loading O is low, in accordance with the humus type, and ranges to about 0.039 kmol of hydrogen ions.

At 109 t. ha-1 the mean dry weight of surface humus in the upper area transect III (an altitude of 1430 m) is the highest observed on any of the investigated monitoring plots. A brown podzol has developed here with a typical humus of very high acidity (pH in H_2O 3.36, pH in KCl 2.52). Accordingly, the group of forest types Piceeta laricina comes from the acid order A and has actual acid loading of up to 9.488 kmol. The middle area of the transect (at 1160 m) has developed surface humus with an acidity analogous to that of the upper area and an average weight of about 80 t. ha-1. The loading is otherwise lower but quite near to the upper area, reaching 8.364 kmol of H^+ ions. The Piceeta pineo-laricina association again belongs to the acid order A. The lowest area on the transect (880 m above sea-level) has the average surface organic horizon weight of 73 t.ha-1. In its form it belongs to the moder type (pH in H_2O 3.65). The proton loading averages 3.250 kmol and the vegetative association belongs to the transitory order A/B, with two groups of forest types (Abieti piceetaequiseti vs Abieti piceeta laricis) having moder brown semigley soil.

Further research on the soil showed the soils of this elevation transect to be extremely acidic. In the area of the Lomnicky transect, the belt of very acid cambisoils reaches to a height of approximately 1100 m a.s.l., where it joins with a belt of practically equally acid cambisoils (brown) podzols. The mean pH value in KCl of the exchangeable soil reaction of the covering humus horizons of cambiso ils amounts to about 3, and in the podzols to about 2.5. The range in the mineral soil layers (down to 50 cm) is pH 3.1 to 3.8, or 2.8 to 4.4, respectively. In comparison with earlier data for these same soil units these are evidently higher by pH 0.5 to 0.6 and are an indication of the effect of man-induced acid deposits on the soils of the TANAP.

An assessment of health conditions according to dendro-indicators permits forest growth on the Skalnata dolina transect to be assigned to the 1st and 2nd degrees of damage. Expressed as a percentage of healthy specimens, the state of health of spruce in relation to elevation is as follows: at 880 m a.s.l., 9 percent; at 1160 m a.s.l., 13 percent; and at 1430 m a.s.l., 18 percent. This yields a mean of 18 percent healthy spruce trees for the transect studied. Similarly, the greatest number of most heavily-damaged (4th degree) spruce trees was found in the uppermost area (22 percent), and then in the middle area (16 percent), with the least damage observed in the lower area (8 percent). Evidently a certain differentiation or selection takes place here in the tree population. It is necessary to underline at this point that the composition, while comparable to other ecosystems in TANAP, is not usual for the other regions of Slovakia. This is caused by the limited ability of most tree species to endure the extreme climate and ecoedaphic conditions of the Central Carpathian region and provides a potential basis for the mass destruction and dying-off of unstable forest ecosystems. The research and evaluation done to date suggests that the following associations can be considered as potentially the most endangered by chemical and climate stresses: Piceeta sorbina, Piceeta laricina, and Piceeta pineo-laricina. The ecophysiological stability of these ecosystems is also low. Abieti piceeta-equiseti has limited resistance to the influence of mechanical stressors. From the climatic point of view, the optimum for the spruce is forest vegetation of the 5th degree. Situated in this belt are the complex of moist ecosystems of the Abieti piceeta-equiseti type only, and this truth ought to be taken into consideration in the monitoring of injurious agents. The Sorbi aucupariae-Piceeta, Sorbi ariae-Piceeta, and Abieti-Piceeta laricis associations can be indicated as relatively the most stable ones.

It is probable that the southern slopes of the High Tatra (inclining into the Poprad valley) resemble those of the Alps in having 2 elevation zones of damage to forests, viz. at 850-1200 m and at 1400-1650 m a.s.l. The lower zone is related to inverted stratification of the air and damage in it is due to classical pollutants, such as SO_2 and NO_x. In contrast the second elevation zone is characterized by the prevalence of ozone-conditioned photooxidative stress.

Finally, we must say that the development and further deepening of this kind of research enables us to signal in time the decline of the potential resistance of TANAP-forest ecosystems and to make provisions to support their stability. The TANAP research is thus linked with the United Nations Environment Program (UNEP) and can help shed light on information which is being obtained from other monitoring categories within the so called "great representative forest investigation" in Slovakia.

REFERENCES

Bublinec E., Cicák A., Štefanèík I., and Kukla J. Soil Properties and Condition of the Spruce on a Vertical Transect in the High Tatras . Zborník prác o Tatranskom národnom parku, 32, 1992, s. 335-352.

Voško M., Kukla J., and Klubica D. The Analysis of the Ecological Factors and of the Forest Ecosystem Structure in the Monitoring Areas on the TANAP-territory. Zborník prác o Tatranskom národnom parku, 30, 1990, s. 227–276.

THE BELOW-GROUND BIOMASS OF MATURE FORESTS AND IMMISSION LOADING

Milan Kodrik
Institute of Forest Ecology
Slovak Academy of Sciences

INTRODUCTION

Roots provide a crucial link in the soil-plant-continuum. Their health depends on both the soil environment and the functioning of the tree canopy. Changes in either one of these compartments gives rise to a root response (Persson 1980), and the state of health of roots in turn determines multiple above-ground functions of plants, such as water and nutrient exchange (Chapin 1980), growth (Ingestad 1982), and hormonal root/shoot interactions (Schulze 1986). There is a strong interrelationship between the tree canopy and the root system, with the canopy supplying carbohydrates for root growth (Marshall and Waring 1985) and the roots supplying water and nutrients to the canopy. However, root growth, mineral concentrations (Bublinec 1992), and the formation of root tips are determined by such chemical and physical properties of the soil as the nitrogen supply (Meyer 1985) and degree of soil acidification.

In accordance with this knowledge, the aim of the work described here is to gain data on the division and total quantity of below-ground biomass in Norway spruce stands under varying pollution regimes.

MATERIALS AND METHODS

Four monitoring plots (MP1-MP4) were established in the area of the Moravian-Silesian Beskids. In all cases the stands involved were Norway spruce monocultures. The soil substrate consisted of an iron podzol, and all plots had northwest exposure with an inclination of 10-15 {SYMBOL 176 \f "Symbol"}. More details can be found below in Table 1 (and see also Kodrík 1992).

TABLE 1 Stand Characteristics of the Four Monitoring Plots in the Moravian-Silesian Beskids (MP1-4)

Plot	Altitude [m]	Age [years]	Height [m]	Diameter [cm]
MP1	900	80	23	26
MP2	920	75	22	28
MP3	910	75	22	28
MP4	830	70	22	25

Pollution regimes were taken into consideration when the plots were chosen. The first three plots were characterized by pollution loadings of different intensities (expressed by 50-60 percent loss of needles), while the fourth was a control plot with minimum inputs of pollution. Exact values for loads in the investigated monitoring plots are given below in Table 2 (Kontrišová 1990).

All data on below-ground biomass were gained through destructive sampling of trees. To get a complete picture of the position of trees as individuals, after repeated stock-takings each tree was sorted by Kraft's classification scale (Vyskot et al. 1971). This scale takes the relative altitudinal position of the tree and the formation of the crown into account. Kraft (Vyskot et al. 1971) distinguishes the following classes: Dominant, codominant, partially codominant, undertopping, and fully-shaded trees. The selection resulted from calculated mensurational tree variables, separately for each Kraft class (Oszlányi 1975).

We processed one sample tree from of the first three classes on each research plot. The tree root system was elevated by means of the archeological method (Kodrík 1992), with the whole root system being gradually uncovered using shovels, hoes and brushes. A tractor with a winch and a powersaw were also used. The fresh weight was determined in the field on scales accurate to 0.05 kg

RESULTS

The results are shown in Table 3. It is evident from the data that the most substantial share of below-ground biomass is on MP4 - at 72.6 t ha-1 in terms of dry weight. There are no substantial differences in the structure of below-ground biomass except in the first diameter category. The most substantial share of the

TABLE 2 Pollution Inputs in the Eadca Area - Average Values in 1980-1990

DUST	TRACE ELEMENTS IN DUST [mg kg-1 year-1]					
[g m-2 month-1]	Cd	Cu	Cr	Mn	Ni	Pb
8.67	9.6	72.1	34.9	440.4	94.5	462.6

biomass in this diameter category is on MP4, where it represents 3 percent of total below-ground biomass.

TABLE 3 Root Biomass of Norway Spruce (Picea Abies (1.) Karst.) in Different Diameter Classes in Terms of Dry Weight [kg ha-1] and Percentage Share in Every Diameter Class

	Root size classes [cm]							
Plot	Total							
	<0.5	0.6-2.0	2.1-5.0	5.1-7.0	.1-10.0	>10.0	Stump	
MP1	740	2810	5960	3960	3880	19420	18370	55140
	1%	5%	11%	7%	7%	36%	33%	100%
MP2	880	4500	7570	3630	3600	19850	23500	63530
	1.5%	7%	12%	5.5%	6%	31%	37%	100%
MP3	1390	2340	4480	2990	2360	18960	22010	54530
	2.5%	4%	8%	5%	4.5%	35%	41%	100%
MP4	2130	3500	6840	3910	4470	32160	19600	72610
	3%	5%	10%	5%	6%	44%	27%	100%

It is obvious from the biomass distribution (Table 3) that almost all diameter categories on the control plot (MP4) obtained higher estimates. Also, while the total biomass is 72.6 t DW ha-1 on MP4, the lowest total biomass on the polluted plots (on MP3) was as low as 54.5 t, or only 75 percent of the total below-ground biomass recorded from the control plot. The differences in biomass noted on the other polluted plots were not so great.

DISCUSSIONS

Nihlgãrd (1972) estimated the below-ground biomass in a 55-year-old Norway spruce stand to be 59 t DW ha-1. On the other hand, Parshevnikov (1975) estimated root biomass in a 110-year-old Norway spruce stand at 66 t DW ha-1. It may be concluded with regard to MP1-MP4 that the stand density is higher and the growth conditions different. Our data are further confirmed by results from Oszlányi (1986), who estimated the root biomass in terms of below-ground fresh weight at 115 t ha-1 in a 60 year-old Norway spruce stand.

REFERENCES

Bublinec, E., 1992. The Content of Biogenic Elements in Forest Tree Species. Lesn.Èas.-Forestry Journal 38, 365-375.

Ingestad, T., 1982:. Relative Addition Rate and External Concentration: Driving Variables Used in Plant Nutrition Research. Plant Cell. Environ. 5, 443-453.

Kodrik, M., 1992. Below-ground Biomass Distribution of Norway Spruce. In: Forest-Wood-Ecology, Internat. Sci. Conf. pp 151-157. Technical University Press, Zvolen, Slovakia.

Kontriková, O., 1990. Air Quality on the Monitoring Plots. Final Report Institute of Forest Ecology SAS, Slovakia. 27 p. (in Slovak) Slovakia.

Marshall, J.O., Waring, R.H., 1985. Predicting Fine Root Production and Turnover by Monitoring Root Starch and Soil Temperature. Plant Soil 91, 51-60.

Nihlgãrd, B., 1972. Plant Biomass, Primary Production and Distribut. of Chemical Elements in a Beech and Planted Spruce Forest in South Sweden. Oikos, 23, 69-81.

Oszlányi, J., 1979: Biomass Energetic Value of Different Biosociological Position Trees. Lesnícky èasopis 23, 177-188. (in Slovak)

Oszlányi, J., 1986: Analysis into Biomass Production and into its Energy Equivalent of the Tree Layer in Five Forest Ecosystems. Biologické práce 32, 1, Veda Bratislava, 1-157. (in Slovak)

Parshevnikov, A.L., 1975: Productivity and Turnover of Chemical Elements in Northern Phytocoenoses. Nauka, Leningrad, USSR, 128 p. (in Russian).

Persson, H., 1980: Fine Root Dynamics in a Scots Pine Stands with and without Near-Optimum Nutrient and Water Regimes. Acta Phytogeogr. Suec. 68, 101-110.

Schulze, E.D., 1986: Carbon Dioxide and Water Vapor Exchange in Response to Drought in the Atmosphere and in the Soil. Annu. Rev. Plant Physiol. 37, 247-274.

Vyskot, M. et al., 1971: Bases of Growth and Production of Forest. State Agricultural Publishing house Praha, Czechoslovakia. 440 p.

DISTRIBUTION OF CRUSTACEA IN SLOVAKIA'S EASTERN CARPATHIANS AND PROBLEMS OF PRESERVATION

Igor Hudec and Dusan Barabas
Institute of Zoology and Ecosozology
Slovak Academy of Sciences
Juraj Platko
Management in Protected Area of Eastern Carpathians

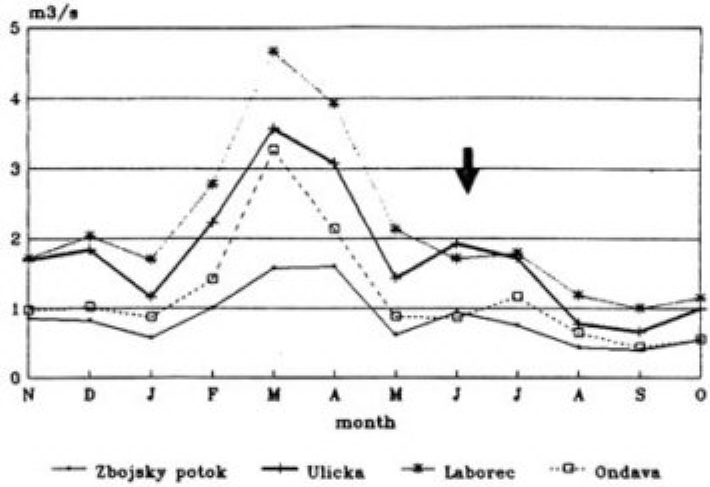
INTRODUCTION

Knowledge about amphipods in Slovakia's Eastern Carpathians is not satisfactory, but the amphipods are nearly the same in all Slovakia (STRASKRABA, 1953, 1959, 1962). Three amphipod species of the genus Gammarus are noted commonly from Slovakia (*G. balcanicus tatrensis, G. fossarum* and *G. roeselli*). Only one record of *G. kishineffensis* was reported by Straskraba (1962) from Zbojsky Brook. The following surface amphipods have been found to date in southern parts of Slovakia: *Sinurella ambulans* MULLER, *Niphargus valachicus* DOBR.& MAN. Other species are restricted to the Danube (Brtek, Rothschein, 1964). The crayfish has not been researched in the Slovakian Eastern Carpathians yet and only two records of *A. astacus* have been reported in Zbojsky Brook (J. Brtek's personal information). We did not find *Asellus aquaticus* L. (Isopoda) in the protected area itself but the species was recorded in the Laborec River near Krzl'ov Brod (below Medzilaborce).

CHARACTERISTICS OF THE WATERSHED

The relatively limited permeability of the East Carpathian flysch ensures a shallow circulation of ground water. The accumulation ability of watersheds is very low in spite of the high percentage forestation of the region (Kupco, 1988).

The hydrological regime has features characteristic of flysh (Figure 1, upper part):



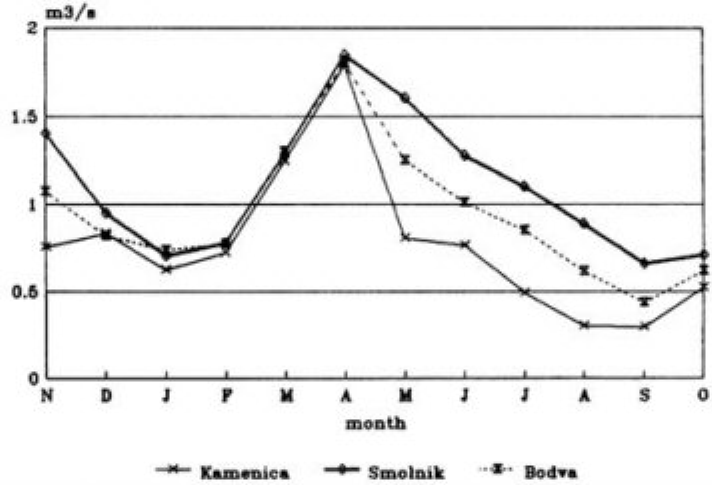


FIGURE 1 Mean Monthly Flows on Some Eastern Carpathian Brooks (upper part) and Comparable Large Brooks on Other Parts in East Slovakia

- Maximal mean monthly flows are in March and April, because of snow melt and spring rains;
- There is later a rapid decrease (May); and
- The next rise (June - July) in mean monthly flows is the result of summer rains.

The hydrological regime in crystalline complexes and neovulcanits of Slovakia (Figure 1, low part) decrease more slowly in its mean monthly flows after spring maxima, so that the summer rains do not have so strong an influence on mean monthly flows as flysch in the East Carparthians. Some characteristics from comparable large watersheds are in Table 1.

Relatively high and fast drainage of rain is also typical for the East Carpathian flysh. Fifty percent runoff is characteristic of the mean annual flow (Table 1) and up to 80 percent runoff is commonly measured during floods. Floods in such an extreme water regime are designated hydrologically as flood waves.

Both maximal and minimal flows are considered to be the extremes for the whole of the East Carpathian flysh on East Slovakian territory.

Water management is very important for many streams because of strong erosion.

MATERIAL AND METHODS

We researched the Crustacean fauna of surface waters during 1993, but older records were also included. Consideration here is restricted to flowing water habitats. We used Carausu et al (1955) and Jadzewski (1975) to determine identity of Amphipoda and Hennig (1982) for crayfish.

TABLE 1 Hydrological Parameters of Comparable Watersheds on Different Background

			Mean Annual Value		
Brooks (background)	Localization of profile	Watershed area (km^2)	Precipitation (mm)	Runoff (mm)	Specific runoff ($l.s^{-1}.km^{-2}$)
Zbojsky potok (flysh)	Nova Sedlica	34.5	1026	768	24.33
Kamenica (neovulcanits)	Kamenienka	39.2	1003	612	19.39
Ulicka (flysh)	Ulic	96.7	967	571	18.09
Bodva (crystallinic)	Nizny Medzev	90.2	890	329	10.43
Ondava (flysh)	Vysny Orlik	108.6	825	343	10.87
Smolnik (crystallinic)	mouth	99.2	937	350	11.09
Laborec (flysh)	Krasny Brod	158.3	953	427	13.52

RESULTS

Amphipoda

Gammarus kishineffensis SHELLENBERGER is an East Carpathian element of the Slovak fauna for it has only been found in the main flow of the Stuzica, the Zbojky, the Ulicka (near Runina), and the Ublianka (up to Klenovz). The species was not recorded from small streams in the watershed, and it was also absent from Ulicka below the town of Ulic as a consequence of urban pollution. We suggest simultaneously that as an East-Carpathian element of the Slovakian fauna, *G. kishineffensis* probably has its westernmost distribution in this area.

Gammarus fossau KOCH was recorded in the Cirocha River both before and during the construction of the Starina Reservoir. However the present study did not locate it there (only *G. balcanicus* tatrensis was found). *G. fossarus* is a common species in the rest of Slovak territory, occurring in the main flows of brooks, streams, and springs. The species was found by the authors below Starina Reservoir and in the lower part of the Laborec River.

Gammarus balcanicus tatensis KARAMAN is the only species in the upper and midparts of the Udava River and in all of the area above Starina Reservoir, including all researched springs. It also inhabits only the upper parts of Ulicka and Zbojsky Brooks, including the springs.

Decapoda

Only *Astacus astacus* L. was recorded from this region, with small populations limited to only some of the brooks and streams of the Udava, Cirocha, Ulicka watersheds. More abundant populations were only noted in and around secondary habitats (stream-ponds) in the western part of East Carpathian region. A surprisingly strong crayfish population was found in the Starina Reservoir when it is recalled that the reservoir was filled only six years ago.

Some individuals were infected with epiparasitic Annelida (Clitellata, Branchiobdellida), mostly *Brachiobdella pentadonta* WHITMAN, 1882, and less so B. parasitica HENLE, 1835.

CONSERVATION ISSUES

Only *Astacus astacus* L. needs special efforts in conservation, as according to the "Red book" (Brtek, 1993) it is a vulnerable member of the Slovak fauna. It is recommended that the preservation of this species be linked with fish management, since both groups have very similar problems where the preservation of habitat is concerned.

The greatest problem in the conservation of crayfish is the water regime on the East Carpathian flysh (Figure 2 and Table 1). Heavy erosion destroys natural

FIGURE 2 Distribution of Crayfish Astacus astacus L. in Slovakian Eastern Carpathians

riverine habitats, especially during floods, and this is probably the main reason for the low populations of crayfish, especially in the eastern part of area.

Some time ago a cascade of weirs was constructed on the upper part of the Zbojsky Brook. It would seems that these constructions were inadequate for the hydrological regime because they are almost destroyed now. The authors recommend than an adequate cascade of weirs be constructed in the upper part of the Zbojsky and Ulicka Brooks.

On the basis of the research presented here, the small brook-ponds would also seem to be one possible and ideal way by which to strengthen crayfish populations.

To date, industrial and urban pollution has not been one of the greater problems in the area. Pollution affects only short sections of rivers (e.g., those below the towns of Medzilaborce, Ubl'a and Ulic). It would seem that a greater problem for riverine habitats will result from the contemporary deforestation of large parts of the area (e.g., the Runina district).

Acknowledgment

We thank the Management of the Protected Area of the Eastern Carpathians (Humenne) for partial sponsoring of the research in 1993.

REFERENCES

Brtek J., 1992. Crustaceans (Crustacea), p.54-59. In: L. Skapec (Ed.). Red Book of Endangered and Rare Species of Plants and Animals in CSFR, 3 Invertebrata. PrZroda, Bratislava (in Slovak)

Brtek, J. & Rothschein, 1964. Ein Beitrag zur Kenntnis der Hydrofauna und des Reinheitzustandes des tschechoslowakishen Abschnittes der Donau. Biol. Przce, Bratislava 10, 5: 62 pp.

Carausu S., E. Dobreanu, and C. Monolache 1955. Amphipoda forme salmastre si de apa dulce. Fauna Rep. pop. Romine, Crustacea 4.4: 409 pp.

Hennig A., 1982: Das System der europaischen Fluákrebse (Decapoda, Astacidae): Vorschlag und Begrundung . Mitt. hamb. zool. Mus. Inst. 79: 187-210

Jadzewski K., 1975. Morfologia, taksonomia i wystepowanie w Polsce kieldzy z rodzajow Gammar dem Sammlungen von Prof. Hrab I. V st. eskoslov. spol. zool. 26, 2: 117-145

Kupco M., 1988. Hydrology: 41-47 p. In: I. Voloscuk (Ed.): The East Carpathian protected area. Priroda, Bratislava.

Straskraba, M., 1953. Preliminary report on distribution of the genus Gammarus in Czechoslovakia. Vest. Ceskoslov. spol. zool. 17, 3: 212-227 (in Czech)

Straskraba M., 1959, Contribution to the knowledge of the amphipod fauna of Slovakia. Biologia. Bratislava 14, 3: 161-172 (in Czech)

Straskraba M., 1962, Amphipoden der Tschechoslowakei nach dem Sammlungen von Prof. Hrabe I. Vest. Ceskoslov. spol. Zool. 26, 2: 117-145

VI

APPENDICES

APPENDIX A

BASIC PRINCIPLES

1. Transboundary areas must be understood as one complex unit. Natural and cultural values of the territory should be evaluated within the whole transboundary unit and management plans should be applied consistently within the entire unit, not separately for each particular part of the unit.
2. Transboundary protection of biodiversity needs to be promoted on each of its levels (ecosystems, species and genetic) through the development of international conservation strategies. These strategies would set general principles of the protection of transboundary units, define priorities for actions, and set unified methodologies for research, monitoring, and data processing. These strategies also should serve as a basis from which the national management plans for national portions of transboundary units (transboundary protected area) shall be derived.
3. Political support is necessary for transboundary areas on both national and international levels.

    International level: Statements supporting transboundary cooperation within the transboundary protected areas should be incorporated into international agreements between concerned countries.

    National level: Funds need to be raised for research, monitoring, conservation, education, and data processing.
4. Legislation and its implementation need to be improved to better preserve the natural resources in existing protected areas.

SUGGESTED RESEARCH AGENDA TO SUPPORT BIOLOGICAL DIVERSITY

This list was developed during the workshop and reflects the general consensus of the individual participants; these suggestions do not necessarily reflect the views of any organizing or sponsoring institution. Although the enumerations reflect the topics as presented, the research is not necessarily meant to be exclusively applicable to the site where the topic happened to arise.

Eastern Carpathian Biosphere Reserve

1. In the near future, decisions on common methodologies, scales, sample design, and intensity should be agreed to by the relevant organizations at each Protected area. Since the work involves common ecosystems, syntheses and comparisons can only be made if the protocols and units are mutually useful and communicated.
2. At each Protected Area, a statement of principles and memorandum of understanding should be drafted and agreed to by each national party. The documents should encourage and reach a wider research population, i.e., a diversity of disciplines and scientists from a much wider variety of organizations. Research on diversity cannot be effective if exclusive or the province of a controlling entity.
3. Much more emphasis on system level, process oriented research (integrated and interdisciplinary) is needed. While further enumeration (e.g., systematics) is useful, there should be a general shift to systems research.

Bialowieza/Byelovschkaya

4. A dysfunctional split exists between applied and academic research at Bialowieza/Byeloveschkaya. This point reflects 1 and 2 above and has tended to harm legitimate and necessary capabilities. The solution is to initiate a systems analysis of the entire forest which would require the input and coordination of a variety of scientists. If competitive exclusion and niche segregation among scientists has been a modus of the past, the new science demanded of transboundary systems will render such approaches archaic.
5. An attempt should be made to have the fence removed in Bialowieza/Byeloveschkaya.
6. There should be a moratorium on forest harvest in Bialowieza pending the results of research on timber harvest methodologies in support of natural forest

system patterns and processes (e.g., long rotation, mixed species, uneven age, snags and fallen logs, and their effects on basic forest parameters such as numbers of species at different trophic levels, and nutrient cycling).

7. Related to 6, research is needed on the direction, scale, and rate of natural processes and changes in remnant natural systems (e.g., changes in natural forest demography and senescence in altered modern environments of Central Europe).

FOREST FRAGMENTS, CONSERVATION BIOLOGY, AND ECOSYSTEM RESTORATION

8. An assessment of genetic and demographic risk of the fragments and populations is needed, and it should include an inventory of natural forest fragments (e.g., the seven in Bieszczady, the five in the Ukraine Carpathians, etc.), their constituent animal populations, the minimum viable populations (MVPs) of these animals, and the carrying capacities required to support such MVPs.
9. Trials/experiments on restoration to natural system characteristics should begin on appropriate (e.g., nearby, similar abiotic character) degraded land with the eventual goal of adding to/buffering the transboundary protected systems.
10. There should be no research conducted in areas where feeding of large wild herbivores is occurring, except as it relates to the impact of these animals.

TOURISM AND RECREATION

11. Research is required on who visits the Protected Areas, inhabitants of the Protected Area's region, who the potential resource-user populations are, what they want, their attitudes toward nature, their decision-making processes, and non-coercive behavior modification to foster the biodiversity-related goals of the Protected Areas based on the above research (e.g., through environmental education).

KRKONOSE TRANSBOUNDARY BIOSPHERE RESERVE

12. Research on the effects of various insect control agents on target and non-target species population dynamics.

13. Research on the genetic variation of plant and animal species from all major trophic levels to determine possible importance of demes on persistence, susceptibility to invaders, genetic dilution, the relationship of variation to pollution resistance, and suitability for restoration material.
14. Trials of management practices presumed necessary to preserve natural areas.

MONITORING IN PROTECTED AREAS

15. Carefully conceived, long-term monitoring plans for biodiversity which employ existing regional scale monitoring models need to be developed and applied to protected areas. A protocol for applying regional models to intensive monitoring at the protected area level, and for their use in research and management, should be developed by the transboundary parks.

In sum, the participating scientists projected a remarkable consensus on research priorities, which seems to reinforce the desirability of:

- More diverse, less institutionally dominated research;
- Integrated systems research, analysis, and depiction;
- Possible forestry practices fostering natural, old systems;
- Planning a population-based geometry for protected areas; and
- Cessation of feeding and moratorium of harvests pending results of research on effects and uses.

APPENDIX B

WORKSHOP AGENDA

PRESERVATION OF NATURAL DIVERSITY IN TRANSBOUNDARY PROTECTED AREAS

Research Needs/Management Options

Polish Academy of Sciences

National Academy of Sciences of the USA

Bieszczady Biosphere Reserve & Tatry Biosphere Reserve

TUESDAY, MAY 17, 1994

9:00 am **Opening of the Workshop**
Welcome addresses:
National Academy of Sciences of the USA
Polish Academy of Sciences
Local Authorities

9:30 am **General Session: East Carpathian Biosphere Reserve**
Chairs: Zuzanna Guziova, Ministry of Environment, Slovakia; Zbigniew Niewiadomski, Bieszczady National Park, Poland
"Ecological Characteristics of the Stuzhytsa Massive (Ukrainian part of Biosphere Reserve)"
Stephan Stoyko, Institute of Ecology of the Carpathians, Lviv, Ukraine
"Floristic Diversity in the Ukrainian part of the Biosphere Reserve"
Lydia Tasenkevich, Institute of Ecology of the Carpathians, Lviv, Ukraine

"Transboundary protected systems in Eastern Poland, Inventory and Preliminary Proposal of Environmental Strategy"
Bozena Degorska, PAN Institute of Geography

1:00 pm Lunch
2:30 pm Excursion

WEDNESDAY, MAY 18, 1994

9:00 am **General session: Bialowieza National Parks and Biosphere Reserves**
Chairs: Czesazw Okolow, Bialowieza National Park, Poland
Vjacheslav Semakov, Sate National Park Belovezhskaja, Belarus
"Problems of Preservation of Biological Diversity in Transboundary Protected Areas of Belarus and Poland"
Victor Parfenov, Institute of Experimental Botany, Belarusian Academy of Sciences, and Michael Pikulik, Institute of Zoology, Belarusian Academy of Sciences

10:30 am Break
11:00 am **Panel 1: Biodiversity Conservation Strategy**
Chairs: Robert Szaro, U.S. Forest Service
Ludwik Tomialojc, Wroclaw University, Poland
Zuzanna Guziova, Slovak Ministry of the Environment
Pavel Parfeov, Belarus GEF Forest Biodiversity Project
Andrzej Weigle, National Foundation for Environmental Protection, Poland

1:00 pm Lunch
2:30 pm **Continuation of Panel 1: Biodiversity Conservation Strategy**
General Discussion
4.30 pm Visit to Bieszczady National Park Headquarters
7:00 pm **Evening Session: Biodiversity or Biochaos**
Jerzy Solon, PAN Institute of Geography

THURSDAY, MAY 19, 1994

9:00 am Panel 2 and Panel 3 held concurrently

Panel 2: Management of Fragmented Ecosystems
Chair: Steven Berwick, WILD System, United States
"Principles of Restoration Ecology"
Karen Holl, Stanford University

Panel 3: Parks for Science and Science for Parks
Chairs: Hubert Hinote, Southern Appalachian MAB Program, US
Leszek Starkel, PAN Institute of Geography
"Distribution of Crustacea in Slovakian Eastern Carpathians and Problems of Preservation"
Igor Hudec, Institute of Zoology & Ecosozology, Slovakia

10:30 am Break

11:00 am Panel 4 and Panel 5 held concurrently

Panel 4: Wildlife Management in Protected Areas
Chairs: Bogusaw Bobek, Institute of Environmental Biology, Jagiellonian University, Krakow, Poland David M. Leslie, U.S. Biological Service
"Wildlife Management in Bialowieza Forest"
Henryk Okarma, Institute of Mammals Research, Bialowieza

Panel 5: Biodiversity and Pollution Monitoring
Chairs: Reginald Noble, International Plant and Pollution Laboratory, Bowling Green State University, U.S. James Quinn, Division of Environmental Studies, University of California-Davis, US
"Flora Diversity and Anthropogenic Transformations in the Dasin of Latorista River (Ukrainian Carpathians)"
Bohdan Prots, Institute of Ecology of the Carpathians, Lviv
"Ecoedaphic Conditions of Forest Ecosystems and Impact of Transboundary Air Pollution"
Milan Kodrik, Institute of Forest Ecology, Slovakia

1:00 pm Lunch

2:30 pm **Panel 6: Recreation and Tourism Management in Protected Areas**

Chairs: Thomas Heberlein, Department of Rural Sociology, University of Wisconsin, US; Grzegorz Rakowski, Institute of Environment Protection, Warsaw

FRIDAY, MAY 20, 1994

9:00 am Tour of Bieszczady

Departure to Zakopane

SATURDAY, MAY 21, 1994

9:00 am **General Session: Tatra Transboundary Biosphere Reserve**

Chairs: Wojciech Gasienica Byrcyn & Zbigniew Krzan, Polish Tatra National Park; Ivan Voloszczuk, Slovak Tatra National Park

"Tatra's Geoecological System Function and Natural Risks"

Adam Kotarba, PAN Institute of Geography

10:30 am Break

11:00 am Visit to Tatra National Park Headquarters, Zakopane

1:00 pm Lunch

2:30 pm **General Session: Karkonosze Transboundary Biosphere Reserve**

Chairs: Jan Jenik, Department of Botany, Charles University, Prague, Czech Republic; Maria Goczol-Gontarek, Karkonosze National Park and Biosphere Reserve, Poland

"Factors Influencing the Diversity of Invertebrates in the Giant Mountains"

Jan Bohacz, Institute of Landscape Ecology ASCR, Ceske Budejovice, Czech Republic

SUNDAY, MAY 22, 1994

9:00 am	Excursion to the Tatra Mountains

MONDAY, MAY 23, 1994

9:00 am	**Panel 7: Design of Protected Areas** Chairs: Zygmunt Denisiuk, PAN Institute of Nature Protection, Krakow; Stan Krugman, US Forest Service "*Present Status and Perspectives of MAB Biosphere Reserves*" Bogusaw Bobek, Jagiellonian University, Krakow
10:30 am	Break
11:00 am	**Panel 8: Creation of Conservation Strategies in Transboundary Protected Areas** Chairs: Kazimierz Dobrowolski, PAN Institute of Ecology Catherine Pringle, University of Georgia *Presentation of Regional Initiatives* International Ecological Institutes: Zofia Fischer-Malanowska, PAN Green Lungs: Krzysztof Wolfram, Bialystok GEF programs: Piotr Paschalis, Poland and Peter Straka, Slovakia ECOFUND: Maciej Nowicki
1:00 pm	Lunch
2:30 pm	**Closing Session** Chairs: Alicja Breymeyer, Stan Krugman, Reginald Noble Discussions on: 1) List of Managers' Greatest Concerns, 2) List of Scientists Greatest Concerns
4:30 pm	**Creation of Conservation Strategy in Transboundary Protected Areas** General discussion
6:30 pm	Farewell dinner

TUESDAY, MAY 24, 1994

9:00 am	**Closing Session**
	Reports of Panel and Session Chairmen
	Reports of Two Groups (Concerns Lists)
	General Discussion
10:00 am	Break
11:00 am	**Closing Session Continued**
	Next steps
	Report preparation

APPENDIX C

PARTICIPANT LIST

Stephen BERWICK
WILD System
36785 SW Southwind Drive
Hillsboro, OR 97123
USA
Tel: (503) 628-0653
Fax: (503) 628-0152

Boguslaw BOBEK
Institute of Environmental Biology
Jagiellonian University
ul. Ingardena 6
30-060 Krakow
POLAND
Tel: (48 12) 336-377

Jaroslav BOHAC
Institute of Landscape Ecology
Na sádkách 7
370-05 Ceske Budeovice
CZECH REPUBLIC
Fax: (42 38) 457-19
Tel: (42 38) 817 w. 524
e-mail: uek@entu.cas.cz

Alicja BREYMEYER
Department of Geoecology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808
e-mail: igipzpan@plearn.bitnet

Tadeusz CHOJNACKI
Secretary
Wydziau II Nauk Biologicznych
Polish Academy of Sciences
00-901 Warsaw, skr. poczt. 24
PKiN
POLAND

Stephen DEETS
Office for Central Europe and Eurasia
National Research Council
2101 Constitution Avenue, NW
Room FO-2014
Washington, DC 20418
USA
Fax: (202) 334-2614
Tel: (202) 334-2658
e-mail: sdeets@nas.edu

Bozena DEGORSKA
Department of Geoecology
Institute of Geography and
Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Marek DEGORSKI
Department of Geoecology
Institute of Geography and Spatial
Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Zygmunt DENISIUK
Institute of Nature Conservation
Polish Academy of Sciences
Lubicz 46
31-512 Krakow
POLAND
Fax: (48 12) 210-348
Tel: (48 12) 210-348

Kazimierz BOBROWOLSKI
Institute of Ecology
Polish Academy of Sciences
Konopnickiej 1
05-092 Lomianki
POLAND

Zofia FISCHER-MALANOWSKA
Wydzial II Nauk Biologicznych
Polish Academy of Sciences
Palace of Culture and Science
Skr. poczt. 24
00-901 Warsaw
POLAND

Witold FRANCKOWIAK
Department of Wildlife Research
Institute of Environmental Biology
Jagiellonian University
Ingardena 6
30-060 Krakow
POLAND
Tel: (48 12) 336-377 w. 407, 466
Fax: (48 12) 337-086
e-mail: frackowiak@eko.uj.edu.pl

Wojciech GASIENICA BYRCYN
Tatra National Park &
Biosphere Reserve
Chalubinskiego 42
34-500 Zakopane
POLAND

Maria GOCZOL-GONTAREK
Karkonosze National Park &
Biosphere Reserve
Chalubinskiego 23
58-570 Jelenia Góra
POLAND

Bozenna GRABINSKA
Institute of Geography and
Spatial Organization
Polish Academy of Sciences
Department of Geoecology
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Tel: (48 22) 269-808
Fax: (48 22) 267-267

Zuzana GUZIOVA
GEF Biodiversity Protection Office
Ministry of Environment
Hanulova 9/a
841 02 Bratislava
SLOVAK REPUBLIC
Fax: (42 7) 786-568
Tel: (42 7) 786-581

Thomas HEBERLEIN
Department of Rural Sociology
University of Wisconsim
308J Agricultural Hall
Madison, WI 53706
USA
Tel: (608) 262-9531
Fax: (608) 262-6022
e-mail: heberlein@ssc.wisc.edu

Hubert HINOTE
Executive Director
Southern Appalachian
MAB Program
1314 Cherokee Orchard Road
Gatlinburg, TN 37738
USA
Fax: (615) 436-5598
Tel: (615) 436-7120

Karen HOLL
Center for Conservation Biology
Department of Biological Sciences
Stanford University
Stanford, CA 94305-5020
USA

Igor HUDEC
Institute of Zoology and
Ecosozology
Slovak Academy of Sciences
Kofflerova 10
040-01 Kosice
SLOVAK REPUBLIC
Tel: (42 95) 622-4170

Beata KABZA
Institute of Environmental Biology
Jagiellonian University
Ingardena 6
30-060 Krakow
POLAND
Fax: (48 12) 337-086
Tel: (48 12) 336-377,
Ext 407, 445, 466

Milan KODRIK
Institute of Forest Ecology
Slovak Academy of Sciences
èt·rova 2
960-53 Zvolen
SLOVAK REPUBLIC
Tel: (42 855) 22-312

Jacek KORNACKI
Office of International Relations
Polish Academy of Sciences
Palace of Culture and Science
skr. poczt. 24
00-901 Warsaw
POLAND
Fax: (48 22) 207-651
Tel: (48 22) 204-349

Simona KOSSAK
Department of Natural Forest
Forest Research Institute
17-230 Bialowieza
POLAND
Fax: (48 835) 12-203
Tel: (48 835) 12-549

Adam KOTARBA
Department of Geomorphology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Sw. Jana 22
31-018 Krakow
POLAND
Tel: (48 12) 224-085

Anna KOZLOWSKA
Department of Geoecology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Frantisek KRAHULEC
Botanical Institute
252-43 Pruhonice u Prahy
CZECH REPUBLIC
Fax: (42 2) 643-6529
Tel: (42 2) 643-6573

Stan KRUGMAN
Forest Management Research Staff
U.S. Forest Service
P.O. Box 96090
Washington, DC 20090-6090
USA

Zbigniew KRZAN
Tatra National Park and Biosphere Reserve
Chalubinskiego 42
34-500 Zakopane
POLAND
Fax: (48 165) 63-579
Tel: (48 165) 63-203

Leszek KUZNICKI
President
Polish Academy of Sciences
Palace of Culture and Science
skr. poczt. 24
00-901 Warsaw
POLAND

David LESLIE
Oklahoma Cooperative Fish and Wildlife Unit
National Biological Survey
404 Life Sciences West
Oklahoma State University
Stillwater, OK 74078
USA
Fax: (405) 744-7673
Tel: (405) 744-6342

Leszek LUBCZYNSKI
National Board of National Parks
Wawelska 52/54
00-922 Warsaw
POLAND
Fax: (48 22) 251-493
Tel: (48 22) 251-493
(48 22) 255-748

Dorota MERTA
Institute of Environmental Biology
Jagiellonian University
Ingardena 6
30-060 Krakow
POLAND
Fax: (48 12) 337-086
Tel: (38 22) 336-377
w. 407, 445, 466

Violetta NARKIEWICZ
Department of Geoecology
Institute of Geography and
Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Zbigniew NIEWIADOMSKI
Bieszczady National Park
38-714 Ustrzyki Górne
POLAND

Reginald NOBLE
Department of Biological Sciences
International Plant and Pollution
Laboratory
Bowling Green State University
Bowling Green, OH 43 403
USA
Fax: (419) 372-2024
Tel: (419) 372-2732
e-mail: rnoble@andy.bgsu.edu

Zofia NOWICKA
National Committee of
UNESCO MAB
Palace of Culture and Science
00-901 Warsaw
POLAND
Fax: (48 22) 207-651
Tel: (48 22) 203-365

Henryk OKARMA
Department of Mammals Research
Gen. Waszkiewicza 1
17-230 Bialowieza
POLAND
Fax: (48 835) 12-289
Tel: (48 835) 12-278
e-mail: mripas@plearn.bitnet

Czeslaw OKOLOW
Bialowieza National Park and
Biosphere Reserve
17-230 Bialowieza
POLAND
Fax: (48 835) 12-323
Tel: (48 835) 12-306

Tomasz OSZAKO
Forest Research Institute
Bitwy Warszawskiej 1920/3
00-973 Warsaw
POLAND
Fax: (48 22) 462-016
Tel: (48 22) 464-660

Pavel PARFENOV
Secretary, UNESCO/MAB
Program
Laboratory of Phytomonitoring
Institute of Experimental Botany
Belarusian Academy of sciences
F. Skoriny 27
Minsk, 220 733
REPUBLIC OF BELARUS
Fax: (7 172) 209-125
Tel: (7 172) 296-804
(7 172) 384-569

Victor Viktorovicz PARFENOV
Director, Institute of
Experimental Botany
Belarusian Academy of Sciences
F. Skoriny 27
220733 Minsk
REPUBLIC OF BELARUS
Fax: (7 172) 209-125

Piotr PASCHALIS
GEF 05-27685 POL.
Wawelska 52/54
00-922 Warsaw
POLAND

Kajetan PERZANOWSKI
Institute of Environmental Biology
Jagiellonian University
Ingardena 6
30-060 Krakow
POLAND
Fax: (48 12) 337-086
Tel: (48 12) 336-377 w. 407, 466

Michail PIKULIC
Deputy Director, Institute of Zoology
Belarusian Academy of Sciences
F. Skoriny 27
220 072 Minsk
REPUBLIC OF BELARUS
Fax: (7 172) 209-125

Andrzej PIOTROWSKI
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 267-789

Joanna PLIT
Department of Geoecology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Krakowskie Przedmiescie 30
00-927 Warsaw
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Catherine PRINGLE
308 Biosciences Building
Institute of Ecology
University of Georgia
Athens, GA 30602
USA
Fax: (706) 542-4271
Tel: (706) 542-4289
E-mal: pringle@zoo.uga.edu

Bohdan PROTS
Institute of Ecology of the Carpathians
Chaikovsky St. 17
Lviv 290000
UKRAINE
Fax: (7 0322) 727-847
Tel: (7 0322) 726-731

Zdzislaw PUCEK
Department of Mammals Research
Gen. Waszkiewicza 1
17-230 Bialowieza
POLAND

Han QUNLI
Division of Ecological Sciences
UNESCO
1, rue Miollis
75015 Paris
FRANCE
Fax: (33 1) 4065-9897
Tel: (33 1) 4568-4142
e-mail: schan@frunes21.bitnet

James QUINN
Division of Environmental Studies
University of California-Davis
Davis, CA 95616
USA
Fax: (916) 752-3350
Tel: (916) 752-8027
e-mail: jfquinn@ucdavis.edu

Zofia RACZKOWSKA
Department of Geomorphology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Sw. Jana 22
31-018 Krakow
POLAND
Tel: (48 12) 224-085

Grzegorz RAKOWSKI
Department of Nature and Landscape Protection
Institute of Environmental Protection
Krucza 5/11
00-548 Warsaw
POLAND
Fax: (48 22) 295-263
Tel: (48 22) 295-264

Helena RUZICKOVA
Institute of Landscape Ecology
Slovak Academy of Sciences
Stefánikova 3
814 99 Bratislava
SLOVAK REPUBLIC
Fax: (42 7) 332-560
Tel: (42 7) 335-113

Vjaczeslaw Vasiljevicz SIEMIAKOV
Bretskaja Oblast
Kamienieckij Rajon
Nacionalnyj Park ‘’Bialowieaskaja Puszcza”
22 50 63 Kamieniuki
REPUBLIC OF BELARUS

Roman SOJA
Department of Geomorphology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Sw. Jana 22
31-018 Krakow
POLAND
Tel: (48 12) 224-085

Jerzy SOLON
Department of Geoecology
Institute of Geography and Spatial Organization
Polish Academy of Sciences
00-927 Warsaw
Krakowskie Przedmiescie 30
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Stefan MICHAJLOWICZ STOJKO
Institute of Ecology of the Carpathians
Ukrainian Academy of Sciences
Czajkowskiego 17
29 0000 Lviv
UKRAINE
Fax: (7 0322) 727-847
Tel: (7 0322) 726-731, 767-623

Peter STRAKA
GEF Biodiversity Protection Office
Ministry of the Environment
Hanulova 9/A
84201 Bratislava
SLOVAK REPUBLIC
Fax: (42 7) 786-568
Tel: (42 7) 786-581

John STRICKLAND
Zielone Plica Polski
15-080 Bialystok
Elektryczna 12
POLAND
Tel/Fax: (48 885) 412-105

Jan SZAFRANSKI
Nature Conservator
Voivodship Krosno
Bieszczadzka 1
308-400 Krosno
POLAND

Robert SZARO
Ecosystem Management
U.S.D.A. Forest Service
P.O. Box 96090
Washington, DC 20090-6090
USA
Fax: (202) 205-1530
Tel: (202) 205-1015

Jaroslaw SMIALKOWSKI
Institute of Geography and Spatial Organization
Polish Academy of Sciences
Department of Geoecology
00-927 Warsaw,
Krakowskie Przedmiescie 30
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Lidia TASIENKIEWICZ
Head of Herbarium
State Museum of Natural History
Teatralna 18
29 0008 Lviv
UKRAINE
Fax: (7 0322) 728-917, 721-623
Tel: (7 0322) 742-307

Jan TERRAY
Director, East Carpathian Protected Landscape Area Biosphere Reserve
Lipová 19
066 01 Humenné
SLOVAK REPUBLIC
Tel/Fax: (42 933) 36-32

Ludwik TOMIALOJC
Wroclaw University
Natural History Museum
50-335 Wroclaw
Sienkiewicza 21
POLAND
Fax: (48 71) 222-817
Tel: (48 71) 225-041

Wojciech TRUSZKOWSKI
Vice-president
Krakow Branch of PAN
ul. Sw. Jana 28
31 018 Krakow
POLAND
Fax: (48 12) 222-791
Tel: (48 12) 224-853, 225-050

Piotr TYSZKO
Ecofund
Wilanowska 372
02-665 Warsaw
POLAND
Tel: (48 22) 434-494

Andrzej WEIGLE
National Fundation for Natural Protection
Krzywickiego 9
02-078 Warsaw
POLAND
Tel/Fax: (48 22) 252-127, 251-428, 251-018

Jolanta WIECKOWSKA
Institute of Geography and
Spatial Organization
Polish Academy of Sciences
Department of Geoecology
00-927 Warsaw,
Krakowskie Przedmiescie 30
POLAND
Fax: (48 22) 267-267
Tel: (48 22) 269-808

Tomasz WINNICKI
Bieszczady National Park
and Biosphere Reserve
38-714 Ustrzyki Górne
POLAND

Wojomir WOJCIECHOWSKI
Director
Bieszczady National Park
and Biosphere Reserve
38-714 Ustrzyki Górne
POLAND

Przemyslaw ZYSKA
Szeczeinska Ornithological Station
"Swidwie"
72 003 Dobra Szczecinska
POLAND