

IUCN European Programme

National Ecological Network EECONET – Poland

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Warsaw 1995

The IUCN Foundation Poland would like to express its gratitude to the Ministry of Agriculture, Nature Management and Fisheries of The Netherlands for its financial assistance for the project 79887C administered by IUCN – The World Conservation Union.

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From the Publisher

For many years IUCN – The World Conservation Union, working within the framework of the European Programme (previously the East European Programme), has been active in evaluating the status of ecosystem conservation in Central and Eastern Europe. As a result the following have been published: The Lowland Grasslands of Central and Eastern Europe, The Wetlands of Central and Eastern Europe and The Mountains of Central and Eastern Europe. In the 1990s, a new initiative began to develop which took into account the need to create an integrated pan-European system concerned with the conservation of the natural heritage of the whole continent.

The idea of the ecological network was first suggested in The Netherlands in the 1980s, and in the 1990s it was accepted as a part of the national plan for nature conservation by the Dutch government. In the beginning of nineties the concept of the European Ecological Network (EECONET) gained much attention as a pan-European approach to preservation of the natural heritage of Europe. As the result of Dutch Government initiative and sponsorship, in 1993 IUCN – The World Conservation Union began to implement a project aimed at widening the EECONET to countries of Central and Eastern Europe. The main objective was to work out the concept of national ecological networks and national plans for conservation of nature in individual countries. In fact, having first acquired the approval of the ministries responsible in each country, IUCN delegated the responsibility of running the 3-year project entitled the National Nature Plan to the IUCN country offices e.g. Foundation IUCN Poland. The first part of this international project has been implemented in Poland, Hungary and the Czech and Slovak Republics, but IUCN hopes to extend the work to other countries of Central and Eastern Europe.

The project does not attempt to intervene in the ecological policy of individual countries. It aims at supporting them. It does not question the internationally acclaimed achievements of these countries, their traditions and experiences in the conservation area. It does not undermine the specific local solutions or systems. The project attempts to combine into one united pan-European system these territories which by virtue of their habitats and mutual ecological relatedness constitute the natural heritage of Europe.

The EECONET concept was born not only because nature does not respect borders, but mainly because the unintegrated local methods of conserving it have limited results and the natural heritage of Europe is both endangered and progressively being destroyed. Despite international initiatives such as the Bonn and Bern Conventions, there is a growing realisation of the need to create a wholly integrated pan-European system for the conservation of nature which would take into account not only the international character of ecological processes and what threatens them, but which would also concern itself with the need to create a platform for international co-operation, thus ensuring effective realisation of promises given in international agreements and conventions.

The increasing environmental threats of a continental and global kind require that a territorially unified pan-European system for conservation of nature be accepted, allowing the individual countries' efforts to be combined into one system which would safeguard the

Acknowledgements

Our sincere thanks are due to all those who have contributed to the development of the National Ecological Network EECONET-PL. Our work was significantly improved by contributions and candid comments of the following experts: Prof. Tadeusz Backiel who prepared evaluation of areas according to the occurrence of fish species in danger of extinction; Prof. Anna Dyduch-Falniowska with the team of specialists working on the CORINE-biotopes data base: Prof. Róża Kaźmierczak, Dr Małgorzata Makomaska-Juchiewicz, Joanna Perzanowska-Sucharska M.Sc., Renata Kot M.Sc., and Katarzyna Zajac M.Sc. who made the extensive data base covering natural sites of international importance available to us; Prof. Maciej Gromadzki and Dr Przemysław Chylarecki, who provided their ornithological evaluation of Polish territory; Marek Kowalski M.Sc. who provided us with information on bat distribution in Poland and Marcin Brzeziński M.Sc. who elaborated the study on the distribution of otters in Poland; Dr Jan Oświt with the team of experts working on cataloguing and evaluation of Polish wetlands: Prof. Henryk Banaszuk, Prof. Dominik Fijałkowski, Maria Hinc-Wanat M.Sc., Andrzej Kalemba M.Sc., Prof. Róża Kochanowska, Dr Leszek Kucharski, Dr Andrzej Łachacz, Prof. Henryk Okruszko, Tadeusz Zajac M.Sc., Dr Tomasz Załuski who presented locations of valuable peatbogs and endangered species within EECONET-PL and also proposed amendments to the structure of the network to take into account the occurrence of hydrogenic habitats. We appreciate the contribution of Jolanta Wójcik M.Sc., Małgorzata Walczak M.Sc. and Barbara Podgórska M.Sc. who updated the map of protected areas in Poland.

We thank cordially Prof. Roman Andrzejewski and Prof. Wiesława Różycka for offering us constant assistance and support during the work on EECONET-PL and for their constructive comments. We also express appreciation to Prof. Stefan Kozłowski for his time spent on our project and helpful comments.

We also thank our colleagues from the Department for Natural Bases of Physical Planning, Institute of Physical Planning and Municipal Economy for their assistance, support and patience.

Authors

Foreword

Degradation of natural habitats as a result of dividing them into isolated fragments has been known for centuries. To counteract the undesirable consequences of the process, the idea was conceived to connect relatively well preserved and rich habitats with ecological corridors, thus creating an Ecological System of Protected Areas [Różycka 1977]. These corridors would constitute a migration route for organisms capable of movement or a flow of genes and individuals lacking such capability.

The idea of the Ecological System of Protected Areas (ESPA) has found acceptance in Poland, both among naturalists and spatial planners. Numerous projects of regional and local systems of protected areas are the best examples of this. The process for implementing ESPA at a national level was much less promising for two main reasons: inconsistent criteria for designating valuable natural habitats and insufficient knowledge of Polish nature. So, in spite of the fact that the theoretical bases of the idea and its potential benefits were recognized, the attempts to create ESPA for the whole of Poland have not been made for many years.

Therefore, the initiative of IUCN – The World Conservation Union to contribute to a European Ecological Network EECONET has been welcomed in Poland what as can be seen by material presented here. It describes the National Ecological Network EECONET-PL project prepared by the Foundation IUCN Poland according to uniform criteria of designating individual elements of the EECONET. The project is based on a complex analysis of environmental conditions and especially on recent knowledge of occurrence and densities of many plant and animal species.

The National Ecological Network EECONET-PL project presented to Polish authorities responsible for nature protection, interested local governments and NGOs, and all Readers is consistent with the aims and requirements of the European Ecological Network EECONET. Although the theoretical bases for creating EECONET-PL are rather obvious, many detailed questions are still to be answered. Some of them are mentioned in the final chapters of this book. EECONET-PL is not going to satisfy all hopes unless scientific studies of the network functioning and methods of its implementation are initiated at the European level. Also, monitoring of its effects is necessary.

Although the material presented shows the range of EECONET-PL areas, further problems related to its implementation and co-ordination on the European scale are still to be solved. Presenting the project the authors hope that it contributes new information on problems of nature protection and development in Poland and Europe. It seems that including Poland in the European Ecological Network EECONET will be of great importance for the protection of genetic, species and ecological resources of Europe.

Professor Roman Andrzejewski

1 The European Ecological Network – EECONET

1.1. The concept

In 1992 the nations of the world, attending the UN Conference on Environment and Development (UNCED) in Rio de Janeiro, urged that efforts to protect the natural environment be integrated and intensified. The Convention on Biological Diversity, drawn up at the conference and ratified by Poland in 1995, aims to strengthen protection of species, ecosystems and gene stocks both within different countries and across continents. Industrial development, increasing emission of pollutants traversing state borders and the intensification of land usage are endangering all forms of life. Leaving aside the consequences of chemical contamination, man's pressure on nature is leading to the depletion of natural resources, the impoverishment of fauna and flora and the fragmentation of ecosystems.

The effects of these changes are confirmed by the various Red Data Books' ever-lengthening lists of vanishing and threatened species of plants and animals [Council Directive 92/43/EEC 1992]. In many countries during the last 10 years or so, protection strategies have changed. The protection of species now generally takes second place to the protection of large areas. Only a few of the many endangered plants and animals have been taken care of; for some time now a significant loss of interest in flora and fauna research has been noticed in Poland. And all too often conservation problems have been perceived solely in national or (at best) regional terms; the panEuropean threat to natural stocks has been ignored.

The limitations resulting from this too parochial view of environmental problems take several years to correct, even when international help is forthcoming. Many Conventions and co-operative Programmes have been established: the Ramsar Wetlands Convention, the Bonn Migratory Species Convention, the Bern European Wildlife and Natural Habitats Convention, UNESCO's Man and the Biosphere Programme, to name but a few. These oblige participating countries to protect species and habitats of international importance. As a result Europe now has many different categories of reserves with specific aims under various criteria. However these reserves are, generally speaking, too isolated and too dispersed to encourage effective animal and plant protection.

Biotic resources, both in individual countries and across continents, can only be properly safeguarded when protective systems are organizationally and spatially integrated.

The countries of the European Union, in furtherance of this aim, proposed the creation of a **European Ecological Network (EECONET)**. Intended as a natural heritage for Europe, EECONET areas are integrated organizationally and spatially. An administrative system within the EECONET programme has been requested to ensure that EECONET principles are implemented at the national level in accordance with the objectives of the various international Conventions and Programmes – such as those already named.

Whilst the natural variation of the European continent will be clearly expressed in the

scapes of a given country should be represented in that country's EECONET system. Where it has only a small amount of a particular physical-geographical feature, it will be acceptable to have this feature represented outside the borders of the country. Some core areas will be of the transborder type.

Ecological corridors are territorially devised so as to facilitate the movement and migration of species between core and adjacent areas. They will have varied forms:

- ⇒ continuous linear form distinctly different in type from the surrounding areas, not intensively used or managed;
- ⇒ areas formed as the belts that link individual core areas and show the main direction of these links;
- ⇒ 'stepping stones' that do not have structural continuity but maintain functional continuity, e.g. migratory bird sanctuaries.

Characteristics of the ecological corridors should be shared with the core areas that they link. On the local scale they should recreate the real translocation routes of examined species. On a national or continental scale, however, the purpose of the eco-corridor will be to encourage a healthy genetic mix by directing the course of the 'stream' that provides it.

Because EECONET has a mainly continental application, attention has been drawn to searching for long-distance migrating and translocating species - in particular, birds, fish and large mammals.

The ecological corridor is an elastic concept. Core areas on a local scale (e.g. animal sanctuaries, small forest complexes) may have corridors on a regional scale. It is advisable that corridors, especially the larger ones, should be characterized by rich habitats and ecological niches. They would thus be more diverse and so better adapted to different migration patterns.

It is assumed that size is as crucial to the functioning of corridors as it is for core areas. No corridor should be less than 500 meters wide and those on a European scale

should be several kilometres wide; where narrowing occurs, there continuity is threatened. Length is another important aspect – the longer, the less effective because further from the core area where conditions for fauna and flora are optimal.

Nature restoration areas may be treated as supplementary elements of the network, being areas degraded due to contamination or overuse, although still retaining characteristics of the former natural habitat. These previous states may well be recreated - for example, drained wetland or deforested slopes of lower montane belt. Alternatively, ecological management can also restore former values: for example, timber forests or intensive farmland.

1.2.3. Establishing the principles of EECONET

The ground-rules of the European Ecological Network are to:

- ⇒ enlarge existing protected areas (often too small to be effective) and to act as functional links reaching much further than the protected areas;
- ⇒ retain the hierarchical structure of EECONET;
- ⇒ identify the areas in need of restoration because of their substantial ecological potential;
- ⇒ ensure connection between core areas via ecological corridors.

The rule that core areas should be larger than the already existing protected areas must be stressed. Nature reserves, national parks or other protected areas as classified by IUCN, usually represent a small percentage of the territory of a given country. According to Bischoff and Jongman (1993) the countries of the European Union protect between 3% and 12% of their land. And these protected areas are relatively small, being a compromise between the needs of protection and those of economic exploitation. The creation of a network of areas of international importance, established under the different conventions, is still in its infancy. As yet they are few in number. Many

internationally important areas are therefore still very ill-protected.

EECONET has a hierarchical structure – meaning that its elements (core areas, eco-corridors) may be distinguished at different levels: local, regional, national and international. The function of a given element in the network depends on its level. Areas of local importance (e.g. nature reserves, areas of ecological value, plant and animal refuges) perform the function of nodal (core) areas at the lower level. This function may be changed on the national scale (local nodes may become an element of an ecological corridor) or the function may not be shown. When the elements of the network pass from local to national level, their internal structure becomes more complicated – selected core areas and corridors become increasingly more complex from a biological point of view. The EECONET hierarchical structure depends upon the size of the area, its projected biotic potential and the level of the element. The areas in the EECONET structure are large and their international importance derives from their importance in preserving biological variety at the local and regional levels.

1.2.4. The National Nature Plan

The integration of political structures in western Europe has paved the way for countries in central and Eastern Europe to integrate their own systems of nature protection with EECONET. First steps in this process were undertaken by IUCN – The World Conservation Union which initiated extensive analyses and proposals for broadening the network in Poland, the Czech Republic, the Slovak Republic and Hungary, within the framework of the National Nature Plan. It must be stressed that the NNP project will not interfere with the ecological policies of member countries nor undermine their achievements in the area of global nature conservation. The aim is to establish a panEuropean system for areas in which natural values and ecological links constitute the natural heritage of Europe.

In Poland the NNP project will be carried out in two stages:

Stage 1: mapping out the bounds of Poland's contribution to the European Ecological Network – EECONET-PL;

Stage 2: drawing up the rules for working within this network and establishing the organizational system and the legal instruments which will enable EECONET-PL to function effectively.

2 The concept of the national ecological network – EECONET-PL

2.1. Basic principles

EECONET-PL aims to form an integrated system of the areas whose natural value measures up to the highest national and international standards. Individual areas within the system should be characterized by a large percentage of well-preserved natural and semi-natural landscapes as well as by areas extensively exploited (rational exploitation by man is of great importance). Additionally they should be integrated functionally and spatially by a network of natural links (eco-corridors).

In the creation of EECONET-PL the aims and principles adopted in forming the IUCN network have been taken into account, whilst preserving and building on Polish achievements in this field. EECONET-PL will:

- ⇒ strive to integrate all habitats typical of a given region in Poland into the ecological network;
- ⇒ ensure the spatial and functional unity of the ecological network in order to protect the migrations and natural journeyings of different species;
- ⇒ include existing protected areas (national parks, landscape parks, nature reserves and areas of protected landscape) insofar as international criteria permit;
- ⇒ deem it important to include traditional agricultural and fish-farming areas and semi-natural ecosystems (man-made values) in compliance with the spirit of the Convention on Biological Diversity.

2.2. Landscape and species-oriented approach to nature conservation

There are many aspects to the aims of EECONET-PL. Initially, however, the approach is landscape-and-species oriented. As far as landscape is concerned, an important role has been played by analyses of structures and the spatial requirements of systems above the organizational level of an ecosystem. Abiotic elements of natural habitat (in particular, geomorphological and hydrological conditions along with plant-cover biotic elements) and certain types of land use have been analyzed. These analyses, together with the results of various ecosystem assessments, are of prime importance in determining which areas should be included in the network and at what level. The comprehensive value of this approach to the forming of EECONET-PL has been verified by analyses of endangered species in Poland and Europe.

2.2.1. EECONET-PL as a structure for 'organizing' nature

The workings of nature occur on different (imperfectly understood) levels. Of prime importance in the forming of EECONET-PL is a right assessment of ecological levels and spatial needs. On the one hand we have ecosystems (biogeocoenoses), ecological landscapes (physiocoenoses), biomes etc.; on the other hand we have populations of some given species. In the quest for 'natural

preservation' nature has developed two main currents:

- ⇒ a specific current, dealing with location, causes and degree of threat for each species;
- ⇒ a landscape current, dealing with areas of natural value worth preserving.

The optimal method to adopt at this stage would be to adjust EECONET-PL to the spatial structure expressed in the hierarchical system of ecological units. However, theoretical knowledge and the practical results of spatial analysis do not allow this. It has therefore been assumed that EECONET-PL structures should deal with already recognized natural structures, especially in relation to the hierarchical, regional systems of complex geobotanical and physical-geographical units (annex, map 1). The structures will not, however, sufficiently reflect man's transformation of natural habitat. EECONET-PL has therefore included systems which combine land use with a fairly minimal change in plant cover. Densely populated areas, urban-industrial agglomerations and the like have been excluded.

2.2.2. Typological and regional variability

Natural systems show typological variability. One should note, however, that even very similar-looking systems have their own singular features showing their individuality. EECONET principles require that both typical and individual features be considered worth preserving.

EECONET-PL's system of core areas and eco-corridors will therefore include representative samples of outstanding and distinctive regional structures as well as more typical habitats and landscapes. The routes taken by the eco-corridors will normally be through similar habitats, thus maintaining a continuity of structure with the core area.

2.2.3. Status of species to be protected by EECONET-PL

Analysis of the status and distribution of target species is intended to identify the areas that should be included in EECONET-PL – taking into account the role these areas play in population function. The following types of species (or groups of species) have been selected on the basis of their status:

- ⇒ vanishing and threatened species – species threatened world-wide and listed in Poland in the Polish Animal (1992) and Plant (1993) Red Data Books;
- ⇒ species (or groups of species) whose populations have plunged over the last 50 years due to loss of biotopes;
- ⇒ rare species, endemic species and relicts found in appreciable numbers in certain places;
- ⇒ certain species which have spread into Poland, indicating suitable habitat and right conditions for survival and genetic mix with local populations;
- ⇒ species which are not necessarily rare or threatened in Poland but whose population comprises a substantial part of the European population – for example, the white stork;
- ⇒ species that migrate over long distances during their life cycles.

Before all the above-mentioned groups were finally placed on the EECONET-PL list they were also compared against the lists of species considered important to Europe and put forward for inclusion in the CORINE database, Habitat Directive and Dutch EECONET [The Nature Target Types Handbook, 1994].

The locations and sizes of refuge for the chosen species have been based on the following criteria:

- ⇒ refuges necessary for the whole life cycle (e.g. fish spawning areas, feeding grounds, bird moulting grounds, bat wintering grounds);
- ⇒ refuges with particularly rich fauna or flora (e.g. breeding or wintering birds, water reservoirs with rich ichthyofauna, invertebrate groups, sites with rare or endangered plants);

⇒ potential routes for chosen invertebrate species (eco-corridors).

2.3. Criteria for selecting the areas and for EECONET-PL structure

2.3.1. Selecting the areas

Criteria used in selecting the EECONET-PL areas have formed the basis for valuing natural structures in order to indicate the areas of highest value. The criteria are:

- ⇒ biological diversity;
- ⇒ natural character;
- ⇒ rarity of occurrence;
- ⇒ degree of threat.

Biological diversity measures the heterogenic character of the area and the intensity of natural-area management. Generally speaking, there is less diversity in the vast areas with homogenic landscape structure - such as large forest plantations and areas of intensive agriculture.

Biological diversity also demonstrates the natural behavior of ecosystems. It has been assessed on the basis of the number of species, relicts and endemic plants found within the different habitats and ecosystems of a given area. Variety of habitat and forms of management have been deemed the main contributors to biological diversity.

Natural character measures the natural attributes of ecosystems, subdivided into the almost natural, the semi-natural and the anthropogenic.

The most natural ecosystems are of natural origin; their species structure, being in natural accord with their habitats, does not differ from their types of phytocoenosis. These systems are usually found in strictly protected reserves and nature refuges not easily accessible to man.

Semi-natural systems are either plant communities of anthropogenic origin often not in accord with their habitat, or communities of natural origin but partly transformed by management – e.g. harvested forests, various types of grassland (meadows, pastures, drained peat bogs). However, many plant species of forest, meadow and moor remain in these areas, creating conditions for richness of ecological niches.

Anthropogenic systems are man-formed so far as the spatial, layer and species structure is concerned. Management by man (farmland, ponds, orchards etc.) is essential in ensuring achievement of desired aims. Correct ecological management can provide vital refuges for many rare and endangered species.

Rarity of occurrence applies both to the rarity of species and habitats due to human activity and rarity stemming from the fact that certain environments are uncommon in nature.

Rarely found species and habitats, as well as their abiotic conditions (e.g. arid grassland, salt marsh, mountain vegetation, lobelia lakes) are those which occur in the country only sporadically. The current (and former) intensive exploitation might cause them to vanish entirely. Natural communities with primeval features (e.g. Białowieża forest) are seldom found.

The existence of an exceptionally rare habitat or species or group of species may be due to a unique combination of biogeographical elements - or exceptional preservation of certain natural phenomena. Good examples include the mobile dunes in Słowiński National Park with many sand communities and Lake Hańcza – Poland's deepest (108.5 m) lowland oligotrophic lake with unique fauna and flora.

Degree of threat applies to individual species, groups of species and plant communities under severe national or continental threat. Species included are those listed in the Polish and European Red Data Books as well as plant communities rapidly decreas-

ing as a result of intensive (mis)management both past and present.

2.3.2. Formation of the EECONET-PL structure

It has been agreed that geomorphological structures which are to be included in EECONET-PL should:

- ⇒ have many heterogenic habitats and contribute to biological diversity;
- ⇒ help to preserve hydrogenic habitats;
- ⇒ help to preserve fragments of natural vegetation in refuges that are not easily accessible to management (annex, map 2). These include:
 - ⇒ mountain areas with morphological and lithological diversity creating good conditions for preservation of different habitats and natural and semi-natural systems;
 - ⇒ finely sculpted hillside areas enriched by eroded or karstic forms;
 - ⇒ plains of rivers and water-glacial accumulation;
 - ⇒ dune areas;
 - ⇒ large lowland river valleys, especially marginal stream valleys;
 - ⇒ bar or cliff coasts.

Hydrological conditions. Hydrographic systems, due to their natural value and great endangerment, should be included in core areas – and also in the network of eco-corridors. That is why there are international corridors on the Baltic coast and in lake districts and large river valleys (annex, map 3).

It is especially advisable to create core areas and eco-corridors which would include the following:

- ⇒ water communities along the Baltic coast including delta and estuary ecosystems. They are endangered not only by natural factors – insufficiently strong links with the sea, shallow waters, desalination – but also by man-made factors such as excessive pollution and over-fishing. They demand protection because they contain specific ecosystems characteristic of salty waters plus many migratory and other bird species;

- ⇒ lowland river valleys that are connected with rich systems of hydrogenic habitats – water, river bank, flood-plain marsh and mire;
- ⇒ mires of a natural or semi-natural character and, especially, rare types of peat bog such as raised bog, calcareous fen and bog heath of the Atlantic type;
- ⇒ other highly hydrogenic habitats, endangered due to water-course (waste) regulations, drainage systems and intensive agriculture;
- ⇒ mountain and lowland rivers with steep drops on the uplands, and lake districts with numerous strongly defined fissures;
- ⇒ areas with lakes of different origin, and especially:
 - ⇒ very large, shallow coastal lakes at near-sea level which are vulnerable to degradation from periodic inflows of brackish sea water;
 - ⇒ delta lakes with similar characteristics to the above;
 - ⇒ karstic lakes, rarely seen, connected with karstic phenomena in the shallow karstic substratum in Polesie;
 - ⇒ numerous post-glacial lakes (especially oligotrophic and dystrophic) varying in size and location depending on the hydrography of the terrain;
 - ⇒ lakes and old river beds, usually small, with amphibians and other fauna not found in open rivers – highly endangered by man-made changes, in particular by river regulations and drainage works;
- ⇒ artificial reservoirs, dammed reservoirs, pond complexes, especially in lake-free regions outside the area of the last glaciation.

Biotic conditions. As already mentioned the EECONET-PL core areas have been drawn up in order to preserve the plant communities and plant and animal species which are, to varying degrees, threatened. Special attention has been given to the following communities:

- ⇒ forest communities in fertile habitats (deciduous and mixed forests);
- ⇒ forest communities in hydrogenic habitats (deciduous and coniferous forests);
- ⇒ large coniferous forests in sandy habitats;
- ⇒ mire vegetation;

- ⇒ maritime communities (white and gray dunes);
- ⇒ aquatic communities;
- ⇒ mountain, subalpine and alpine communities;
- ⇒ semi-natural, especially xerothermic grassland, extensively exploited meadows and heathland;
- ⇒ field-weed communities strongly linked with traditional farming;
- ⇒ rare communities or trans-frontier communities extending into Poland.

Landscape structure. This has been determined on the basis of land exploitation (annex, map 4). From the standpoint of values to be protected by EECONET-PL the chosen landscapes are:

- ⇒ large forest complexes;
- ⇒ large green land complexes;
- ⇒ large areas of water (sea, lakes, large rivers);
- ⇒ mosaic systems with a large percentage of forest, permanent green land, open water (even considerably dispersed) and extensive traditional farming.

Large areas of land in the northern and western parts of the country, as well as in the southern mountain region, have excellent land-use systems, so allowing core areas and important eco-corridors to be formed there which assure east-west continuity. (Land use of this calibre seldom occurs in other areas.) Valleys, too, have a landscape structure which permit the creation of core areas plus internationally important eco-corridors.

Occasionally mosaic systems, when containing the right mix of forest, water and green land, may independently play the role of core area. These types of system are well known in the country, giving continuity to the EECONET-PL network, especially in central and southern parts.

Poorly structured systems, totally dominated by cultivated fields, are particularly prevalent in central and southern regions. In areas where these systems are most abundant, the important role is played by the

network of eco-corridors with a rich landscape structure, thus preventing the formation of multisurface complexes acting as barriers within the system.

Existing protected areas. The structure of protected areas in Poland is the result of activities for the protection of nature undertaken over many years (annex, map 5). The Act on Environmental Protection (1991) calls for a national system of protected areas. The process of forming this system is not yet complete; many important areas have as yet to be included [Denisiuk et al. 1990]. At present protected areas cover 23.7% of the country. They comprise 20 national parks (0.8%), 1031 nature reserves (0.36%), 91 landscape parks (5.5%) and 245 protected landscapes (17%) (figures for 31 December 1993). These various existing and proposed areas will nearly all become part of the EECONET-PL network. And certain protected landscapes and landscape parks and reserves will now form part of the eco-corridor structure at a European level.

2.4. EECONET-PL implementation: special points

The team preparing EECONET-PL was forced to introduce certain changes in the working methods initially agreed between the Polish, Czech, Slovak and Hungarian teams. These changes mainly referred to scale – how detailed should the various analyses be. In Poland the working scale was 1:500,000 as against 1:50,000 and 1:100,000 in the other 3 countries. The latter were thus able to analyze on a local level, then gradually pass to a synthesis at a national level on a scale of 1:500,000. This discrepancy arises from the fact that Poland is very much the largest of these 4 countries.

3 Nature in Poland

3.1. Special characteristics of Poland's natural environment

The Polish environment is characterized by infiltration from neighbouring areas – especially from the west and east. Sandwiched between the oceanic, varied landscapes of the west and the monotonous continental landscapes of the east, Poland possesses nearly all the components of these regions in its natural environment, especially with regard to geological or climatic phenomena and, to a lesser extent those of soil and water.

Poland's unique geological structures are the result of its position abreast the contact points of Europe's tectonic plates: Precambrian east European, mid-European, Palaeozoic formations and the younger alpine systems (figure 3.1). Each of the plates has a different geological structure, differing depths of troughs in the ancient crystalline foundations, connected with the thickness of the sedimentary rocks [Gilewska 1991].

In the north-east of Poland, on the edge of the ancient monolithic east European plate, the crystalline foundation dips very steeply covered in places by a layer of sedimentary rocks only a few centimetres thick. However, in the south-western part of the country, a region of more varied west European Palaeozoic structures, the crystalline foundation is extremely deep, covered by sedimentary rocks several kilometres thick. Only the south-western edge of Poland's crystalline substratum is close to the surface;

forming the Sudeten massif it has many cracks and faults. Cyclical changes in the Scandinavian ice sheet in the Pleistocene affected almost the entire country, stopping only at extreme elevations in the Carpathian and Sudeten ranges, influencing and layering the parallel system of the major geomorphological units (see figure 3.2). In the parallel southern and northern regions of Poland lie the following morphological zones:

- ⇒ young alpine-system mountains – the Carpathian and sub-Carpathian basins characterized by wide flysch and submontane basins not found in the Alps;
- ⇒ old Sudeten mountains and uplands (plus the Sudeten foothills, Świętokrzyskie mountains and southern Polish uplands) which vary from other European forms of this type by having deeper fissures – a post-glacial effect;
- ⇒ lowland zones of central and northern Poland (covering as much as 70% of the country), consisting of the old glacial area in the south and the young glacial area – of a fresh post-glacial appearance – in the north and extending beyond Polish borders.

East-west layers of the Polish landscape are emphasized by the positioning of large marginal stream valleys that absorbed thaw waters in the consecutive stages of ice-sheet disappearance (among others, Wrocław–Magdeburg, Głogowo–Baruck, Warszawa–Berlin and Toruń–Eberswalde). Part of these later made up rivers running south-north, creating the very distinctive parallel southern system of main river valleys. This system is characterized by the asymmetry of the main river basins (above all the Odra and the Vistula and, beyond Polish borders, the Niemen and the Dźwina), right-hand

inflows being more numerous and longer than left-hand.

The transitional nature of Poland's natural environment is also shown particularly clearly where humid air from the Atlantic meets dry air originating in the east. This creates a rapid movement of barometric high and low pressures and a resultant changeability in weather systems. Towards eastern Poland the climate becomes more continental: winters are severer, snow cover lasts longer, the temperature range is greater and the growing period is shorter. The mountain areas of southern Poland have an entirely different climate from the rest of the country, with climatic vertical zones caused by the drop in air temperature at high altitudes.

The specific characteristics of plant cover and the animal world are the result of Poland's position on the contact area between western and eastern Europe in the wide belt of post-glacial relief (limited from the south by the Carpathian and Sudeten mountain ranges, but open to outside influence from both east and west – figure 3.4).

The most distinctive feature of Polish plant cover is its transitional nature as compared with neighbouring areas. There is a distinction between west and east (as the climate becomes more continental) and between north and south (corresponding with the parallel layering of the landscape zones) with vegetation varying according to whether Atlantic or continental influences dominate - with even some Pontic-Panon elements.

As you move east, lowland sub-continental mixed pine-oak and sub-boreal spruce forests become more common (with Eurasian features being especially prominent in the far north-east) while the lowland beechwoods and acidophilous oakwoods characteristic of western Poland gradually disappear. In lowland regions two basic types of habitat have emerged – deciduous forests on fertile soils and coniferous forest on poorer soils [Matuszkiewicz W. 1981, Matuszkiewicz W. et al. 1973, Matusz-

kiewicz W. and Matuszkiewicz A. 1985, Szafer 1972].

Demonstrating the transitional nature of Poland's flora is the fact that over 50% of species are so-called transitory species, that is, species whose full range does not occur on Polish territory [Pawłowska 1972]. They are usually common species, representing the Holarctic geographical element and the Euro-Siberian and mid-European sub-elements. Species, which reach their geographical limits within Poland, account for 40% of Poland's flora. Arctic and Mediterranean sub-elements are relatively rare, although Atlantic and Mediterranean-Atlantic sub-elements are well represented in western and north-western regions. In the south-east Poland there is increased evidence of the Pontic-Panon elements and, to a certain degree, a Mediterranean element reaching west towards the Polish highlands. Northeast Poland is characterized by numerous boreal and boreal-continental elements and (to a small extent) Pontic, Arctic and Mediterranean-Atlantic elements.

Another characteristic of Poland's plant cover is the clear contrast between the lowland-upland areas and the mountain areas which cover only 3% of the total. In spite of its lowland appearance Polish vegetation is much more varied in the mountains (over 20% of vascular plants and plant communities are found here) than in the lowland-upland areas. Mountainous areas show distinct altitudinal zones which depend upon climatic as well as other factors change with elevation.

The fauna, consisting of many species from all over the continent, also displays a transitional character. There are few endemic species (species unique to Poland) and pre-holocene relicts are confined almost exclusively to the upper parts of mountain ranges. Mountain fauna is distinct from that found in upland and lowland areas. Containing many species of vertebrates and butterflies, Polish fauna is far from monotonous.

The previously mentioned hydrological, geological and biotic factors account for the

characteristics of the Polish pedosphere, The main soil types are brown-earth (brown and lessive) dominating over half the surface of the country. Podzol earth (rusty and typical podzol) covers 25% of this area. Also occurring mainly outside the climatic-vegetal zones is a black earthy soil, 'chernozem'. West of Polish borders lie more fawn-coloured soils – to the east, yet more podzol soils. Non-zonal soils – such as peat, former peat and alluvial – play an important role in the structure of Polish soils. Salty soils are a rare curiosity.

The real differentiation of the Polish environment is evident in its division into complex physical-geographical units. On the one hand these reflect the parallel belt-like relief; on the other, the climatic, meridional changeability of the country (see figure 3.5). According to a recent regionalization account of Europe [Kondracki 1991], Poland is generally viewed as the physical-geographical area of western Europe. Only to the east and north-east is there any evidence of the units denominated as eastern Europe. This high regional differentiation is not that obvious in the physical-geographical landscape, as the Polesian landscape, not found in western Europe, may only be detected in the lowlands, valleys and extensive plains. The area of Poland designated as western Europe covers two sub-areas: non-alpine western Europe and the Carpathian and sub-Carpathian depressions. There are five provinces considered to be within western Europe: the mid-European lowlands, the Czech Massif, the Polish uplands, the western Carpathians and the eastern Carpathians. Eastern Europe has just two provinces; the west Russian lowlands and the Ukrainian uplands.

The borders of these large units, with their own climatic, geological and historical characteristics of flora and fauna, are not always clearly manifested in the physical-geographical landscape. Typological differences in the landscape of the lower-level units may be seen clearly. However, the landscape patterns of the parallel units within the area of western and eastern Europe are often quite similar. In general the landscapes of those zones formed during

the same period and under the influence of the same geomorphological factors share a common and specific character.

These zones are as follows:

- ⇒ The Baltic coastland – totally incorporated within the mid-European lowlands;
- ⇒ The early-glacial lake districts – including the south-Baltic lake districts (a region of the mid-European lowlands) and east-Baltic lake districts (a region of the west-Russian lowlands);
- ⇒ The Peryglacial lowlands – including the Saxon-Łużyce lowlands and mid-Polish lowlands (found in the mid-European lowlands) and the Podlasie-Belorussian uplands and Polesie (found in the west-Russian lowlands);
- ⇒ The uplands – including the Polish uplands from the west European area and Wołyń-Podole uplands (the western part of the Ukrainian uplands) from the east European zone; the pre-Carpathian Depression – totally within the west European area (the west Carpathian province);
- ⇒ Mountain areas:
 - ⇒ Sudetens and Sudeten foothills – which form part of the Czech Massif;
 - ⇒ Carpathians.

Regional differences within these landscape zones are expressed first of all in different plant cover. Landscape consisting of valleys and extended plains occurs in many different regional units, illustrating the important role they play in integrating Poland's natural habitats. The fact that the physical-geographical landscapes within the area of parallel east-west landscape zones are very similar with similar habitats is evidence of basic ecological connections which entirely justify the creation of eco-corridors.

3.2. Regional differences

The landscapes of Poland and their differences in biotope and plant cover were dealt with in the chapter discussing landscape zones (annex, map 1).

3.2.1. The Baltic coastland

The Baltic coast is characterized by specific natural landscapes: sand-bar coastland grading into peat-lake landscape – the best representation of this landscape type in Europe. Apart from the open Baltic featuring the Pomeranian, Puck and Gdańsk bays there are further bays connected with the sea by narrow straits, e.g. the Szczecin and Vistula bays and the coastland and delta lakes uniquely characteristic of this region. Other characteristics are sandy beaches, bars, coastland lakes, white-and-gray dunes and also older forest-covered dunes. Dunes often emerge from high and transitional moorland areas. Steep and eroded coastland may be found only where these zones have ecosystems characteristic of the contiguous lake districts.

Oceanic impact is strongly marked on the Baltic coast – particularly its western part where many fairly rare Atlantic and sub-Atlantic species are found. In this region, as well as species wholly connected with the sea, occur the following plants: wax-myrtle, *Myrica gale*, woodbine, *Lonicera periclymenum*, heaths, *Erica tetralix*, and Swedish mountain ash, *Sorbus intermedia*.

The most characteristic plant communities are those of salt marsh, white-and-gray dunes vegetation, maritime crowberry moor, Atlantic wet heathland and the Atlantic-type high peatbog. On strengthened dunes occurs a special type of pine wood: *Empetro nigri-Pinetum*. Deciduous forests occur in places where moraine heights meet the coast. They belong to the sub-Atlantic type with predominant beech woods (both lowland-rich and poor) and acidophilous oak forests. Only in the western part of this region in poor, acidic, permeable habitats (which elsewhere are covered with pine forests) do oak-birch woods, typical of such habitats in western Europe, appear. Oak-hornbeam forest, *Quercus-Carpinetum sensu lato* ("grond"), also occur in the region as a community with distinctive sub-Atlantic features – *Stellario-Carpinetum* association.

This zone contains too the big river estuaries (the Vistula and the Odra): estuary plains

are the dominant landscape – a landscape that is well preserved in the Żuławy Wiślane area. The whole area has deeply indented small valleys with small rivers flowing directly into the Baltic.

3.2.2. The upper glacial lake district

This vast and richly sculptured zone, which extends westward into Germany and eastwards into Lithuania, Belorussia and Russia, has a network of unimpressive surface outlets, numerous post-glacial lakes and small depressions which often take the form of peatbogs. This type of landscape, described as washboard moraine and lake-district outwash [Kondracki 1981, 1991], is characterized by a rich sculpture of undulating hummocks, kame fields, broad outwash plains, lake district plains, small peatbogs and numerous eutrophic, oligotrophic and dystrophic lakes. In the moraine landscape these conditions give rise to a large variety of habitats which favour biological diversity.

Climatically the whole zone shows a gradual continentalization as you progress east. In addition the eastern part contains a steep drop in altitude from the high point created during the Pomeranian phase of the Baltic glaciation. In this marginal area the vegetation changes greatly, from (going east) sub-Atlantic to sub-continental to sub-boreal.

Conditioned by climate and habitat variability, this zone can be divided into areas corresponding to the prevailing type of landscape brought about by age and geobotanical region [Matuszkiewicz J.M. 1993].

- ⇒ moraine sub-zone of the Pomeranian phase of Baltic glaciation west of the Vistula valley (Pomeranian divide, Szczecin region, central Pomeranian lakelands);
- ⇒ outwash sub-zone of the Pomeranian phase (Pomeranian divide, Sandrian forelands of central Pomeranian lakelands);
- ⇒ Toruń-Eberswalde proglacial stream valley (Brandenburg – Great Poland

divide, Noteć-Lubus region, Noteć woodland sub-region);

- ⇒ lake district sub-zone of the earlier phases of Baltic glaciation (Brandenburg – Great Poland divide, central Great Poland region, southern Great Poland – Łużyce region);
- ⇒ upper glaciation lake district in the transition region (Mazovian – Polesie divide, Chełmno-Dobrzyń region);
- ⇒ Mazurian – Lithuanian lakelands (northern divide-, Mazurian region).

Baltic glaciation: moraine sub-zone of the Pomeranian phase. The most characteristic feature of this zone is the existence of young post-glacier formations, especially in the hummock zone of the terminal moraines at altitudes, in eastern parts, of above 300 m. (On smaller areas altitudes exceed 150 m in the west and 250 m in the east – the Wieżyca region.)

These formations have produced deep erosive cuts and water courses similar to mountain streams. Altitude plus closeness to the sea make for higher precipitation and lower temperatures than in neighbouring areas. As a result sub-ocean plant communities and species occur more often here than in other areas of other (even more westerly) zones. Argillaceous and sandy-argillaceous moraine subsoil mean most habitats are rich. In western parts, in particular, lowland beech forest (rich *Melico-Fagetum* and poor *Luzulo pilosae-Fagetum*) is predominant. More prominent in the east are sub-Atlantic beech-oak-hornbeam forests, *Stellario-Carpinetum*. Among poorer habitats, sub-Atlantic acidophilous oak and beech-oak forests (*Luzulo-Quercetum* and *Fago-Quercetum*), rare in other areas, predominate; mid-European pine-oak mixed woods, *Quercus roboris-Pinetum*, are less common; pine forests, represented by sub-Atlantic association of *Leucobryo-Pinetum* are relatively rare. There are no moist pine forests, *Molinio-Pinetum*; their habitats have been colonized by acidophilous oak woods [W. and J.M. Matuszkiewicz 1973]. Marshy woods in the vicinity of small rivers, as well as often being found in Poland *Circae-Alnetum* association, are represented by the *Carici remotae-Fraxinetum*

association in its lowland, sub-ocean variety.

In numerous waterlogged depressions with no outflow are found swamp alder forest, *Carici elongate-Alnetum*, on lowmoor peat and sub-continental bog pine forest *Vaccinio uliginosi-Pinetum* on highmoor peat, as well as sub-Atlantic swamp birch forest, *Betuletum pubescentis*, on transitional peatbog.

In this zone also occur natural end semi-natural non-forest communities, some of them rare or even endangered nation-wide. The large number of depressions with no outflow makes for a surprising plenitude (particularly in the eastern part) of small areas of transitional and highmoor peat not found in other regions. On highmoor peat, as well as mosses, *Sphagnetum magellanicum*, which other regions do have, occurs the Atlantic-type peatbog, *Erico-Spagnetum medii*. Also occurring in some places is the very rare (in Poland) calcareous fen, *Caricion davalliane* [Herbich 1982].

Numerous lakes are the other characteristic feature of the moraine zone. There are lakes of all types eutrophic, oligotrophic and dystrophic with typical vegetation (many lakes have stoneworts). Well preserved in this zone – and very rare in other regions – are lobelia lakes with corresponding vegetation and species, *Isoetes setacea*. All five Polish localities are in the south-east part of the zone. Here are found *Lobelia dortmanna*, *Isoetes lacustris*, *Najas marina*, *Litorella uniflora* etc. Reed and cyperaceous vegetation, *Phragmition* and *Magnocaricion*, are found in the vicinity of the lakes. Worth emphasizing is that here too occurs the twig rush, *Claditum marisci*.

Baltic glaciation: outwash sub-zone of the Pomeranian phase. This zone adjoins to the south of the zone described above. Moraine plains from earlier periods of the Baltic glaciation are still a feature of this widespread outwash with its Pomeranian-phase dunes. In the outwash area large wood complexes are preserved. Although partly transformed by forest management, some areas still exist in a close to natural form. There are habitats similar to those in the

zone described above but the proportions are different. Leafy wood habitats are not numerous. Pine woods predominantly appear in their fullest diversity - from dry lichen-rich pine wood, *Cladonio-Pinetum*, and mesic mid-European pine forest, *Leucobryo-Pinetum* to swamp pine forest, *Vaccinio uliginosi-Pinetum*. Starting from the terminal moraines towards the Toruń-Eberswalde proglacial stream valley, sub-ocean features become less prominent. On poorer soils, mixed woods, *Quercu-Pinetum*, are more common than acidophilous oak woods. On richer soils, beech woods occur less often and sub-Atlantic beech-oak-hornbeam forest rarely. Mid-European *Galio silvatici-Carpinetum* is dominant.

The essential element of this zone is valleys rich in rivers running from the lakeland region. Valleys still in their natural state include floodplain forests of marshy lowland willow-poplar. Prominent in some areas are the half-natural communities of inland moor, *Calluno-Genistion*, and, on sandy soils, dry grassland, *Crynephoretalia* and *Festuco-Sedetalia*. There are a great many lowmoor, transitional and highmoor peat-bogs as well as eutrophic, oligotrophic and dystrophic lakes (including a few lobelia lakes).

The Toruń-Eberswalde proglacial stream valley. This is a broad-valley area filled by fluvio-glacial and river sand with, on the lowest terrace, lowmoor peat and river mud which form a corridor joining the Vistula and Odra valley systems. The dominant landscape is that of valley bottoms, terraces and dunes. Chiefly found on the valley bottoms are vast area of lowmoor peat with reeds, *Phragmition*, and tall sedge communities, *Magnocaricion*, and well preserved, for the most part, low sedge communities of *Caricion fuscae*. The prevailing meadow vegetation includes many wet meadows, *Calthion*, accompanied by – increasingly rare in Poland – single-harvest moor-grass meadows, *Molinion*, and forb meadows, *Filipendulo-Petasition*, preserved due to non-intensive use.

Woods and marshy bushes are preserved in small parcels. However the area covers a

whole series of marshy habitats due to different frequency of flooding – from very common willow bushes, *Salicetum triandroviminalis*, and annually flooded willow-poplar wood, *Salici-Populetum* to occasionally flooded elm-ash forest, *Fraxino-Ulmetum* and swamp-marsh alder-ash forest, *Circaeo-Alnetum*. There are also alder swamp forest, *Carici elongatae-Alnetum*, on areas turned into marsh osiers, *Salicetum pentandro-cinereae*.

Upper terraces represent sandy and poor habitats where large forest complexes are preserved. Forestry has had a significantly transforming effect but numerous areas of phytocoenosis survive, representing full habitat diversity ranging from dry pine forest, *Cladonio-Pinetum* on dunes to the mesic sub-Atlantic mid-European pine forest, *Leucobryo-Pinetum*, to bog moss pine forest, *Vaccinio uliginosi-Pinetum* in depressions between dunes. Locally, highmoor peat and transitional peat occur. On monadnock hills, preserved in a proglacial stream valley, is a rich beech wood, *Melico-Fagetum* and a mid-European oak-hornbeam forest, *Galio-Carpinetum*.

High up and exposed to the south a proglacial stream-valley slope is the habitat of xerothermic grassland, *Festuco-Brometea*, and sub-xerothermophilous oak woods, *Potentillo albae-Quercetum*. Both types of vegetation occur on the northern fringes of the area.

Lake district: earlier phases of Baltic glaciation. This zone is characteristically rolling or hummock and is shaped by moraines. Lakes, mostly eutrophic, are not as numerous as in the moraine zone of the Pomeranian phase; the moraines are less high, the sub-ocean features less marked. The mid-European element dominates; beech woods, both rich *Melico-Fagetum* and poor *Luzulo pilosae-Fagetum* are common; oak-hornbeam forest is exclusively represented by mid-European association *Galio-Carpinetum*. Moderately poor habitats have beech-oak woods, *Fago-Quercetum* and *Luzulo-Quercetum*, and oak-pine, *Quercu-Pinetum*. On poor habitats - not very common - are found mid-European pine,

Leucobryo-Pinetum, dry pine, *Cladonio-Pinetum*, and bog pine, *Vaccinio uliginosi-Pinetum* forests. *Molinio-Pinetum* is not found. Corresponding sites are occupied by acidophilous oak woods or humid mixed woods. In hydrogenic habitats low-moor peat is very common – as are swamp alder, *Carici elongate-Alnetum*, and swamp marsh, *Circaeo-Alnetum*. In agricultural areas forests or extensive meadows are rare; core areas are concentrated on land less transformed by man.

The upper glacier lake district in the transitional region. This region includes areas in the range of the Baltic glaciation with a significant number of lakes, reed beds and peatbogs, but dominated by central Polish or sub-continental features. Sub-Atlantic elements are few and confined to northern and western peripheries where rich beech woods, *Melico-Fagetum*, still exist. In most of the area, though, beech and spruce are absent. Within deciduous forests is found sub-continental *Tilio-Carpinetum*, while mixed woods contain mid-European *Quercu-Pinetum* and sub-continental *Serratulo-Pinetum*. In mesic pine woods is found the sub-continental *Peucedano-Pinetum*. There is virtually no *Molinio-Pinetum* but *Potentillo albae-Quercetum* is quite common.

Mazurian - Lithuanian lakelands. These fragments of the upper glacial lake district have large and variable habitats, exposed to the east, and are distinctly sub-boreal. They continue east and north into Lithuania and Belorussia. The sub-boreal character is shown by spruce forest, *Quercu-Piceetum*, and peatbog spruce, *Sphagno-Piceetum*; the only representative of mixed forest is *Serratulo-Pinetum*. Low birch and willow bushes, *Betulo-Salicetum repentis*, periodically occur, along with other communities specific to the region. Plant communities not found elsewhere in Poland, central or western Europe, occur here – for instance, *Carici chordorrhizae-Pinetum* [Palcz 1975], *Carici globularis-Pinetum* and *Thelypteri-Betuletum* [Czerw 1970]. Moist forest *Molinio-Pinetum* is common and several large complexes of 'primeval forest', mainly on the outwash, have survived.

Other data relating to the more eastern area are not available; whether they represent borderland forms of sub-boreal communities and significantly marked regional forms of communities known in other areas of Poland or successive stages would be hard to determine. They contribute, however, to the region's peculiarity.

Apart from its many lakes the characteristic feature of this region is its lowmoor, transitional and (less often) highmoor peat with fragments of calcareous and spring fen. There are also great numbers of waterfowl and birds of prey.

The region has a significant plenitude of species, including numerous types of flora that are very rare in Poland. There is too quite a large number of glacial relicts.

3.2.3. The periglacial plains

This zone has no lakes and is dominated by flat or rolling periglacial plains. This type of landscape - though it boasts a fine river network - militates against diversity of habitats. Only the river valleys have significant features, often with terraced dunes. Connected to proglacial streams, these valleys are highly diversified hydrogenic habitats amenable to exploitation.

Within this zone the east-west variability is less marked than in the lake district zone. (A small number of elements of sub-ocean character exist on the level of plant species rather than plant communities.) The mid-European element is dominant. In western parts there are beech woods and, in moderately poor habitats, acidophilous oak woods, *Luzulo-Quercetum*. In the east are found *Calamagrostio-Quercetum* (but without the distinctive sub-ocean *Fago-Quercetum* which exists in Pomerania) and mid-European *Quercu-Pinetum* - although as you go east the latter gradually gives way to *Serratulo-Pinetum*, initially of the Sarmatian type and then in sub-boreal variety. Oak-hornbeam forests are less variable than in the lake district due to the absence of *Stellario-Carpinetum*.

On poor habitats along the Vistula occur mid-European *Leucobryo-Pinetum* and, towards the east, sub-continental *Peucedano-Pinetum*. Sub-xerothermophilous oak forests, *Potentillo albae-Quercetum*, are quite common here – unlike the lake district. With no natural lakes, water and mire vegetation, including waterfowl habitats, are mainly connected to the river valleys and old river beds. Locally important enrichment of habitats is shown by the existence of old fish ponds and clay ponds.

In this zone fragments of natural or semi-natural vegetation – such as are seldom now found in Europe – still survive in the big river valleys. Riverside willow bushes, *Salicetum triandro-viminalis*, and marsh *Circaeo-Alnetum* woods are common – less so are *Ficario-Ulmetum* (and exceptionally *Salici-Populetum*) and swamp alder, *Carici elongatae-Alnetum*. Still less common are herb meadows, *Filipendulo-Petastion*, one-harvest variably-humid meadows, *Molinion*, lowmoor peat, *Caricion fuscae* and cyperaceous *Magnocaricion*. On high terraces are found pine wood communities with swamp alder and transitional peatbog, *Scheuchzerietalia palustris*, plus highmoor peat, *Sphagnetum magellanici* and *Ledo-Sphagnetum*.

Close to natural vegetation favouring numerous animal species is also still found in certain forest complexes. While these are normally poor habitats unattractive to agriculture, their survival is often attributable to historical factors.

The eastern borders of this zone give onto the west Russian plains, a very specific region thanks to its genesis and geological structure. A major role (particularly in the north) is played by the Pleistocene river formations which nowadays often become marshy. In the subsoil occur Cretaceous formations formed by the karst process, creating numerous and widespread depressions covered by lakes and peatbogs. The result is a type of landscape called the Polesie plain. Extremely exposed to the west and extending onto Belorussian and Ukrainian territory, its flora has numerous sub-continental and sub-boreal elements. At the same

time its spacious lakes and swamps give a relatively humid local climate, allowing certain sub-Atlantic elements to flourish some distance from their main range.

3.2.4. The uplands

The uplands differ strongly from zones so far described, so much so that their borders (defined according to different criteria – biogeographic and physical-geographic) do not greatly vary. In this zone the Quaternary formations have a smaller significance, the decisive role belonging to the old Caledonian mountains and the high uplands – often made of carbonate rocks. These rocks have a great many karst formations, including caves which serve as rare habitat for certain endangered species, such as bats. Rare types of xerothermic and saline habitats are connected to outcrops of gypsum in the Nida basin.

The upland zone is erosive with differentiation of geological structure and sculpture contributing to a significant mosaic of habitats favouring biological diversity. Most of the area is in the range of fir and beech (with the exception of the Lublin uplands which for this reason are not counted as uplands in some geobotanical regionalization – J.M.Matuszkiewicz 1992). Mountain and Pontic-Panon flora are more plentiful here. Frequently occur *Festuco-Brometea* arid grassland ('steppe'), sub-termophilous oak forest, *Potentillo albae-Quercetum* and, in its special upland variety, oak-hornbeam *Til-lio-Carpinetum*. In the western part are habitats of acidophilous oak woods, *Calamagrostio-Quercetum*, which give way in central and eastern parts to mid-European mixed woods, *Querco-Pinetum*. Among marsh communities, besides those inhabiting the plains, is sub-montane ash wood, *Carici remotae-Fraxinetum*.

Due to the differences in terrain and geological structure within the province of Wyżyny Polskie, 3 sub-provinces have been selected: the Silesian-Cracow uplands in the west, the Małopolska uplands in the centre and the Lublin-Lvov uplands in the east. The eastern edge of the strip is included in the Ukrainian uplands (Wołyń-Podol)

[Kondracki 1991]. The geobotanical regionalizations incorporate broadly similar divisions [Matuszkiewicz M.J. 1993, Matuszkiewicz W. 1991, Szafer 1972].

3.2.5. The Carpathian foreland depression

The Carpathian foreland depression is a sub-province of the western Carpathians. It is filled by Pleistocene glacial silts, glacial water, and Pleistocene and Holocene river mud. Soil temperatures are fairly warm. An important role is played by pulpy sand silts which often create a landscape of dune terraces at the bottom of the valleys of the Vistula and its tributaries flowing from the Carpathians. It is a land of farming and commercial forestry – with the forests occasionally damaged by industry (for instance, Puszcza Sandomierska). Large and dense forest complexes still occur to the north-east in the region of Równina Biłgorajska.

3.2.6. The Sudeten mountains and foothills

The Sudeten mountains are part of the Czech Massif and comprise an area of ancient mountains with a very varied geological structure. The range is made up of different rocks throughout – acid crystal, metamorphic, (granite, gneiss, schist), silt silicate (sandstone, greywacke), carbonate (limestone, marble) and, which is very rare in Poland, volcanic (basalt, porphyry, gabbro, serpentinites). The result is a diversity of habitats and plant communities, including rarities found only on particular kinds of rock.

The plant cover of the Sudeten range varies markedly with altitude – becoming Alpine on its highest elevation. On lower levels, at around 400 m [Kondracki 1981] are found submontane forms of mid-European oak-hornbeam forest, *Galio-Carpinetum*, acidophilous oak woods, *Luzulo-Quercetum*, and the Sudeten beech - on rich soils, *Dentario enneaphyllidis-Fagetum*, on poor soils, *Luzulo nemorosae-Fagetum*. The lower montane belt occurs at up to 1000 m. It is an area of rich and poor Sudeten beech woods and

mountain spruce, *Abieti-Piceetum montanum*. The upper montane belt (rising to 1250-1300 m) is the habitat of spruce forest, *Plagiothecio-Piceetum hercynicum*. The subalpine belt is characterized by dwarf mountain pine, deciduous bushes and tall forb vegetation. The geological history of this area contributes to a great mosaic of habitats (significantly greater than in the Carpathian flysch) conducive to biological diversity. Although the impact of man has been considerable, numerous areas survive almost unaltered. The Sudeten range boosts many rare plants, some of which are found nowhere else in central Europe.

3.2.7. The Carpathians

Only the northern part of the impressive ridge of the Carpathians is on Polish territory. The geological structure, as compared with the Sudetens, is less diverse; the eastern and western extremities consist of sandstone formed between the early Cretaceous and the Oligocene. The varying sculpture of the landscape comes from the varying hardness of the rock. Formed in the late Cretaceous the west central Carpathians have a significantly different geological structure. During the forming of the outer Carpathians the western Carpathians were 'rejuvenated'; powerful upheavals exposed earlier structures. Today the central part of the mountain chain comprises a Palaeozoic crystalline trunk – the High Tatra massif. Mesozoic structures are revealed in the limestone's of the western Tatras, in the Tatra's lower regions and in the range of Jurassic limestone which has Pieniny as its highest part. On the Tatra foreland is a depression formed at the same time as the remaining central Carpathians but not subsequently elevated. Tertiary sediments now fill it.

Carpathian vegetation differs significantly from Sudeten, due, partly, to the size of its massif, higher altitude, and more eastern location. This affects the main vicariant communities of vegetation. The submontane belt reaches 550 m [Pawłowski 1972] and as high as 600 m in eastern parts (Bieszczady). Habitats of sub-continental oak-hornbeam forest (*Tilio-Carpinetum*) in a spe-

cial, upland-submontane variant, predominate, accompanied by mixed wood, *Quercus-Pinetum* (there are no acidophilous oak woods in this region), while beech woods play a supporting role [Matuszkiewicz W. 1984]. Lower montane belt reach to 1100 m in Beskid Śląski and to 1220 m in Bieszczady (but in Beskid Niski only to 1000 m). At these altitudes are Carpathian beech woods, *Dentario glandulosae-Fagetum*, spruce and fir forest, *Abieti-Piceetum montanum*, mixed mountain forest, *Galio-Piceetum carpaticum*, and mixed beech and fir forest, *Galio-Abietetum*, which have no equivalent in the Sudetens. In certain mountain ranges, still other associations are found. Woodlands are accompanied by rich meadows, *Gladiolo-Agrostietum* and tall forbs, *Arunco-Doronietum austriaci*. As well as willow-poplar, *Salici-Populetum*, in large river valleys, plus *Carici remotae-Fraxinetum* in small stream valleys, mountain gray alder, *Alnetum incanae*, and marshy mountain alder, *Caltho-Alnetum*, also occur here.

Upper montane belt do not exist in Poland's eastern Carpathians nor in Beskid Niski; in Beskid Zachodni it reaches 1257 m, in Beskid Śląski 1360 m and in the Polish Tatras 1500 m. It consists of spruce woods, *Piceetum tatricum*, and, in the limestone area of the Tatras, *Polysticho-Piceetum*. At both montane levels the grass community, *Hieracio-Nardetum*, is common pasturage.

Alpine and sub-alpine pastures are found only in the Tatras and Beskid Żywiecki. The border line between the two occurs at around 1650 m. The sub-alpine level consists of bushes of dwarf mountain pine, *Pinetum mughi carpaticum*, and forb and fern vegetation, *Adenostyletum alliarie* and *Athyrietum alpestris*. At the Alpine level (only in the Tatras and on Babia Góra) the most common vegetation is the tall grassland, *Calamagrostietum villosae tatricum*, and the alpine short grassland, *Caricetea curvulae*. In Bieszczady, mountain pastures occur only at heights of 1220-1348 m.

Carpathian flora is richer than Sudeten. The former boasts around 500 types of mountain plants against about 200 for the latter (although 22 of these 200 are not found in the

Carpathians). The Carpathians also have numerous eastern (Pontic-Panon) plants absent in the Sudetens. Only 6 sub-ocean species existing in the Sudetens do not occur in the Carpathians.

Endemism is a feature of the Carpathians. There are nearly 100 Carpathian endemics (plus nearly 20 sub-endemics), of which more than 20 occur in the west Carpathians and a substantial group in the east, although some of these do not reach Polish territory. (There is also a certain number of Tatra and Pieniny endemics.) In the eastern Carpathians Balkan flora is a prominent feature - as are certain continental species; in the western part sub-ocean species are found. The two regions are quite distinct. It is usually assumed [Kondracki 1991, Pawłowski 1972] that within the borders of Poland the eastern Carpathians include Bieszczady, Góry Słonne and Pogórze Przemyskie.

Although many Carpathian forests have, to a greater or lesser extent, been transformed by man, numerous complexes survive in their natural and even near-primeval state. While the foothill levels are significantly transformed, there has been relatively little change at upper montane, sub-alpine and alpine levels.

Core areas are considered to be best protected by making an ecological corridor of the mosaic landscape and semi-natural vegetation of the remaining parts of the Carpathians, thus safeguarding population contacts within the whole mountain chain.

4 The existence of selected plant and animal species as criteria for the mapping of core areas in EECONET-PL

4.1. Assessment of species diversity in Poland

Decreasing variety of habitats and the fragmentation of initially large forest complexes and wetland drainage are inevitably connected with the development of civilization. They have led (and are leading) to a reduction in the number of plant and animal species. The phenomenon is world-wide, Poland being no exception. Although large numbers of animal species are protected in Poland (including 99 totally protected vertebrates species – and a further 95 partially protected in line with hunting laws), the populations of many species are decreasing, and many are threatened with extinction. Out of 430 vertebrate species reproducing in the country only 44 are not endangered and as many as 41 are extremely endangered [Andrzejewski, Weigle 1993]. Then again, of some 235 species of breeding birds, 40 are down to fewer than 100 pairs, 34 have between 100 and 1000 pairs and a further 43 between 1000 and 5000 pairs – a number that is often considered to be the lowest number for a bird species to be reasonably secure.

Of the 48 invertebrate species considered extinct, 20 have died out since 1950 [Andrzejewski, Weigle 1993]. The home range of many species constantly decreases – for example the Apollo butterfly, *Parnassius apollo*, found formerly on many sites in the lowlands can nowadays be found only on a few sites in the mountains [Głowaciński 1992a, b]. Mollusc skopka perloronda, *Margaritifera margaritifera*, is no longer found and an attempt to reintroduce it failed

[Głowaciński 1992]. The reason why so many species have disappeared and the extent to which the remaining invertebrates are endangered is not satisfactorily explained, due to great differences in habitat needs and sensitivity, and also due to the inadequately examined biology and ecology of individual species. Only 74 species are totally or partially protected.

Polish flora has over 2300 vascular plant species (some discrepancies between data here are due to differences in approach), over 600 moss species, about 250 liverworts and some 1200 species of lichen [Zarzycki, Kaźmierczakowa 1993]. The threats though are very considerable. Among vascular plants, 34 species in the Polish Red Plant Book are extinct. Especially worrying is the fact that they included 3 endemic plants: *Cochlearia polonica*, that had survived only on a substitute site, small bloom gladiolus, *Gladiolus parviflorus*, that has not been seen for the last 20 years on any site (some of these sites have been totally destroyed) and Pieniny dandelion, *Taraxacum pieninicum*, whose only known site was destroyed by collapsing rock. Searches for other sites have drawn a blank although one cannot be absolutely sure that some specimens have not survived on inaccessible limestone. Additionally, 92 plant species are considered to be disappearing, 148 are endangered, 108 are rare and 33 are of unknown status. (Rare plant species are defined in the Polish Red Book as those found on very few or sometimes only a single site in Poland.)

One should add that disappearing and endangered species can die out rather fast. Probably over half of the sites of *Luronium natans* mentioned in the 19th century and

first half of the 20th century are now gone while the water caltrop, *Trapa natans*, has disappeared since 1870 on at least 188 sites – on 57 of them during the last 20 years [Zarzycki, Kaźmierczakowa 1993].

It seems that the protection of species and the protecting areas (reserves, national parks) is not sufficient to stop the negative trends in populations of rare species. It is important to draw attention to the existence of some species also outside the areas that stretch over only a small part of the country. EECONET-PL has been created for this purpose (among others) and locating endangered and/or rare species is an important part of its work.

EECONET-PL also plays an important role in protecting species that, although still often found in Poland, are gravely threatened or extinct in other parts of Europe. Poland may become a supply source for such species. The appearance of some of these species was one reason for giving EECONET-PL its present shape. The rare and/or endangered species that decrease in number when habitats shrink were taken into consideration as were those which constitute a substantial part of the European population (e.g. aquatic warbler, *Acrocephalus paludicola*). The list of species considered when planning EECONET-PL (annex), was prepared on the basis of the Polish Red Book of animals [Głowaciński 1992] and the Red list of dying and endangered animals [Głowaciński 1992b], the Red Data Book for endangered plants [Zarzycki, Kaźmierczakowa 1993], the list of endangered vascular plants [Zarzycki, Szelaąg 1992], the European Red list of animals [Wajda, Żurek 1992] and lists of species of the CORINE programme as well as materials in individual works prepared for the EECONET-PL project [Gromadzki, Chylarecki 1994; app. 10.4, Kowalski 1994]

The EECONET-PL list does not include invertebrates that are not certain to be found in Poland (e.g. green lizard, *Lacerta viridis*). The crucial criteria in making the list were the number of a given species and how often it may be found. Some endangered species are not on the list (e.g. some species of am-

phibians and reptiles, although all are to a lesser or greater degree endangered). When selecting species attention has been paid to migratory animals (e.g. fish traveling to spawn – such as the brown trout, *Salmo trutta trutta* – and bird ‘stopovers’)

The basis for mapping out the boundaries of core areas and corridors was via analysis of the appearance of selected species of plants, invertebrates, fish, birds and mammals (paying special attention to bats). The work was based on the already quoted individual works, the CORINE database and natural habitat map (annex, map 7), the atlas of mammals appearing in Poland [Pucek, Raczyński 1983] and works on national and landscape parks. Work was also based on the protected areas in Poland [Walczak and others 1993], the Polish Red Books of animals [Głowaciński 1992] and plants [Zarzycki, Kaźmierczakowa 1993] and other available works (see references).

Due to very evident differences in habitat needs and an uneven degree of study of individual invertebrate groups, the decision was made not to give special importance to any one group. Core areas were chosen to reflect the needs of invertebrate communities, particularly the large number of rarer species. In the less studied Polish regions, little changed habitat fragments for rare and endangered species became a criterion for differentiating core areas.

4.2. Flora diversity and character

The present delimitation of EECONET-PL considers only vascular plants because they are the best analyzed group with regard to frequency of appearance in different regions. An assessment of the individual areas could be influenced not by the richness of different plant groups but by the extent to which the area has been examined. Among the lower plants only stoneworts (*Chara*, *Nitella*, *Nitellopsis*), often treated as indicators of water purity have been analyzed.

Also the materials collected for the CORINE programme, which helped shape EECONET-PL, discussed only the higher plants.

The 2400 vascular plant species found in Poland are considered a moderately large number by European standards. The countries north and east of Poland have much poorer plant cover, those to the west and south much greater. The vascular flora of the whole of Fennoscandinavia embraces 1800 species (inclusive of subspecies), for the former Czechoslovakia the figure is 3100, for France and Corsica 4500 and for the Balkan peninsula over 7000 [Pawłowska 1972]. These figures are, of course, a reflection of latitude and humidity. There are only a few endemic plants in Poland. Endemism is hindered by a number of factors. One is the open character of the Polish landscape eastwards and westwards. Another is that Poland's flora is young; the Pleistocene glaciation which covered both the lowlands and the uplands including large mountain areas, interrupted plant-cover development. As a result Poland has not too many endemic or sub-endemic plants and these are often represented by so-called small species (e.g. *Galium cracoviense*, *Alchemilla babiogorensis*, *Alchemilla jasiewiczii*) or taxa lower than species (e.g. *Saxifraga moschata* ssp. *basaltica*, *Viola collina* ssp. *porphyrea*, *Asplenium onopteris*, *silesiacum* form), or occasionally critical specimens that need further research in order to establish their taxonomic character (e.g. *Gladiolus parviflorus*). The most interesting Polish endemic plants are two species in the Pieniny region (the Pieniny dandelion, *Taraxacum pieninicum* and *Erysimum pieninicum*), and the uplands *Cochlearia polonica*. Carpathian (or even just west Carpathian), Tatra and the few Sude-tan endemic plants are not dependent on the state borders, and the areas situated within Polish borders are of prime importance for their survival. The existence of endemic and sub-endemic plants was considered when the core areas were formed, and also when giving them international status (the areas of Jura Krakowsko-Częstochowska, Karkonosze-Izery, Śnieżnik massif, Żywiec Beskid, Tatras, Sądecki region, Beskid Niski, Bieszczady, Przemyśl foothills).

One should also examine a group of endemic plants with sites in Poland situated far from their main area of distribution – e.g. the snow saxifrage, *Saxifraga nivalis*, an arctic species found in Karkonosze and then not again south of central Sweden; *Dendranthema zawadzki* found in Pieniny (the Sądecki area) whose next population is found a few hundred kilometres away on the mid-Russian uplands; the yellow rhododendron, *Rhododendron flavum*, a Pontic species, found in Leżajsk, whose nearest island site is about 300 km away in the southern Polesie (and not occurring to any great extent before reaching the Kaukaz region); *Quercus pubescens* found in Bielinek in the Odra estuary area, a Mediterranean species, whose nearest usual habitat is southern Germany. An attempt has been made to include such distant sites within the EECONET-PL nodal areas and they have also influenced what status the area has been allotted.

The core of Polish flora – over 50% [Pawłowska 1972] – consists of so-called transitory species, that is, species whose full range does not occur on Polish territory. They are usually common species, representing the Holarctic geographic element, and the Eurosiberian and mid-European sub-elements. Rare elements define the specific character of Polish and regional flora, especially those species which reach their geographical limits here. Relatively rare are Arctic and Mediterranean sub-elements. In the west and north-west of Poland there are substantial numbers of Atlantic and Mediterranean-Atlantic sub-elements. This is particularly true of the Baltic coastland and the Pomorze lake districts and to a lesser extent of Great Poland and Silesia. On the other hand south-east Poland is characterized by Pontic and to a certain degree Mediterranean elements that may be found in the western part of the Polish uplands. Northeast Poland is characterized by numerous boreal and boreal-continental elements and less numerous Pontic, Atlantic and Mediterranean-Atlantic elements. In marking out EECONET-PL core areas, attempts have been made to consider the specific character of the regions with regard to species at the limits of their natural habi-

tat and especially those species with different types of boundary limitations (e.g. the areas of Tucholski forest, west Mazury, lower Silesian forests, Wieluń uplands, Bieszczady and Przemyśl foothills). It was also one of the important criteria when establishing the national and international status to be allotted to an area. For example, the international status was allotted to the area of west Mazury because, among other factors, its border regions have many sub-Atlantic and boreal species. The sites and varying extent of habitat of some species in EECONET-PL are shown in figures 4.1-4.3.

Documentation of the core areas includes the sites of endangered and even extinct species (as there is always the possibility of finding them in the region they previously inhabited). This category contains many maritime species which accounts, in part, for the network of core areas along the Baltic. Among endangered species only *Ligularia sibirica* is not found in a core area but its two Polish sites are secured eco-corridors. Due to the fact that the species endangered to a greater or lesser degree contain groups of species connected with particular habitats (e.g. sub-alpine species, oligotrophic-lake species, extensive hay-growing meadow species and traditionally farmed ploughfield species), the existence of these habitats was one criterion for inclusion in the EECONET-PL network.

Due to the great variety of species in Polish flora, the very existence of relict species is of great importance. Many are on the red list; EECONET-PL preparatory work considered all relicts, even those most frequently found (none of them are common); survivors from former climatic periods are all equally endangered.

Polish flora includes many species that are considered endangered on a European scale. These, together with species that are

important for maintaining European species variety, are on the IUCN list for the EECONET programme and on the CORINE programme list. Most of these species are on the Polish red list, but some of them are more frequently found in Poland (e.g. cotton-grass *Eriophorum gracile*, common larch *Larix decidua* ssp., *Polish polonica*). However, none of them are common. All the species (84) were taken into account when planning EECONET-PL and formed one of the most crucial criteria when determining the international rank of the area.

All in all the EECONET-PL project, as it now stands, protects a large majority of the sites of endangered and rare species. In the case of many species it protects all of their sites.

4.3. Degree of endangerment for rare invertebrates – and locations*

The fauna of invertebrates in Poland covers almost 30,000 species and is not yet fully documented. Species that were previously found in Poland are constantly being spotted. One of the difficulties of obtaining accurate information is that there are no data on species that are disappearing because hitherto specialists studied systematic groups. The data obtained were found to be more precise for groups of species connected with particular places – rare endemic plants, for example, found only on some fixed sites for *Formicidae*. Many invertebrates listed on the international lists (IUCN, CORINE) are found quite frequently in Poland, e.g. the wood ant *Formica rufa*, *Formica pratensis*, *Formica polyctena*. In most fauna studies such species are not considered particularly important; that is why

* The basis for the choice of invertebrate species when planning EECONET-PL were: the Red list of disappearing and threatened animals in Poland [Głowaciński, 1992b], the Polish Red Book of animals [Głowaciński 1992a] and IUCN/CORINE lists of endangered species. The EECONET-PL list of comprises: *Crustacea*, *Hirudinea*, *Bivalvia*, *Gastropoda* (terrestria and aquatica) and *Arachnida*, and *Insecta*. The *Insecta* group has the following orders: *Orthoptera*, *Hymenoptera*, *Lepidoptera*. With the help of Polish lists *Odonata* was added and on the basis of international lists some of *Coleoptera* was also added.

there is not enough documented data on them. One can, however, assume that they are found wherever suitable habitats occur.

The huge variety of species of some invertebrate groups and the degree to which they are endangered is illustrated in a table.

Table. Categories of threat (invertebrates)

Taxonomic group	Number of species		Threats	Occurrence
	total in Poland	rare and endangered *		
<i>HIRUDINEA</i>	23	8R, 3V	deteriotation of water quality, lowering of ground water table, extinction of small water bodies, plant succession in old river beds, decrease in number of fish species	
<i>CRUSTACEA</i>	120	1ExP, 2E, 11V, 23R	deteriotation of water quality	30 species in freshwaters, 50 in Baltic, 40 in wet inland habitats; 3 endemic species
<i>BIVALVIA</i>	35	1ExP, 7E, 9V, 8R	eutrophication, deteriotation of water quality, extinction of small water bodies - 70% of species are endangered	29 inland species, 6 in Baltic
<i>GASTROPODA (terrestria)</i>	173	12E, 28V, 35R	catching (<i>Helix sp.</i>), forests monocultures, habitat dessication, extinction of small water bodies, managing peatbogs	many range boundaries, natural insular occurrence
<i>GASTROPODA (aquatica)</i>	56	4E, 7V, 16R	water pollution, extinction of small water bodies, managing banks of water bodies	in water bodies and streams, build pollutants into mineralized tissues
<i>ARACHNIDA</i>	688	3E, 5R	landscape homogeneity, intensification of management, environment pollution, dessication	in all types of habitats
<i>INSECTA: Odonata</i>	70		water pollution, extinction of small water bodies	banks of water bodies, amidst vegetation
<i>Trichoptera</i>	260	1E, 29V, 41R	water pollution, acidification, regulation of rivers and hydrotechnic developments	larvae in clear water, imagines are short lived
<i>EPHEMEROPTERA</i>	120	1ExP, 14E, 10V, 10R	water pollution, eutrophication, regulation of rivers	90% of species occur in mountain regions, poorly known in lowland
<i>ORTHOPTERA</i>	103	6ExP, 4E, 8R	chemicalization, extinction of xerothermic communities, intensification of management	natural opean areas, often with xerothermic and calciphilous vegetation, ecotones
<i>HYMENOPTERA Apoidea</i>	454	12ExP, 3E, 38V, 115R		
<i>other</i>	± 10000	4E, 15V, 52R	pesticides, destroying boundary strips and bushy areas in agriculture fields, difficult to assess, variation among species	honey eating, related to open areas and ecotones
<i>LEPIDOPTERA</i>	± 3000	12ExP, 46E, 116V, 342R	difficult to assess (not enough knowledge of biology and ecology of nuemerous species)	larvae mostly related to specific host plant species

* E -declining species; V - endangered species; R - rare species (according to IUCN Red Data Book); ExP - extinct species or presumed extinct species in Poland (according to red data book of declining and threatened animals in Poland).

The number of species considered to be endangered varies from source to source: for example, 389 according to the statistical annual publication on Environmental Protection 1994, 1171 (in four categories) according to Andrzejewski and Weigle [1993], 1182 (divided into six categories according to the degree of danger) to quote Głowaciński [1992b], and this list does not contain many systematic groups.

It is estimated that a further 2500-3000 Coleoptera should be included – leaving aside other possible under-estimates. The species considered rare and endangered may be divided into several categories according to where they are situated, which in turn determines the way in which they should be protected.

Relict species (in Poland these are most often from glaciation periods) and endemic plants clearly demonstrate links with given locations – be they small areas or isolated sites (figure 4.4). In Poland these are mainly mountain areas, with Tatra and Pieniny as the centers for endemic plants. These relict species can also be found – although not as frequently – in different regions; for example, *Formica uralensis* and *Formica forsslundi* on the highmoor in the 34M area. Most of the locations of such species have been previously protected as reserves and they were also included within the core areas of EECONET-PL. However, due to their insular occurrence, it is difficult to give them any role in the European system.

Species typical of various sites in southern Europe (Pontic-Mediterranean elements) and found in southern and central Poland (particularly on the uplands) are usually less evenly spread, more dispersed, than the boreal and Eurosiberian species further north. European species denominated as Atlantic are rare and appear mainly in the north-western part of Poland and in individual sites in central Poland. These kind of species may play an important role in the European system, because spatial communication and preservation of good habitats may contribute to the re-emigration of species to their original territories where they are now extinct.

The transitional nature of Polish flora and fauna is particularly well exemplified by the frequent overlap of invertebrate species whose main centers of population are quite elsewhere – for example, far to the east or west (figure 4.5). This coexistence often occurs in the belt between Gdańsk Bay and the eastern Sudeten or western Carpathian fringes. In the upland belt in the south of Poland where these borders are not so marked, southern and south-eastern species can be seen more frequently. That is why this area has a relatively rich structure and a large variety of invertebrates. It is an important area due to its biological variety and to its quite high management level. It may also be an important southern and south-eastern 'refuge' area of the European system.

Not many species are identified as central European elements, and their sites are grouped (for example, *Trichoptera*) in the western part of the Carpathians, in the Sudetens and the southern part of Great Poland.

Species found in areas with a specific character show even stronger links with the character of the terrain. For example, mountain species cannot be found in the lowlands – with occasional exceptions (e.g. *Pirata piccolli* in Białowieża forest; area 29M). Linking EECONET-PL with mountain areas of the network in neighbouring countries is very important for these species.

Xero- and thermophilous species are dependent on specific conditions and vegetation, and steppe xerothermic grass. These *Orthoptera* are grouped in southern and central Poland, reaching as far north as Bielinek (core area 1M) and in the Chełmno area (lower Vistula corridor). Boreal and Eurosiberian species of thermophilous grass reach their southern extent in Poland, embracing northern and western Poland and the submontane and mountain areas of southern Poland. This type of habitat is quite rare in Poland – it occurs only in small areas. Invertebrate species connected with xerothermic grass are rare. However, due to the specific character of their habitat, they might be important in areas with similar

conditions and generally do not require a direct link between habitats.

Descriptions of individual EECONET-PL core areas have lists of rare species, with documented occurrence in the given area. The best known areas, so far as invertebrates are concerned, are the following: 1M, 9M, 13M, 29M, 30M, 40M, 42M, 43M, 45M, 12K. The exact status of these invertebrates is not known - in particular their range. Studies take years, are not often undertaken, and focus on small areas. Very inaccurate descriptions of sites and locations make finding them difficult. Different areas are not examined to the same degree – the study is usually undertaken by specialists working in different groups and with particular interests in mind. The most carefully examined are the protected areas, although information on invertebrates is not often found in the relevant documents.

Not all documented sites of rare and endangered invertebrates were included in the system. Most invertebrate species placed on the EECONET-PL list are sited within the core areas or in the corridors (figure 4.6). Data on their exact positioning is in the documentation.

At the moment documentation covers only part of the known sites of the selected species found in the individual core areas. Work at present is based mainly on synthetic data, referring to small numbers of species and not precisely locating their sites. Precise information can mostly be found in the results of specific studies in selected points. Dispersal of data and the time needed for data collection has meant deferring making use of them until the next stage. Data from the last 30 years has been accepted (for now) as being current.

4.4. The areas important for fish and lampreys

Problems connected with ichthyofauna distribution were dealt with by Backiel and

Freytag [1994]. The following text is largely an extract from their work. They claim that Polish waters contain 74 species, subspecies and forms of lampreys and fish. Due to pollution almost all of them are endangered. Especially endangered are 16 species, 2 of them still-water species (minnow, *Phoxinus phoxinus* and powan, *Coregonus lavaretus*). The remaining species listed as susceptible or endangered are flowing-water fish or those dependent on them (brown trout, vimba). Over 20% of endangered and rare species are a substantial part of our sweet-water ichthyofauna

The variety of species (calculated by the number of fish species) is a function of the size and variation of the water environment (for example, isolated lakes, lake complexes, river fragments, small Pomeranian river basins, large basins). In small dystrophic lakes exist some (often only one) fish species. In a small system of the Wieprzowka river (Skawa inflow, 27 km long) 18 fish species were found [Skóra, Włodek 1989]. In the entire Pilica basin (340 km long) 89 fish species and 2 lamprey species were found [Penczak 1989]. Ample ichthyofauna groups were found in a relatively large and morphologically varied water region; one lake is usually not rich, but a lake complex connected by isthmus (or rivers) may have rich ichthyofauna ecosystems.

The preservation of endangered species of fish and lampreys is very often a task contrary to the previous one. A good example of it is the minnow *Phoxinus phoxinus*, mainly found in small isolated reservoirs with very poor ichthyofauna. The need to protect the spawning grounds and habitats of traveling and lake trout is reduced to the protection of flowing water segments with a very poor variety of fish species. Taking into account fish species that travel regularly, it is relatively simple to point out places of greater importance (core areas and the corridors). The corridors mark migration routes, while spawning places are the core areas. The matter is complicated by artificial obstacles to migration – dams, weirs etc. As far as other species of fish are concerned, the core areas are where important rare or endangered species can be

There are certain problems in assessing the avifauna on a national scale. It is practically impossible to estimate correct populations for individual species. It has therefore been decided to limit the assessment to simple criteria connected with a number of target species.

Maintaining species diversity of Polish avifauna has been considered a priority, so concentration has been centred on particularly endangered species (those low in numbers and/or with a limited range). Taken into account next was species status on a European scale [Tucker, Heath 1994] because species at risk of extinction in Poland are not always equally endangered throughout Europe.

A distribution assessment of all breeding species has been made on large areas of 10x10 km. On the basis of the propagation value of distribution 2 threshold values of 5% and 25% have been distinguished and, respectively, 2 groups of rare species in Poland:

⇒ R1 – propagation 0.1-5% nation-wide;

⇒ R2 – propagation 5.1-25% nation-wide.

Population value, distribution and theoretical premises have given 3 threshold values of population numbering 100 pairs, 1000 pairs and 5000 pairs (the theoretical thresholds of populations resilient to extinction from natural causes – respectively species N1, N2, N3). Species endangered on a European scale (ETS – European Threat Status n great then 25) were also taken into account. The list of species in different categories was put into annex. Criteria of all species found on the given area were not very useful for the EECONET-PL project. (For example, rare species occurring in mountain and maritime areas are not shown as valuable when using this method.)

Assessing the country from the point of view of avifauna protection, the following criteria were used:

⇒ whether the area is the crucial concentration place (resting, feeding, night stopovers) for large numbers of passing lamellilostral birds (*Anseriformes*),

plovers (*Charadriiformes*) or cranes (*Grus grus*);

⇒ whether this area is a crucial moulting ground of lamellilostral birds or cranes;

⇒ whether this area is the wintering area for a large number of lamellilostral birds or for the white-tailed eagle, *Haliaeetus albicilla*.

‘Crucial area’ means an area with a 1% transit population or wintering in Europe (as far as lamellilostral birds are concerned); 5% of population wintering in Poland; populations of 10,000 waterfowl or 500 shore birds.

Areas crucial for preserving rich non-breeding avifauna, so especially recommended for EECONET-PL, are mostly limited to reservoirs and waterlogged areas (sea coast, river estuaries and bays, river valleys, lake complexes etc.). This is due to species choice and also to data availability (it is easy to identify and count birds on reservoirs).

The distribution maps for species N1 and R1 (figure 4.8 and 4.9) were helpful for EECONET-PL planning as were bird sanctuaries [Gromadzki et al, 1994, annex, map 8]. Distribution of species in other categories (N2, N3, R2, ETS) was so dispersed that it did not allow for the separation of particularly important areas: Baltic coastland (included in the relevant core area - 2M), the Odra estuary (1M), the Vistula estuary (3M), River values: Warta (4M & 19M), Noteć (8M), Vistula (20M, 23M), upper Narew (25M), Biebrza (26M), Barycz (18M – Milicki), Mazury (13M, 14M, 15M), Polesie (27M), Białowieża forest (29M) and Carpathians (42M, 43M, 44M, 45M).

All the most important areas with rare R1 and scarce N1 species were included in the core areas of EECONET-PL.

A considerable proportion of the bird areas of national and international importance [Gromadzki et al. 1994] has been included in EECONET-PL; 20 out of 33 national sanctuaries and 75 out of 85 international ones are in core areas. The sanctuaries, apart from having many precious bird species, are sometimes man-made (for example, reservoirs).

4.6. The areas crucial for mammal populations

4.6.1. Bats

Threats to this group of animals originate in the wandering nature of their lives, difficulties in finding the right hiding places (wintering and breeding places) and in pesticides that kill them [Kowalski 1994]. The most endangered are 8 out of 35 European species: lesser horseshoe bat *Rhinolophus hipposideros*, large-mouth eared bat *Myotis myotis*, Geoffroy's bat *Myotis emarginatus*, pond bat *Myotis dasycneme*, Bechstein bat *Myotis bechsteini*, parti-coloured bat *Vesperugo murinus*, Northern bat *Eptesicus nillsoni* and Leister's bat *Nyctalus leisleri*.

The enclosed map of where the above listed bats may be found was made on the basis of data from 1945-94 (annex, map 8). They were taken from an Atlas showing mammals locations in Poland [Pucek, Raczynski 1983], and from later publications and non-published materials.

The enclosed map also shows wintering grounds which at least once since 1985 have had over 100 wintering specimens. There is a separate work on bats [Kowalski 1994] because they are the most endangered group of mammals.

The presence of bats could not always be taken into consideration when planning EECONET-PL. Bats' wintering grounds are often found in large cities, which by definition are outside the EECONET-PL network (e.g. Staroleka fort in Poznań, the cellars of the castle in Kostrzyn and Swiec, tunnels in the Tarnów mountains, the church cellar in Warsaw Służewiec). Altogether 9 of the 20 most important wintering grounds are included in EECONET-PL, 3 with the largest wintering population (the Nietoperek reserve – Miedzyrzecze area, 5M, the Szachownica caves – Wieluń upland area, 15K, and the fort in Strzalin-Drawa area, 7M).

4.6.2. Other selected mammal species

Not enough knowledge on distribution and the biological needs of certain species has meant that only some mammals were taken into account when drawing up EECONET-PL. Some species (like the badger) are on the European target-species lists, but are regularly found in most areas in Poland, while at the same time being species that live in different kinds of habitats. It is not easy, then, to point out exact places where they and their habitats should be protected. Other species, limited to high mountain areas, live in the areas included in the EECONET-PL network for different reasons: for example, the Alpine marmot, *Marmota marmota*, the endemic Tatra plant, darniówka tatrzańska, *Pitymys tatricus*, the chamois *Rupicapra rupicapra*. Their areas are the Tatra area, 42M and (for the chamois) the Śnieżka massif, 39M. Otter distribution – a species of great international concern – is discussed later in this chapter.

Predatory mammals are also on the EECONET-PL list: Lynx, *Lynx lynx*, wild cat, *Felis silvestris*, wolf, *Canis lupus*, and bear, *Ursus arctus* (all these species are in the Polish Red Book of animals). There is one difficulty with these animals – they are active and often one cannot exactly determine the borders of their territory (figure 4.10). So the lynx can be found in north-eastern Poland (core areas 13M, 14M, 15M, 16M) and in the Carpathians, but was recently reintroduced into Kampinos forest (20M). Both wild cat, an extremely endangered species, and bear are found only in the Carpathians, (core areas: 39M, 42M, 44M, 45M for the bear and 43M, 44M, 45M, 46M for the wild cat). The wolf is limited to the eastern part of the country (eastern and north-eastern core areas) and forests in the west (core areas 3K and 12M).

When mapping out EECONET-PL rodents of the dormice family *Gliridae* were taken into consideration (figure 4.11). These dormice (especially *Dryomys nitedula* and *Glis Glis*) live mainly in deciduous and mixed forests. Forests with dense undergrowth and old hollowed trees are favoured by the

dormouse *Muscardinus avellanarius*. Plans are to use these rodents as target species in forest monitoring, including national parks [Andrzejewski 1993]. They are found mainly in the eastern part of the country (in the case of *Myoxus* it is at the limits of its north-western range). The only dormouse found – in small numbers – in the north-west of the country is *Muscardinus avellanarius* (areas 1M, 2M, 3M,). The rarest dormouse species in Poland, the garden dormouse, is probably found in the Beskid Żywiecki, Tatra and Pieniny areas (40M, 42M, and 43M) but little is known about its existence here.

Among the remaining mammals on the list is the spotted tortoise, *Spermophilus suslicus*; it is only found in the Zamość area, most of which is included in core area 22K. The hamster, *Cricetus cricetus*, is found in southern parts of Poland (within areas 27M, 30M, 33M). The beaver, *Castor fiber*, is not numerous, but can be found in the north and its numbers are growing. Sea mammals were not analyzed when EECONET-PL was formed.

The river otter, *Lutra lutra*, is a cause of great concern in Europe as a vanishing species. It is also in the Polish Red Book which is why it has been dealt with separately (annex, map 9). It appears that the river otter population is stable in our country and many areas may serve as a source for revival in neighbouring countries.

The otter is most numerous in the northern lake districts and in the Carpathians, where its natural habitats are. The species may also be found in extensively transformed habitats: in Wielkopolska, Mazowsze, Podlasie, Lubelszczyzna. It is not found in badly polluted areas - Silesia, the upper Vistula, the Kielce area and the Bzura basin. Valleys of large rivers, Odra (above Wrocław), Warta, Noteć, Pilica, Vistula (above Tarnobrzeg), San, Bug and Narew, are especially important for the otter as probable national and international ecological corridors. Through these rivers, the exchange of Polish specimens and those of neighbouring countries can take place.

5 Plant communities of Poland and their characteristics as criteria for mapping EECONET-PL

The plant communities of Poland show their variability with regard to diversity of soils and habitat humidity, as well as climatic conditions. In creating EECONET-PL, phytocoenoses (primary producers in the ecosystem) with a close-to-natural character were, to a large extent, taken into consideration. Apart from special rare habitats (mountains, coastline, lakes and moors) it means, under temperate climate, forest communities. More attention was given to communities of fertile habitats (deciduous forests), because these areas, being very attractive for farming, are to a greater or lesser degree deforested. Reducing the number of deciduous forests has, for some time, been the accepted consequence of certain types of forest management – with an excessive introduction of pines. As a result well-preserved deciduous forests, especially of large complexes, are not often seen today. This is also the case in the mountains where, especially in the Sudetens, well-preserved lower montane beech forests are rarely seen; it is important not only to keep what is left but also to restructure forest stands in order to help regeneration.

Hydrogenic type forests (deciduous and coniferous) have been classified as an important group of forest ecosystems. Threatened by disturbances in water relations, they have an important function in water-retention processes and thus in the regulation of environmental equilibrium over large areas.

Large coniferous complexes on arenaceous sites are of great importance. This results from a high number of well-preserved natural phytocoenoses and from the fact that, growing on permeable bedrock, they are a natural filter to protect ground waters

against contamination received from the surface and from precipitation.

In highly transformed regions, such as the mid-European lowlands and Polish highlands, all large forest complexes which maintain historically traditional forest ecosystems have been treated as protection-worthy. Even though these forests are to a certain degree spoiled by forest management, they still provide refuges for many characteristic species of flora and fauna. The distribution of smaller or larger forest ecosystems has been of fundamental significance also in establishing ecological corridors. Peat-bog communities, places of many rare, often relict, species highly threatened by changes in water relations have been classified as an important group of natural and semi-natural communities. In establishing EECONET-PL, all types of peat-bogs have been considered. However, special attention has been drawn to high bogs occurring in the lake-district zone and in the Kashubia lake district, in particular, as well as in the Polesie macroregion and sometimes in the mountains. Coastal plant communities, particularly dune communities characterized by heavy man-made pressure and poor resistance, are also very important.

Aquatic communities are another group of communities on which the identification of core areas in EECONET-PL is based both for their specific nature and ability to enrich ecological landscape over larger areas. Special attention has been drawn to oligotrophic and dystrophic lakes as more rare and more threatened. Many of them occur in such areas as the Kashubia lake district (9M) and the Tuchola forests (11M) and greatly

contribute to the identification of the boundaries of these areas.

Mountain ecosystems, with sub-alpine and alpine plant communities, in particular, were the basis for identifying core areas and classifying them as international because of their specific nature and limited range in Poland. It must be explained that hazards to these communities are less than elsewhere because they have long been protected as national parks or, in the case of the Śnieżnik massif, nature reserve.

Among semi-natural communities, the xerothermic grasslands, the so-called steppe communities, often of a relict character, have a great effect on biodiversity of both species and ecosystems. Their existence is usually highly threatened by changes in land-use (e.g. giving up grazing or afforestation of wastelands) or by passive protection leading to succession of forest plant communities.

Extensively used large meadow complexes have been classified as an important group of semi-natural plant communities for their protective function in water retention and purification as well as species richness of plants and animals and the enrichment of the landscape mosaic. In this group, attention has been paid to the widespread disappearance in Europe of one-harvest litter meadows. Meadow complexes have been an additional criterion in the identification of core areas and one of the main criteria in the identification of ecological corridors.

Heaths are an important group of semi-natural plant communities in some areas; they represent certain values (especially some types of heath) as rare communities disappearing as a result of intensive management. However, some xerothermic psammophilous grasslands included in some IUCN materials (i.e. the Dutch project) are still common in Poland in such low numbers that they are not included in EECONET-PL. Mid-field shrubs play an important role in the formation of a diversified landscape in many regions – as recorded in the documentation. Rarer communities,

though, have contributed to the classification of areas, yet could not be the basis for mapping out of the network because of lack of data on their occurrence.

Finally among the synanthropic communities, weed communities associated with a very extensive, traditional agriculture were a prerequisite in the identification of EECONET-PL (e.g. the Kurpie forest area, 22M, classified as an international core area).

Vegetation communities show a clear climate-conditioned variation, strongly represented in the core areas. It must be stressed here that efforts have been made to include in EECONET-PL all types of communities characteristic of a given region. Special emphasis has been put on the communities, on the boundaries of their ranges, as well as the regions in which the variety of geographic forms of the same community types meet (e.g. the various forms of hornbeam forest in the west Mazurian area, 13M, or in the Wieluń uplands, 15K).

In establishing EECONET-PL according to these criteria, emphasis has also been put on the occurrence of some types of communities that are rare in Poland and even in Europe. A list of various community types, ranked as rare or having range boundaries to which special attention has been drawn in mapping out the network, is presented below:

- ⇒ all communities of the sub-alpine and alpine regions;
- ⇒ plant communities assigned to the following classes of associations (according to phytosociological approach):
 - ⇒ *Lemnetea* (free-floating duckweed communities): *Wolffietum arrhizae*;
 - ⇒ *Zostereta marinae* (submarine herb and algae meadows) – all types of plant communities;
 - ⇒ *Thero-Salicornietea* (species poor saline-site vegetation) – all types of plant communities;
 - ⇒ *Ammophiletea* (pioneer coastal dune vegetation) – all types of plant communities;
 - ⇒ *Asplenieta rupestris* (vegetation in rock crevices) – all types of plant communities

- except *Asplenietum trichomano-rutae murariae*;
- ⇒ *Cakiletea maritima* (coastal halophilic therophyte vegetation) – all types of plant communities;
 - ⇒ *Ruppiaetea maritima* (subtidal maritime *Charophyta* meadows) – all types of plant communities;
 - ⇒ *Charetea* (submerged freshwater *Charophyta* meadows) – all types of plant communities;
 - ⇒ *Potamogetonetea* (rooted leaf-floating and submerged littoral vegetation of mezo- and eutrophic fresh water) – *Trapaetum natantis*;
 - ⇒ *Utricularietea intermedio-minoris* (aquatic vegetation of shallow dystrophic water) – all types of plant communities;
 - ⇒ *Litoretetea uniflorae* (littoral vegetation of oligotrophic lakes) - all types of plant communities;
 - ⇒ *Phragmitetea* (reed and cyperaceous swamp vegetation) – *Cladietum marisci*, *Caricetum buxbaumii*;
 - ⇒ *Asteretea tripolium* (salt marshy meadows) – all types of plant communities;
 - ⇒ *Sedo Scleranthetea* (arenaceous xerothermic grasslands) – *Festuco psammophilae-Koelerietum glaucae*;
 - ⇒ *Molinio-Arrhenetheretea* (meadows and pastures on mineral soils) – forb-rich meadow communities of the alliance *Filipendulo-Petasition* (as indicator of low-level land-use); litter meadow *Molinietum medioeuropaeum*;
 - ⇒ *Festuco-Brometea* (xerothermic steppe-like grasslands) – all types of plant communities;
 - ⇒ *Scheuchzerio-Caricetea fuscae* (fen, transitional bog and a hollow-phase of raised bog) - the communities of the order *Scheuchzerietalia* (transitional bogs), especially the associations: *Rhynchosporietum fuscae*, *Caricetum diandrae*, *Caricetum chordorrhizae*; and *Carietalia davallianae* (calcareous fens), especially: *Orchio-Schoenetum nigricantis*, the community of *Schoenus ferrugineus*;
 - ⇒ *Oxycocco-Sphagnetetea* (raised bogs) - all types of plant communities and particularly *Ericetum tetralicis* (the Atlantic wet heaths), *Erico-Sphagnetum medii* (the Atlantic raised bogs), *Pino mugho-Sphagnetum* (dwarf pine bogs), associations of the alliance *Oxycocco-Empetrion hermaphroditi* (boreal-subarctic-type raised bogs);
 - ⇒ *Nardo-Callunetea* (poor grasslands and dry heaths) – the communities of the order *Calluno-Ulicetalia* (heaths);
 - ⇒ *Trifolio-Geranietea* (thermophilous edge vegetation) – *Geranio-Peucedanetum cervariae*;
 - ⇒ *Rhamno-Prunetea* (edge and mid-field deciduous shrubs) – the communities of the alliances *Berberidion*, *Prunion fruticosae*;
 - ⇒ *Salicetea purpureae* (floodplain osiers and willow stands) – *Salici-Populetum* (willow-poplar riverside forest regularly flooded);
 - ⇒ *Alnetea glutinosae* (swamp alder and willow stands on peat) – *Myrico-Salicetum auritae* (Atlantic-type osiers) and *Betulo-Salicetum repentis* (boreal-continental-type osiers);
 - ⇒ *Erico-Pinetea* (xerothermic pine stands on calcareous sites) – all types of plant communities;
 - ⇒ *Vaccinio-Piceetea* (coniferous stands) - associations of the alliance *Rhododendro-Vaccinion* (subalpine dwarf-mountain pine shrubs and blackberry heathlands), *Plagiothecio-Piceetum hercynicum*, *Plagiothecio-Piceetum triticum*, *Polysticho-Piceetum* (upper-montane conifer forests), *Sphagno girgensohnii-Piceetum*, *Quercu-Piceetum* (sub-boreal spruce forests), *Abietetum polonicum* (upland fir forest), *Empetro nigri-Pinetum* (coastal crowberry coniferous stands), *Vaccinio uliginosi-Pinetum* (sub-continental bog pine stands), *Calamagrostio villosae-Pinetum* (submontane wet coniferous stands), *Betuletum pubescentis* (suboceanic bog birch stands), *Carici chordorrhizae-Pinetum* (sub-boreal coniferous stand on transitional bogs);
 - ⇒ *Quercetea robori-petrea* (acidophilous oak stands) – all types of plant communities and particularly *Betulo-Quercetum roboris* (Atlantic birch-oak forest);
 - ⇒ *Quercu-Fagetea* (European deciduous forests) – all associations of the order *Quercetalia pubescentis* (thermophilous oak stands and hazel shrubs), of the alliance *Alno-Padion* (ash and alder woods): *Ficario-Ulmetum* (*Fraxino-Ulmetum*) (occasionally flooded alluvial ash-elm forest in big river valleys), *Alnetum incanae*, *Caltho-Alnetum* (montane alder stands), of the alliance *Carpinion* (oak-hornbeam forests = ‘grond’): *Stellario-Carpinetum* (suboceanic beech-oak-hornbeam stands) and *Aceri-Tilietum* (submontane maple-linden stands), of the alliance *Fagion* (beech forests): *Carici-Fagetum*, *Taxo-Fagetum* (thermophilous orchid-rich beech forests on calcareous sites), all associations of the suballiance *Acerenion pseudoplatani* (montane sycamore stands), and the remaining communities

of hornbeam, beech and montane alder stands at the limits of their ranges.

The above list does not exhaust Poland's rare and protection-worthy plant communities. However very scarce information on the location of some communities (such as elm-alder stands *Astrantio-Fraxinetum*) has meant that they cannot be a basis for the marking out of EECONET-PL. Nevertheless, as already remarked, EECONET-PL covers most phytocoenoses of these plant communities including all mountain and coastal ones.

6 Threats to EECONET-PL

EECONET-PL covers a variety of landscape types whose properties and internal structures differ according to the region. The effects of man's activity will also vary – depending on its intensity and the character of the environment in a given place. Threats to the most valuable sites and regions covered by EECONET-PL can be divided into:

- ⇒ **absolute**, irrespective of the specifics of the protected site – for example by total elimination of vegetation over a vast area through drastic changes in land use, or rapid changes in habitat conditions;
- ⇒ **landscape uniformity (monotypification)**:
 - ⇒ related to intensification of current forms of land use (amelioration, fertilization, weed-killing in crops or introduction of 'useful' species) leading to a reduction in species composition and gradual transformation of habitat conditions;
 - ⇒ connected with processes occurring over a vast area (e.g. changes in water relations, long-term pollution impact, etc.), eliminating species sensitive to change and, consequently, leading to transformations in the biocenosis structure;
- ⇒ **landscape fragmentation**, related to the erecting of barriers to natural migration patterns (e.g. through motorway construction, elimination of mid-field woodlots, building construction or dam construction on rivers, etc.).

The seriousness of the all-too-many threats will vary in scale from the national to the local. Particular hazards will now be discussed, beginning, on a national scale, with a factor of global proportions – population density.

6.1. Population density

6.1.1. Permanent population density

The highest population density is in towns and suburbs, while the highest environmental transformations are in built-up areas. Open spaces in towns, with cultivated parks and green areas, sometimes include fragments of old forests and complexes of trees, shrubs and grass. Yet their isolation and pressure from surrounding areas mean that rare species and their semi-transformed ecosystems survive only sporadically. Areas around Poznań, Wrocław, Warszawa, Szczecin, Koszalin and Gdańsk may serve as examples. Many big towns are centers of urban and industrial agglomerations (annex, map 10).

One serious threat is urban development and its various forms of in-filling. Intensified use of space primarily threatens those valuable sites which are located in open areas favourable for building on; but also threatened are forest areas attracting villas (summer houses) or recreation grounds. Urban areas frequently traverse corridors linking core areas, especially where the corridors include river basins.

Apart from urban and industrial centers (which cover relatively small areas), population density is related to agriculture, where factors such as quality of soil and conditions for rural settlement – as well, perhaps as historical traditions – dictate size of farmsteads.

Northern Poland has the lowest population density (annex, map 10). Least populated areas are in Pomerania, western Wielkopolska, northern and western lower Silesia, Mazury, Suwalszczyzna and the northern part of Podlasie. Big concentrations of rural districts showing high population densities are connected with the neighbourhood of towns and urban agglomerations along the Vistula valley, or with historical centers of those regions. Moreover, they are frequently built in areas of fertile soil with forests, large well-preserved wetlands, and lake and peat-bog complexes. A relatively high number of precious nature sites and rare species refuges are preserved in these regions.

Southwards the population density gradually increases, peaking in Podkarpacie (Carpathian foothills), Silesia and Lubelszczyzna (Lublin region). Pockets of dense population in central Poland are related to the occurrence of fertile soils, regional centers, industry and mining. Where population density and development are relatively low, many rare thermophilous species areas and also numerous post-glacial relicts (e.g. in core areas 17M, 30M, 32M, 33M, 15K, 16K, 17K, 22K, annex, map 6) still survive.

Drastic changes in forms of land ownership resulting in large farms, intensified land use, elimination of landscape mosaics as well as landfill tips and the like on wasteland, jeopardize precious nature sites in these regions.

6.1.2. Temporary population density

Areas of tourism and recreation are characterized by seasonal or weekly increases in the number of incoming visitors which substantially increases pressure – especially in landscapes noted for their beauty but not greatly frequented by local folk. Usually they are areas classified as the most precious of nature spots. Attempts were made not to include in EECONET-PL week-end recreational areas in the vicinity of big towns. On the other hand, many valuable nature spots, including national and landscape parks, be-

ing core-area centers or their buffer zones and corridors, are areas of big tourism in both summer and winter. Land penetration, noise nuisance to animals and inhabitants and all-round degradation of vegetation pose hazards to the environment. Unprotected as yet precious sites need more thorough investigation followed by proposals for their conservation.

Areas of greatest tourism are, in winter, mountains and their foothills and, in summer, sea-side resorts (1M, 2M) and the Great Mazurian Lake District (areas 14M, 15M, annex, map 10). Tourism in sea-side areas is accompanied by excessive penetration of adjacent forests, damage to slopes and dunes, noise and trampling nuisance. Tourism in lakelands is accompanied by strong penetration of areas adjacent to the lakes, noise nuisance and also lake pollution as a result of poor sanitary facilities at tourist centers. Fragmentation of fields, meadows and forests into very small plots around lakes, accompanied by the construction of colonies of summer houses discharging sewage directly into lakes, is a frequent practice.

6.2. Changes in methods of land use

The already established national parks and conservation sites (protected by law from changes in land use) as well as landscape parks (where changes are controlled) form only a part of the core areas and corridors of EECONET-PL. The large areas now covered by EECONET-PL include land previously not protected at all. Here changes in land use are regulated exclusively by local councils (or parishes). These councils will need to be advised how best to protect their most precious sites.

Woodlands, fens and river valleys in sparsely populated areas, where landscape features determine usage, are less endangered. The endangered areas are those where the most precious sites – constituting

central parts of core areas or eco-corridors – are agricultural landscapes near centers of increasing population or tourism, or in the middle of planned road construction. Preservation of precious sites has been worst hit in southern and central Poland where population growth has been greatest.

6.3. Intensive use of land

6.3.1. Forestry

Larger forest complexes usually occur in areas unsuitable for agriculture. These are state-owned commercial forests with disturbed species composition (with pine and, in the south, spruce as predominant species) and, on the whole, young stands (from 20 to 80 years of age). Older stands have been preserved in areas enjoying various forms of protection, or in places with difficult access, such as mountains. In recent years, improved methods of forest management and an increase in the proportion of broad-leaved species are reported. This will slightly reduce the threat of mass epidemics of pests requiring the ‘cure’ of pesticides over vast areas.

Sustainable forestry, in the form of less intensive management, can preserve plant and animal refuges. A great number of rare species survive in the better maintained fragments of forests (with a more abundant variety of trees and vegetation) complete with clearings, lakes and peat-bogs. The current monoculture of most commercial forests is highly hazardous, as it increases their vulnerability to pollution and fire. And the frequent introduction of more resistant foreign tree species, plus ‘improvement’ of forest areas and large-scale logging, pose hazards to rare species.

6.3.2. Farming

Intensive working of the land requires favourable soil and climatic conditions – and for the most intensive of all, gardening and horticulture, closeness to a large town or

industrial centre. Intensive use of this kind, as well as needing crop protection with untold amounts of pesticides, fungicides and herbicides, creates hazards to plant and invertebrate communities, particularly in areas where they have survived in small enclaves in the agricultural landscape or on forest fringes. Also threatened, indirectly, are the higher animal species through the impoverishment or poisoning of their nutritional base.

Another hazard associated with intensive farming is the maximization principle: elimination of ‘wastelands’ (e.g. mid-field woodlots or small patches of wetland), intensified management of meadows and pasture, and use of small forests, peat-bogs and the like as tips. This leads to the disappearance of landscape mosaics, liquidation of refuges, impoverishment of communities, and even to the elimination of many (mainly ecotonic) species.

6.3.3. Land reclamation

Wet or flooded lands are used, variously, as meadows. Greater intensity of use (frequency of mowing, improvement of fodder) is related to land reclamation (mainly drainage). Reclamation is chiefly in western Poland and in the northern part of the central belt.

Wetland (marshes, peat-bogs, river valleys) is the most endangered type of land in Poland, due to the prevailing fondness for land drainage, as well as (in the big river valleys) flood control and water projects. The major national and international core areas and ecological corridors (with the exception of some mountain areas) can be included in this category.

These changes are hazardous. Especially so is the earlier first mowing which coincides with the breeding season of many bird species. A change in species composition of the flora of the fertilized and intensively mowed meadows totally eliminates natural vegetation and the majority of animal species, both invertebrates and vertebrates. Excessive drainage and disturbance of water balance over vast areas of land is an addi-

tional outcome. Up till now, only a few sites of importance to nature conservation, including marsh land, have been protected. Usually, these are nature reserves to protect small sites such as peat-bogs whose small size makes them vulnerable to nearby intensified land use. The only national park covering a large area of mires is Biebrza National Park which, together with part of its surrounding zone, is the core area 26M.

Land reclamation and its environmental consequences concern not only farmlands but also forests. Drainage of wet forest areas leads to the reduction and elimination of site and species diversity, particularly of the herbaceous layer. This applies mainly to forest complexes which, for the most part, are commercial forests, not subject to protection.

6.4. Pollution

Lands abundant in mineral resources also bring potential hazards. Mining, apart from the likely contamination of both soil and ground water, brings in its wake the growth of processing industries and human settlement. This in turn causes a further increase in effluent emissions and the plundering of still more land for disposal of waste. Areas with a high concentration of mines and associated industries are located in southern and south-western parts of Poland and, to a lesser extent, in the southern part of central and central-eastern regions. Areas marked 12K, 15K, 16K, 17K and 30M are located in their vicinity.

At the same time, despite great pressure from industry, a large number of valuable sites including numerous habitats of rare species, have been preserved. Some rare species habitats are very close to industrial zones (e.g. in upper Silesia), and although these sites have not been included in EECONET-PL (due to their excessive scattering in a highly transformed environment), this phenomenon deserves attention.

Distribution throughout Poland of the country's foremost beauty spots points to

the fact that the richest ecosystems have survived in some places despite atmospheric or water pollution. It is also possible that the environmental pollution assessments (based in great measure on emission-monitoring) do not include the strong and spatially variable local pollution. Area 1M, despite having in its neighbourhood a large urban agglomeration and heavy industry, can serve as an example. Rare species, bird refuges and fragments of valuable vegetation can still be found there.

On the basis of measurements of many parameters and the so-called 'industrial damage' to forests,²⁷ 'areas of ecological threat' including concentrations of industry environmentally harmful to quality of human life, have been established in Poland. The most frequent cases of exceeding permissible emissions were reported from these areas. That is why the monitoring of emissions is concentrated there. The effect they have on living organisms other than human are various, depending on the type of contamination. Frequently, direct reactions similar to, for example, diseases in man, are not observed. Changes that occur in ecosystems are usually slow changes, observed in long-term cycles. As a result of intensified protection, emission monitoring and installation of cleansing equipment, atmospheric and water pollution in some areas of ecological hazard has decreased considerably over recent years.

These 'areas of ecological threat' partially overlap important bird as well as threatened plant and animal areas. At the same time they also include areas of high tourism. One such is the core area 1M. Therefore it seems that of all man-made threats to species, the gravest comes from degradation of the earth – through strip mining, changes in land use, building construction, waste dumping, etc., the more so in that landfills are usually located in depressions, forests or wasteland which are often sites of high but as yet unrecognized natural values. The study of our natural environment is far from being focused on preventing degradation of this type.

Also the execution of large capital projects, now in the design phase, without sufficient knowledge about the natural environment and the impact thereon of these projects pose another threat. The Vistula cascade regulation project or the west-east waterway construction project are examples of such investments.

6.5. Transport

Vehicles cause about 70 per cent of town pollution, and unquantifiable environmental damage outside towns. Yet pollution effects are fairly local; the highest emissions occur in small areas, alongside roads, and are proportional to traffic volume. On the other hand, fragmentation of the land by both roads and railways is considered a serious threat to the environment. While local roads with little traffic seem to be of small significance, the construction of a rail and motorway network can have a serious environmental impact during both the construction work and subsequent operation. Small vertebrates and invertebrates are killed *en masse* crossing motorways.

Transport as a factor stimulating the growth of settlements and economic activity along traffic routes is an additional hazard to small animals. Co-operation between designers and ecologists, as well as site survey prior to the commencement of the planned development, would help minimize adverse effects.

From analysis of the projected rail and motorway network we can estimate the extent to which it conflicts with EECONET-PL. At present it appears that relatively few areas would be affected (1M, 5M, 30M or 16K and 46M, 25K and 16M). However only when we know the exact routes to be followed and the construction techniques to be employed will it be possible to make a final assessment. Potential conflict areas should be subject to additional analysis, and the planned development subjected to environmental assessment, followed, if necessary, by project modification.

7 Research needs related to EECONET-PL implementation

EECONET-PL was developed on the basis of available data – plus the mass of data acquired during the build-up of the network thanks to Poland's long research traditions in the natural sciences. Our knowledge is, however, incomplete with regard to the distribution of Polish fauna and flora and population trends of many plant and animal species - though this is not true of birds, whose territorial range is well known. Given the current inadequate level of knowledge and the need to develop EECONET-PL, further research studies are required, aimed at:

- ⇒ developing protection and management principles in core areas and ecological corridors;
- ⇒ improving the structure of the network;
- ⇒ enhancing knowledge on the occurrence and functioning of key species in the network.

The development of protection and management principles within EECONET-PL, along with an indication of the means (legal instruments) by which different levels of the country's administration (especially the provincial and district) would enforce implementation, will be the subject of the second stage of work on the National Nature Plan. This stage should cover the following issues:

- ⇒ analysis of diversity of spatial structure and management forms on farmlands included in the system;
- ⇒ indication of the principles of ecological farming with regard to preservation and protection of existing natural values and shaping the vegetational cover;

- ⇒ analysis of the anticipated impact of changes to land use (on lands abandoned by farmers) on biological diversity;
- ⇒ analysis of threats to forests resulting from current management practices aimed at immediate commercial benefits;
- ⇒ principles and instruments (legal, economic) of protection and increase of biological diversity in forests;
- ⇒ assessment of the influence of tourism and recreation on the network;
- ⇒ natural and economic effects of creation of ecological corridors on farmlands, forest and urban areas, stating reasons for and against their formation;
- ⇒ social, economic and legal framework of EECONET-PL and how to convince local communities to support implementation.

The EECONET-PL concept requires further work to enable its boundaries to be mapped on a more generous scale (1:100,000, 1:50,000). Detailed land-use (CORINE land use) maps, geological and hydrological maps, working plans, provincial development plans, local district plans, nature documentation for protected areas, regional and local publications – all these will together form the basis for this work. Diversity of ecological systems with regard to land use and forms of property will be subject to analysis. This will enable the network boundaries to be verified in a way that is useful to administrators and users of the system.

The following issues require studies:

- ⇒ coherence and continuity of ecological corridors, their real structure and function as species migration routes;

- ⇒ enhancement of ecological corridors by technical means – enabling migrating animals to bypass barriers such as motorways, installing watering places, shelters, animal feeders, etc.;
- ⇒ detailed characterization of the natural structure of core areas for more exact alignment of buffer-zone boundaries and determination of nature development areas;
- ⇒ deepening knowledge of those areas in the network whose natural values have not been fully discovered and undertaking complementary studies.

The establishing of EECONET-PL should foster research on:

- ⇒ occurrence, population trends and protection methods of amphibians and reptiles which belong to a relatively little known high-hazard group;
- ⇒ occurrence and population dynamics of dormice (*myoxidae*) which can serve as indicators of a given ecosystem's sustainability;
- ⇒ confirmation of bat hibernation sites, identification of sites requiring protection and annual monitoring of animals in main hibernation sites;
- ⇒ assessment of relative concentrations of bats feeding in various environments, and determination of environments of specific importance to them;
- ⇒ estimation of death rate for various animal species killed on roads, and genetic diversity of populations now become discrete for whatever reasons (including man-made extinction and geographic limit to their range) in order to determine micro-evolutionary changes, and hence the possibility of reintroduction;
- ⇒ methods of monitoring changes in the population abundance of animals of low population densities, especially those species which live a hidden mobile life and are prone to cyclic alterations of population;
- ⇒ re-introduction of selected vanishing species specifying the principles governing species selection, methods of catching, their choice of site and, finally, methods of re-introduction;
- ⇒ captive breeding of animals most endangered by extinction for re-introduction to their natural habitat;

- ⇒ methods of assessing environmental changes responsible for endangering specific species and creating substitute ecological niches for them, e.g. water reservoirs for amphibians, constructions for the nests of raptors, road crossings for animals, hibernation shelters for bats and many others;
- ⇒ ideal requirements of an ecological corridor in various types of landscape, and its functional dependence on its structural characteristics – natural components, length, width, role of various barriers, etc.;
- ⇒ role of the ecological corridor for various stenoecious species (species confined to a restricted range of habitats) and euryecious species (which have a wide range of habitats), and traffic flow of species with different ecological requirements through the corridor.

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Annex

Maps

