Mission:

To sustain and restore wetlands, their resources and biodiversity for future generations through research, information exchange and conservation activities, worldwide.

Peatlands are vital economic and ecological resources which contribute to biological, landscape and cultural diversity. They comprise characteristic assemblages of species which can exhibit intense patterning of plant and animal communities. Peatlands are also the best ecosystem for sequestering carbon (with current stores far exceeding those held in rainforests).

Guidelines for Global Action on Peatlands were agreed at the last Conference of Parties to the Ramsar Convention. These guidelines note that *"There is a wide range of threats to peatlands that require urgent national and/or international action"*. To help counter these threats, the Ramsar Convention is working with its sister conventions, on biodiversity and climate change.

The Ramsar Secretariat is pleased to see this report, which provides a significant step forward by presenting a summary of current knowledge and a Strategy and an Action Plan for Central Europe; a region that still harbours large peatland areas and types which are virtually extinct elsewhere. But changes in land management, ownership and the nature of economic exploitation are now placing peatland in this region under increasing threat.

This present publication will help inform all concerned to achieve better governance, and thereby management and conservation, for Peatlands in Central Europe.

Peter Bridgewater
Secretary General, Convention on Wetlands (Ramsar, Iran, 1971)

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Danish Cooperation for Environment in Eastern Europe
Ministry of Environment and Energy

International Mire Conservation Group

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University of East London

WETLANDS INTERNATIONAL

Strategy and Action Plan for Mire and Peatland Conservation in Central Europe

O. Bragg, R. Lindsay, M. Risager, M. Silvius and H. Zingstra

Wetlands International Publication 18

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Central European Peatland Project (CEPP)

Compiled and edited by:
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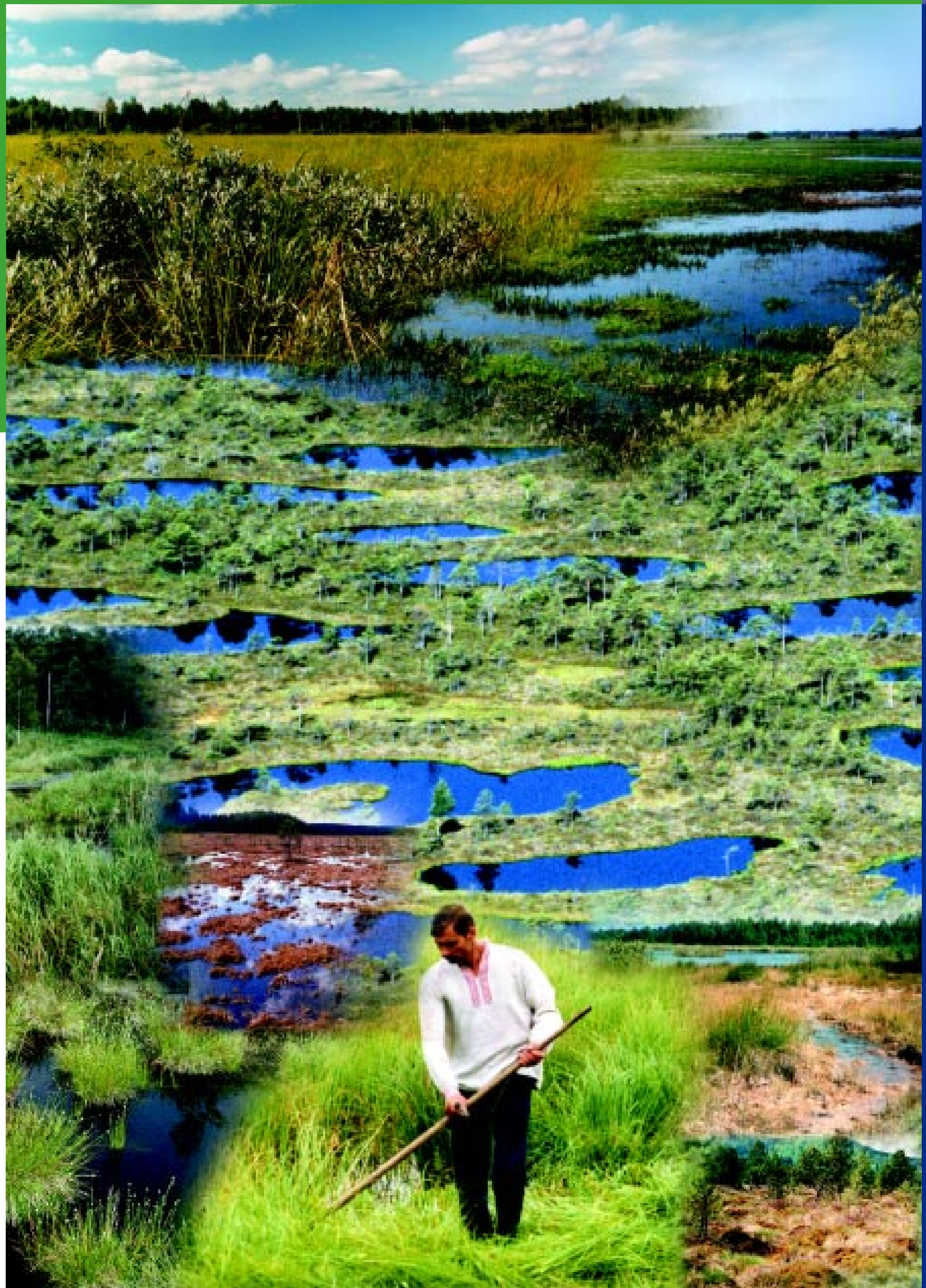

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1. Introduction

1.1 Background

The loss of peatlands and their biodiversity through drainage and peat extraction has been on the agenda of a number of consecutive Conferences of the Contracting Parties (CoP) to the Ramsar Convention, resulting in an appeal to the Parties to increase the number of peatlands listed as Wetlands of International Importance (Ramsar Sites). The 1999 CoP adopted a draft Global Action Plan for Peatlands (GAPP) to provide guidance on the protection and wise use of peatlands, and this was developed into the Guidelines for Global Action on Peatlands (GGAP) adopted in 2002.

Western Europe has now lost most of its natural peatlands, largely as a result of agricultural and industrial development. Whilst similar influences have affected peatlands in Central Europe (CE), losses have so far been less severe, so that this region still harbours many excellent examples of peatland types that are virtually extinct further west. Focus on the region is particularly appropriate at this time because of the impact of ongoing political, social and economic reforms, to a large extent driven by the imminent accession of six of its constituent countries (Czech Republic, Estonia, Latvia, Lithuania, Slovakia and Poland) to the European Union (EU). Although it is unlikely that Belarus and Ukraine will enter the EU within the next decade, these two countries are part of the same biogeographical region. They face their own significant political, economic and social challenges, which offer both constraints and opportunities for biodiversity protection.

Figure 1. The CEPP focal countries.

1.2 Strategic concept

The Central European Peatland Project (CEPP) was established to ensure that the natural heritage of peatlands would not be lost – indeed that it would be enhanced – during a challenging period of economic transition, stabilisation and growth.

Its specific intention was to:

- assist the eight participating countries (Figure 1) to implement the recommendations of the Ramsar Convention, through the development and distribution of a Strategy and Action Plan for Peatland in Central Europe;
- produce an overview of the distribution of **peatlands in Central Europe** and to identify those peatlands that are of significant value for **biodiversity**;
- increase awareness about the values and functions of peatlands, not only for the protection of biodiversity, but also for their significance with respect to **atmospheric carbon dioxide levels** and for their roles in **flood attenuation and water purification**.

The CEPP was not set up to impose conservation obligations on the participating nations. It was conceived from the outset as a mechanism whereby national and local specialists would be given the means to develop their own peatland conservation programmes. A unifying element, however, was the principle that a strategic document providing a broader international context for these programmes would be of value in determining the most appropriate and effective national and local actions. The process of developing such a strategic context would also encourage information exchange between participating nations, providing opportunities to identify and address peatland conservation needs at national and international levels.

A particular strength of the project was the collaboration of representatives from government, non-government and scientific bodies, supporting inter-sectoral awareness raising and dissemination of information.

The project should result in the enhancement of peatland protection in each of the participating countries, and proposals to help move towards this goal have been formulated.

1.3 Main components of the Central European Peatland Project

The CEPP embraces a wide range of issues, including peatland ecology, land-use history, financial incentives, international directives and public education. The major aspects of peatland conservation addressed were:

- the scale of peatland loss in Europe;
- causes of that loss;
- the biodiversity of peatland systems;
- the reasons for loss of peatland biodiversity in Europe;
- assessment criteria for the biodiversity values of CE peatlands;
- proposals for a common peatland terminology and classification;
- GIS and maps presenting an overview of the distribution and condition of peatlands in Central Europe;
- review of international initiatives promoting the conservation of peatlands (establishing linkages with the Global Peatland Initiative GPI[1], GGAP and Wise Use Guidelines WUG);
- the possible link between peatlands and climate change;
- wise use of peatlands;
- assessment of training needs;
- peatland education programmes.

A significant obstacle to improved peatland conservation is lack of clear understanding about the habitat itself, and thus about its importance to local and global ecology and its place within the provisions of environmental policy at all levels. It is thus necessary to provide explanations of a range of concepts relating to the natural peatland heritage of the region, from a basic working definition of the term "peatland" to identification of relevant international agreements, conventions and directives. These are to be found in Section 2 of this document.

A substantial part of the project involved the collation of spatial data describing the present distribution of peatlands, historical patterns of land-use change, and the extent of current peatland protection. These have been compiled using a Geographic Information System (GIS), and the results are described in Section 3. The outputs from the GIS are available to each participating country, providing an information base to allow the CEPP to be taken forward at the national level.

Data gathering and identification of national priorities were performed under contract by national project co-ordinators representing each of the countries. The outcomes of these activities are recorded in comprehensive country reports which were submitted separately to Wetlands International, and are summarised in Section 4 of this document, providing the basis for the overviews of Central European peatlands and their conservation requirements that appear in Sections 5 and 6.

1 The Global Peatland Initiative (GPI) is a partnership initiative that aims to provide a worldwide platform to promote the wise use and conservation of peatlands, using both sectoral and integrated approaches. It involves six agencies: Wetlands International (WI), the International Commission for Irrigation and Drainage (ICID), the International Peat Society (IPS), the International Mire Conservation Group (IMCG), the IUCN Netherlands Committee and Alterra. It incorporates a grant scheme for developing countries, encouraging landscape and multi-sectoral approaches; for example involving the forestry, energy and agricultural sectors.

2. Peatland conservation: concepts and issues

This Section explains what peatlands are, why they are important, and how some of their important features are described; it begins to consider the peatlands of the focal countries in their global and regional context.

2.1 Mires and peatlands – the invisible habitat

Peatlands comprise over 50% of the world's wetlands. They have generally been regarded as wasteland rather than as any special, or even recognisable, part of the natural world. This is because people have tended to avoid them in their everyday lives – peatlands are too wet to plough, yet too dry to fish. This avoidance, or lack of use, means that relevant cultural references and popular vocabulary in relation to peatlands are also poorly developed. Today we cannot *see* peatlands because we cannot describe them, even to ourselves. This is in stark contrast to many other habitats. Even a young child can draw a woodland or a meadow, but is likely to be at a loss if asked to draw a peat bog.

Recently, perceptions of peatlands have begun to change dramatically, and they are now increasingly acknowledged as a habitat type of global significance. Apart from their biological diversity, they provide goods and services to people, they play an important role in water regulation, they store carbon, and they are of value for education and research (Section 2.3).

Unfortunately recognition has come too late for many countries of Western Europe, where agricultural and economic development since the Second World War have led to substantial peatland loss. This has affected enormous areas throughout Europe. Some of these changes have been caused by ignorance and others by a deliberate desire to exploit particular characteristics or benefits of the peatland area; whether it be the peat itself, the surface vegetation, the potential of the soil for agricultural development, or simply because a locality has fewer planning constraints than other areas of land.

Plate 1. *Common butterwort* Pinguicula vulgaris *in a travertine spring system in Stankovany, Slovakia.*

Jan Seffer

In Western Europe, many countries have lost more than 90% of their peatland heritage, and nations such as The Netherlands have destroyed almost 100% of their natural peatlands (see Figure 6, Section 2.7.3). In such cases, domestic peatland conservation programmes are focused on hugely expensive restoration of the remaining damaged fragments. Such prodigious efforts are not merely nostalgic attempts to rescue something that has been lost; there are sound reasons for believing that the retention, enhancement and even restoration of peatland ecosystems is more vital than many people had previously realised.

> Understanding the profound importance of peatland ecosystems within landscapes has lent even greater strength to the calls for peatlands to be accorded special attention at all levels of decision-making.

2.2 Definition of the peatland habitat

If peatlands are indeed so easily overlooked, then one of the first things that must be done is to help make them visible – to show the way in which peatlands form part of the living landscape around us.

It is most important that we all talk the same language and have the same understanding of the key words – "peat", "peatland" and "mire". Although there is no universal agreement about the words used to describe peatlands, a set of reasonable working definitions can be adopted for the purposes of this report. The definitions used here explain simply what is meant by each of the terms; they differ in small but significant respects from those used in the recent publication by Joosten and Clarke (2002), which are given in footnotes.

The term "peat"[2]:

> **peat** is partly decomposed plant material that has accumulated *in situ* (rather than being deposited as a sediment) as a result of waterlogging.

This definition leads logically to the definition of "peatland"[3]:

> a **peatland** is an area where peat has accumulated *in situ*.

2 Peat is defined by Joosten and Clarke (2002) as "sedentarily accumulated material consisting of at least 30% (dry mass) of dead organic material".
3 A peatland is defined by Joosten and Clarke (2002) as "an area with or without vegetation with a naturally accumulated peat layer at the surface".

By convention, peatlands are recognised as entities. An entity may be as small as a spring-head a few metres across or as large as an entire landscape.

So far, the definitions have taken no account of the present vegetation. Thus the term "peatland" may embrace a wheat field on peat soil; even if the natural vegetation has been replaced by an agricultural crop, the definition would still class the area as peatland. For the purposes of a project that is concerned with both the maintenance of existing peatland ecosystems and the restoration of damaged systems, this definition is usefully inclusive rather than restrictive. Examples[4] of peatlands under cereal production in the UK, which within five years have been restored to species-rich peatland vegetation, lend weight to the merits of using this definition. Furthermore, it is important to recognise that many of the distribution data provided by the eight nations for input to the GIS (Section 3) are based on just such a definition – they are derived from soil surveys rather than habitat surveys.

Finally, there is the term "mire"[5]:

> a **mire** is an area that supports at least some vegetation known to form peat, and usually includes a peat deposit.

For some purposes it is helpful to distinguish two or three types of mire on the basis of nutrient status and vegetation characteristics. Bog is fed exclusively by precipitation which is normally a poor source of plant nutrients; whilst fen receives not only precipitation but also water that has been in contact with soil or rock, and so has higher nutrient status. Intermediate types, termed transitional mire, may also be recognised. The basis of these distinctions is explained more fully in Appendix 1.

The definition of "mire" acknowledges the importance of the existing vegetation and probably describes the type of area that most people would expect to be the subject of this project. Note, however, that it does not require the system to be laying down peat, or even to possess a peat deposit. This is because, in certain conditions, particularly those where water is extremely base-rich, vegetation that would normally lay down a significant peat deposit fails to do so[6], yet in all other respects the system is identical to the more usual peatland systems. Other peatland systems that have significant conservation value even though they may not be laying down peat are fen meadows, which are peatlands that have developed modified but species-rich vegetation under long-term traditional management regimes.

These, then, are the key terms that must be grasped if the focus of this project is to be understood and recognised. To assist further in clarifying this point, and to demonstrate the relationship between peatlands and other ecosystems, Figure 2 provides an overview of the world as seen from the perspective of all wetland environments.

Figure 2 indicates the place of peatlands in the world in a relatively simple, conceptual sense. From such a broadly conceptual diagram, it can sometimes be difficult to see exactly where particular examples of habitats fit within the identified categories. Given that the characters of wetland systems are influenced by three key factors – water, peat and vegetation – it is possible to construct a 'wetland triangle' and to highlight within this specific examples of habitat types. Figure 3 shows such a triangle, with its three sides divided into presence and absence of each of the three major factors. Thus the base of the triangle is divided into those parts of the world that have a peat deposit, and those that do not. The left side distinguishes between those parts of the world that can be defined as wetlands (taken in that term's widest meaning), and those that cannot. The right side of the triangle distinguishes between those parts of the world that support some form of vegetation (including phytoplankton or sargasso weed), and those that are largely or totally devoid of vegetation. The triangle enables the various overlaps between these key factors to be highlighted. Moreover, specific examples of habitats are presented to help interpret the diagram in terms of real-world ecosystems.

As with Figure 2, it is important to recognise that the areas indicated in the diagram do not reflect the actual surface area occupied by each category around the globe. The deep oceans clearly occupy a much larger proportion of the earth's surface than is indicated here, whilst the size of the area indicating the unusual but very important non-peat fens (largely travertine fens in the CEPP focal countries) far exceeds their extremely limited real-life extent.

Another feature highlighted by Figure 3 is the overall range of peatland/mire habitats that are relevant to the CEPP. This 'boundary of interest' is indicated in red. It can be seen that the focus of the CEPP extends a considerable way beyond what might initially have seemed to be the natural focus of such a project – namely those peatland sites that are evidently mire systems in various states of naturalness or disturbance. The CEPP has a very clear interest in areas that were once peatland but are now subject to commercial peat extraction or intensive agricultural use. Such areas represent the potential resource-bank on which future conservation programmes may need to draw in order to maintain or restore the natural range and diversity of peatland systems within the region.

It can also be seen that certain types of mire fall outside the remit of the CEPP. These include systems that are found in sub-tropical and tropical regions (e.g. peat-forming mangroves).

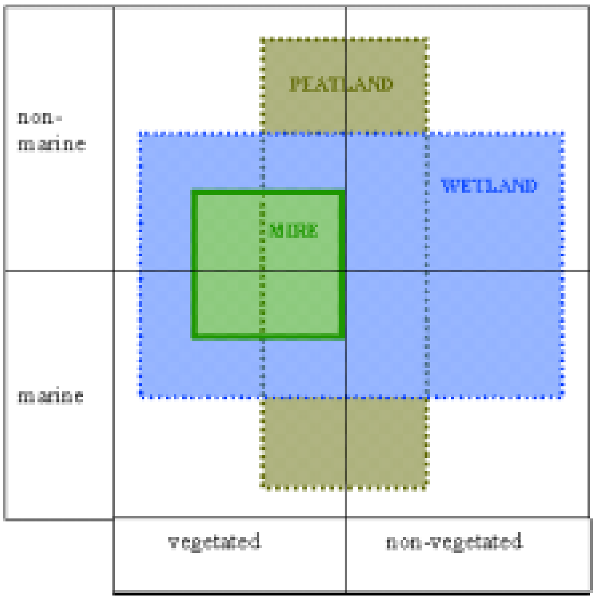
The key terms "mire" and "peatland" have in the past been used with a range of meanings, leading to widespread confusion. The concepts of both "peat" and "peatland" vary with the percentage of organic matter defined as the threshold (e.g. Footnote 2). Similarly if a *thickness* of peat is included in the definition, then a further degree of variation is

4 e.g. Cors Geirch, Wales (UK).

5 A mire is defined by Joosten and Clarke (2002) as "a peatland where peat is currently being formed". Thus, their definition deviates from the generally accepted usage of the term in that it excludes mires that lack a peat layer.

6 Examples include the Slovakian travertine fens which accumulate calcareous rather than organic deposits (Plate 1), and *Schoenus ferrugineus* mire with no peat layer.

Figure 2. The relationships between mire, peatland and the four principal categories of wetland, distinguished on the basis of marine influence and presence/absence of vegetation.



added to the picture. For the definition of "mire", some studies have included the whole hydrological unit, whereas others restrict the term to only that part of a system which is currently accumulating peat. In the absence of a common standard, every nation, and indeed every study within each nation, has tended to devise its own particular definition of these terms. However, for ease of reading, the word "peatland" is used throughout the present document to indicate the habitat that forms the focus of the CEPP.

2.3 Why peatlands are important

Peatland systems are found throughout the globe, from tropical to polar regions. In addition to being the most extensive single wetland type of the terrestrial (as opposed to the marine) environment, peatlands have a functional significance far beyond their actual geographical extent. Peatlands can provide humans with many benefits, the most important of which are described briefly below.

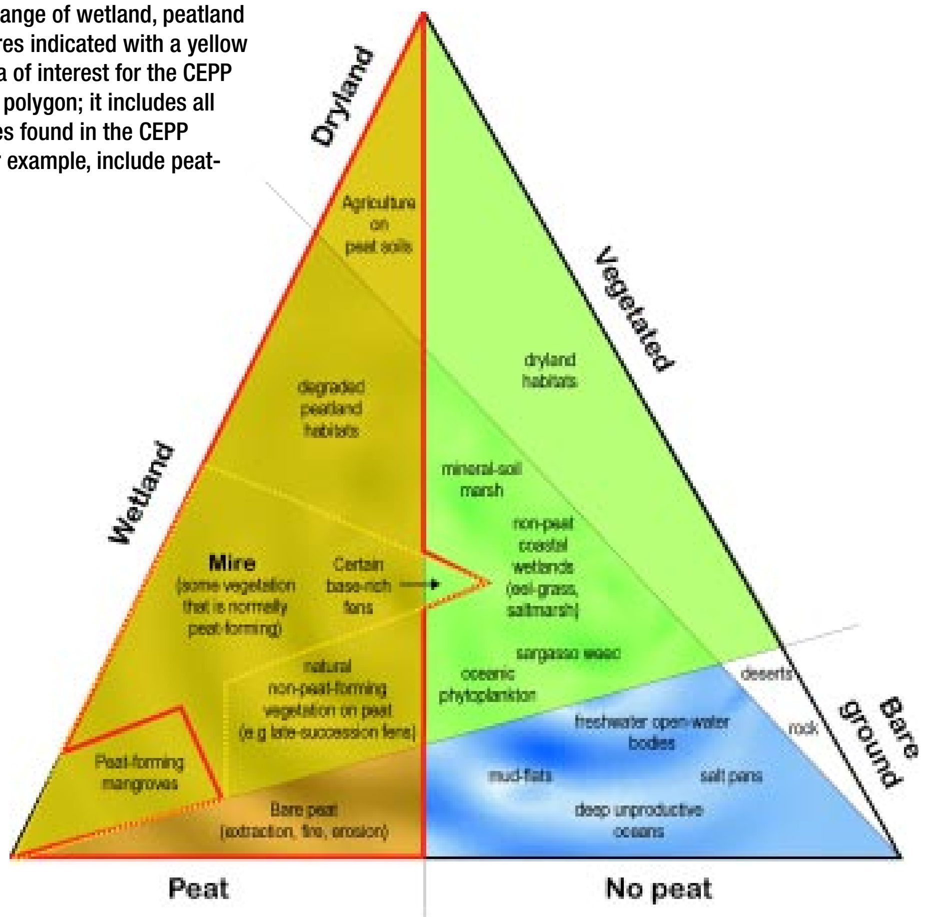
2.3.1 Carbon storage and sequestration

Peat accumulation and storage are generally the most characteristic properties of peatlands; many of the other functions arise from these characteristics. Peat accumulation involves the sequestration and storage of carbon from the atmosphere. Peat wastage, which is promoted by some types of peatland management, releases the stored carbon back to the atmosphere (Figure 4). Carbon stored in peat represents one quarter of the world soil carbon pool, and up to 70% of all carbon stored in biotic systems. Thus peatlands potentially play a major part in climate control.

2.3.2 Water regulation functions

Peatlands often form major components of local or regional hydrological systems. Peat has the ability to purify water by removing pollutants, and can prevent soil erosion.

Figure 3. The global range of wetland, peatland and mire habitats (mires indicated with a yellow dashed line). The area of interest for the CEPP is bounded by the red polygon; it includes all peatlands and all mires found in the CEPP region (it does not, for example, include peat-forming mangroves).



Moreover, large peat bodies are capable of influencing the regime of surface- and ground-water, and have roles in the mitigation of droughts and flooding. Peatlands also have a function in supplying water to people.

2.3.3 Diversity value

Peatlands are major contributors to the natural diversity of many parts of the world, at more than one level. They are components of the optimal natural biodiversity for extensive parts of the temperate, boreal and sub-arctic regions of both hemispheres, as well as in some tropical areas. They are important sources of biological material and genetic richness, as they contain specialised organisms which contribute significantly to the global gene pool. The variety of peatland types likewise provides a rich source of ecosystem diversity and functions. They provide significant landscape diversity by mixing a great variety of peatland habitats with more familiar temperate and boreal lowland environments.

2.3.4 Provision of goods and services

Peatlands are of considerable value to human societies as well as to other ecosystems for the "invisible" goods and services which they provide. Through their ecological processes, they help maintain food resources that are important for human consumption or for the maintenance of other biological communities, both within the peatland itself and within adjoining systems – for example, iron-rich peatland waters stimulate fish productivity in downstream coastal systems. They also provide foods and other natural resources which can be utilised sustainably (i.e. without damaging the system's ability to accumulate peat), to the benefit of local communities and national economies. For instance, wild plants can be collected for food and medicine; drinking water can be utilised; and in some areas it is possible to harvest timber sustainably. Conversely, peatland systems are damaged by afforestation, the overgrazing of peatland meadows or over-exploitation of berries and mushrooms.

2.3.5 Education and research

Peatlands are also valuable for education and research, since they contain important archives of cultural and environmental history reaching back more than 10,000 years. In the peat matrix it is possible to find preserved material, including pollen (studied by the science of palynology), plant remains, archaeological artefacts and even human sacrifices, that reveal the ecological and cultural history of the peatland itself, the surrounding area, and even of more distant regions.

2.4 Peatlands and global warming

The "greenhouse effect" is primarily due to the release of carbon dioxide to the atmosphere through the use of fossil energy. As a result, the atmospheric concentration of carbon dioxide had already increased from 280 ppm to 354 ppm before 1980 (Houghton *et al.* 1990), and continues to rise. Peatlands are important in this context because, although they cover only a few percent of the world's land area, their peat is the only long-term terrestrial store of carbon. It has been estimated (Immirzi *et al.* 1992) that peatlands contain more than 20% of the world's soil carbon, which is 3 to 3.5 times the amount stored in the world's tropical rainforests, and about 200 times the annual release of carbon from fossil energy.

> Uncontrolled release of carbon from the world's peatlands is potentially disastrous for global climates. The Indonesian peat and peatland forest fires of 1997 are estimated to have released between 0.81 and 2.57 Gt of carbon, and so could account for most of the sharp increase in emissions of CO_2 to the atmosphere – from 3.2 to 6.0 GtC yr^{-1} – observed in 1998 (Page *et al*. 2002).

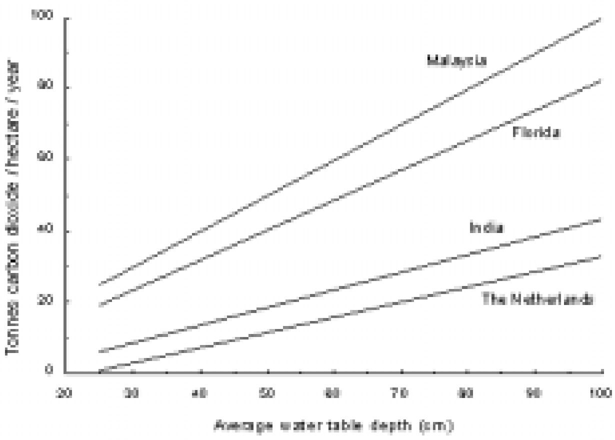
2.4.1 Causes of peatland oxidation

In recent years, there have been extensive peatland forest fires also in Central and Eastern Europe, and smoke haze has caused public health alerts in principal cities. Peat fires have occurred during droughts throughout history, but fire has become increasingly catastrophic for peatland systems as human activities have intensified, because drained peat and disturbed forest burn much more readily than wet natural peatland. Indeed, drainage alone causes release of carbon; simply lowering the water table to one metre depth can cause annual emissions of 40–100 tonnes CO_2 ha^{-1} as a result of oxidative wastage (Figure 4).

2.5 The description and evaluation of peatland diversity

Just as each nation has tended to establish its own definitions for the identification of peat soils and peatland habitats (Section 2.2), each nation – and to some extent each specialist – has taken a different approach to describing and classifying the diversity of peatland features. Although this may seem to be an impediment to the objectives of this report, once again the picture is not so bleak as it may first appear because there is a considerable degree of overlap between many of the basic elements used to describe peatland systems. In many cases confusion arises simply because different names have been applied to what is essentially the same feature. Therefore, a brief account is provided here of the main elements that contribute to peatland diversity, with an explanation of how these can be used to judge the conservation value of peatland sites.

Figure 4. Effects of lowering the water table in peatland on carbon dioxide emission rates in selected countries with different climatic conditions (based on H. Wösten, 1997).



2.5.1 The components of peatland diversity

It is possible to summarise the major sources of peatland diversity as follows:

- vegetation
- fauna
- water source – whether the sites are rain-fed or groundwater fed
- hydromorphology – the overall shape of the peatland
- water chemistry – both the chemistry of the peatland water (e.g. Plate 2), and the effect of peatland waters on other parts of the landscape
- small-scale surface patterns – related to growth forms such as hummocks and hollows (Plate 3)
- larger-scale surface pattern – the overall 'fingerprint' of the peatland surface (Plate 4)
- peat matrix – the carbon stored in peat
- peat archive – the history stored in the peat

Plate 2. *Sulphur springs in Raganu Mire in the Kemeri National Park, Latvia.*

Mara Pakalne

Plate 3. *Small-scale surface pattern at Klin National Nature Reserve, Slovakia.*

Viera Stanová

J. Vanek

Plate 4. *Úpské rašeliniště, Krkonoše/Karkonosze (Czech Republic/Poland): mires on the summit plateau display outstanding patterning which is affected by cryogenic processes.*

- habitats
- ecosystems and ecological complexes.

Details of how each of these contributes diversity to peatlands can be found in Appendix 1.

2.5.2 Evaluation of diversity and conservation value

A record of the range of diverse characteristics of a peatland system is, however, simply an inventory. Evaluation requires that one unit, whether it be a site or a feature of that site, be compared and judged against another of the same type.

> Judgements about relative value are made using criteria, and the two key criteria that define biodiversity are **naturalness** and **diversity**.

Naturalness has one key component – freedom from human interference. This can be expressed either as the lack of evident human disturbance; or as a full display of all expected components of natural diversity. Appendix 1 provides guidance by which the naturalness of a site may be judged.

Diversity embraces a wide range of peatland characteristics, as reviewed above, but when these come to be evaluated they can be grouped according to two broad criteria, namely rarity and representativeness (typicalness).

Rarity operates on a threshold principle. If a site is rarer than a defined threshold, then it qualifies. It can be judged from the overview of the CEPP nations and their peatland resources provided in Section 4. It can also be judged using the listings of threatened habitats or species provided by a range of international treaties and agreements such as the Bern Convention and the EU Habitats and Birds Directives (Annexes), by BirdLife International Bird Areas (IBA) documentation, and by IUCN and national Red Data Books.

Representativeness, though more difficult to define, is a significantly more flexible and valuable tool for judging the conservation value of sites. In terms of protecting natural biodiversity, it is also far more important than rarity as a concept. This is because it embraces the full expression of natural ecological diversity, rather than focusing merely on those aspects of diversity that are now rare (and therefore by definition somewhat unusual).

The concept of a "representative" site is that it should be the best example of what is *typical* for a particular feature in a particular region. It should also be recognised that a *single* example of such a type is not sufficient because, unlike valued specimens protected in a museum, sites are subject to a range of external influences. Natural phenomena such as lightning strikes may cause catastrophic fires, storms may cause windblow of trees or re-shaping of watercourses, while accidents caused by a dropped cigarette in a dry summer can have just as dramatic effects. It is vital, therefore, not to 'keep all the eggs in a single basket'. A selection of 'best' sites spreads the risk to an acceptable level.

Sole reliance on the concept of "rarity" for the identification of conservation value results in an emphasis on sites that may in fact not be representative for the region. This is particularly true for examples that are outliers on the edge of (or even beyond) their normal range. Whilst these may be of interest because they demonstrate the influence of an atypical locality on the expression of type features, they are unlikely to reflect faithfully the core characteristics of the type.

Reliance on rarity as the sole, or major, criterion of conservation evaluation also means that conservation action is initiated only when something becomes rare. Thus a widespread peatland type that plays a major part in regional climate control, carbon balance and support for biodiversity is not vested with conservation value until it has lost the capacity to provide all these functions and is reduced to a few fragments that can offer little in terms of significant contribution to the region. Such fragments may in contrast represent a drain on local resources because they are no longer self-sustaining and require special efforts to maintain their character.

The concept of the "typical" or "representative" site embraces the idea that ecosystems (or species) have natural ranges, distributions and characters, and that the expression of these attributes should be maintained. This is particularly important if part of the argument for conservation is that the typical ecosystems and species make significant contributions to the functioning of the landscape, region, or even global system. Such a claim is difficult to sustain in the case of rare features or species.

The whole concept of biogeography is based on the notion that both species and ecosystems have characteristic centres of distribution and natural ranges. No single site can encompass this, and thus it is logical to consider the suite of sites that best expresses this core distribution, as well as the natural range and essential character of the species or system.

Thus, **representative** sites are those that are best able to display, for a specified ecosystem type, the characteristic diversity and ecosystem function across the natural range of that type.

The identification of such sites is clearly bound up very closely with the concept of biogeographical area, and thus it is important to be able to draw on information that is of relevance to the bioclimatic, geobotanical or biogeographical regimes within the area of interest.

Although not the first of the international environmental treaties, the Convention on Biological Diversity (CBD) provides a clear definition of the diversity that is now generally taken as a measure of natural value. The term given to this concept is "biodiversity":

In the Convention on Biological Diversity, also known as the Rio Convention, **biodiversity** is defined as "the variability among living organisms from all sources, including, *inter alia*, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

In the context of the objectives of this report, it is significant that this definition explicitly includes diversity both between species and within ecosystems.

2.6 The diversity of Central European peatlands

The peatlands of the focal countries now occupy a "frontier position" in Europe. There have been immense losses of the habitat from Western, West-Central and Southern Europe, so that the rich resource of peatland that remains in Central Europe has now assumed even greater importance for maintenance of the continent's biodiversity.

Within the temperate forest biome of Eurasia, Central Europe still harbours many excellent examples of peatland types that are virtually extinct further west. This diversity is underlined by the fact that four major mire regions and many mire districts are represented, including those with the highest diversity of ecological and hydrogenetic mire types in Europe (Jeschke *et al.* 2001).

The countries are heterogeneous with respect to their mire types. In the Baltic countries, living bogs are still rather numerous, whereas living fens have become scarce. An important concentration of spring-fed "percolation" fens[7] has survived in Polesia (Belarus and Ukraine). Although they are not particularly rare in these countries, such natural peatlands are of very high international conservation importance.

Central European peatlands play an important role in the global and international conservation of species. They harbour viable breeding populations and play a central role as migration and wintering sites of many bird species of global conservation concern. The area has a special responsibility for the conservation of those rare bird species whose global distributions are concentrated in Europe and Central Europe (Table 1). Globally rare and threatened mammals living in east-Central European peatlands include European mink *Mustela lutreola*, beaver *Castor fiber*, root vole *Microtus oeconomus* and northern birch mouse *Sicista betulina*. Other internationally important mammal species include common otter *Lutra lutra* and Miller's water shrew *Neomys anomalus*. Amphibian and reptile species of global and international importance are represented by the European pond turtle *Emys orbicularis*, great crested newt *Trituris cristatus*, fire-bellied toad *Bombina bombina*, European tree frog *Hyla arborea*, moor frog *Rana arvalis* and dice snake *Natrix tessellata*.

Globally threatened vascular plants of mires within the focal area include fen orchid *Liparis loeslii*, bog orchid *Hammarbya paludosa*, slender cottongrass *Eriophorum gracile*, common spotted orchid *Dactylorhiza fuchsii*, bog hair-grass *Deschampsia setacea* and the butterworts *Pinguicula bohemica* and *P. vulgaris* ssp. *bicolor*. Additional EU Habitats Directive priority species for which the area has responsibility include the waterwheel plant *Aldrovanda vesiculosa*, angelica *Angelica palustris* and marsh saxifrage *Saxifraga hirculus.*

7 Fens fed by spring water which seeps laterally beneath the surface.

It is worth noting here that high species diversity does not always go hand-in-hand with naturalness. In peatlands that have long histories of traditional extensive management with grazing or mowing, these uses may have contributed significantly to the development and maintenance of species biodiversity for both flora and fauna. The high species diversity values of these areas are specifically linked to human land-use practices and are currently threatened by abandonment or land-use intensification.

Table 2 lists a range of plant species that are considered to be internationally important within the European context, but which have unfavourable conservation status within the eight focal countries.

In the Slovakian Nature Reserve *Abrod*, 480 higher plant species have been recorded within a 92 ha area of managed (mown) fen grassland. Eighteen per cent of them are Slovakian Red List species. In the Nature Reserve *Rojkov*, 160 plant species have been recorded within an area of 2.9 ha of hand-mown peatland meadow.

2.7 Distribution and current condition of peatlands in Europe

2.7.1 Difficulties of inconsistent data

It will be obvious from the discussion in Section 2.2 that, even with just the three concepts of “peat”, “peatland” and “mire”, it is possible to produce widely varying estimates of the extent of an individual peatland. Consequently the difficulties facing anyone attempting to bring together information about the peatland resource throughout Europe are considerable, and no pan-European dataset based on currently available information can describe itself as “definitive”.

Plate 5. Dactylorhiza incarnata *ssp.* ochroleuca *in Abrod National Nature Reserve, Slovakia.*

Jan Seffer

Table 1. Some rare and threatened bird species associated with Central European peatlands.

	Latin name	English name
Species of global conservation concern breeding in Central European peatlands	*Acrocephalus paludicola*	Aquatic warbler
	Aquila clanga	Spotted eagle
	Aythya nyroca	Ferruginous duck
	Crex crex	Corncrake
	Gallinago media	Great snipe
	Haliaeetus albicilla	White-tailed eagle
	Pelecanus crispus	Dalmatian pelican
	Phalacrocorax pygmaeus	Pygmy cormorant
Globally threatened species migrating and wintering in Central European peatlands	*Anser erythropus*	Lesser white-fronted goose
	Branta ruficollis	Red-breasted goose
	Numenius tenuirostris	Slender-billed curlew
Rare species whose global distribution is concentrated in Central European peatlands	*Aquila pomarina*	Lesser spotted eagle
	Botaurus stellaris	Bittern
	Ciconia ciconia	White stork
	Ciconia nigra	Black stork
	Limosa limosa	Black-tailed godwit
	Platalea leucorodia	Spoonbill
	Porzana parva	Little crake
	Porzana porzana	Spotted crake

Table 2. Internationally important peatland plant species with unfavourable conservation status in the eight focal countries.

Latin name	English name
Betula nana	dwarf birch
Carex buxbaumii	club sedge
Carex davalliana	Davall’s sedge
Cladium mariscus	saw sedge
Dactylorhiza baltica	Baltic orchid
Dactylorhiza maculata	spotted orchid
Dactylorhiza majalis	western marsh orchid
Gentiana pneumonanthe	bog gentian
Gladiolus imbricatus	common gladiolus
Gladiolus palustris	three-flowered gladiolus
Gratiola officinalis	hedge hyssop
Herminium monorchis	musk orchid
Iris sibirica	Siberian iris
Isoetes echinospora	spiny-spored quill-wort
Isoetes lacustris	quill-wort
Ligularia sibirica	Siberian leopard plant
Lobelia dortmanna	water lobelia
Nymphoides peltata	fringed water-lily
Orchis militaris	military orchid
Pedicularis sceptrum-carolinum	moor-king lousewort
Pedicularis sylvatica	lousewort
Primula farinosa	bird’s-eye primrose
Salix myrtilloides	bog willow
Schoenus ferrugineus	brown bog-rush
Schoenus nigricans	black bog-rush
Sparganium angustifolium	floating bur-reed
Swertia perennis	alpine bog Swertia/star gentian felwort

The most important factor in making progress with such a mis-matched set of data is that everyone who views and uses it knows very clearly the limitations of the component data and of the combined dataset. Thus it is valuable to know that the basis for the inventory data for Great Britain is based on “presence of a peat soil at least one metre in depth”, whereas the basis for the Austrian inventory is “the presence of mire vegetation”. Additional information, such as the present condition of the vegetation, may render these two datasets more closely compatible, but the underlying differences mean that they are still not strictly comparable.

2.7.2 The European peatland resource

Given these limitations – and there are serious implications for the GIS inventories of the eight focal countries – it is instructive to look at available data for the peatlands of Europe as a whole. Various broad reviews of global peat resources have been published over the years, the most recent by Lappalainen (1996). These datasets have been collated and updated specifically for Europe, as the initial stage of a formal European review currently being undertaken by the International Mire Conservation Group (IMCG). The results of this initial synthesis can be seen in Figure 5.

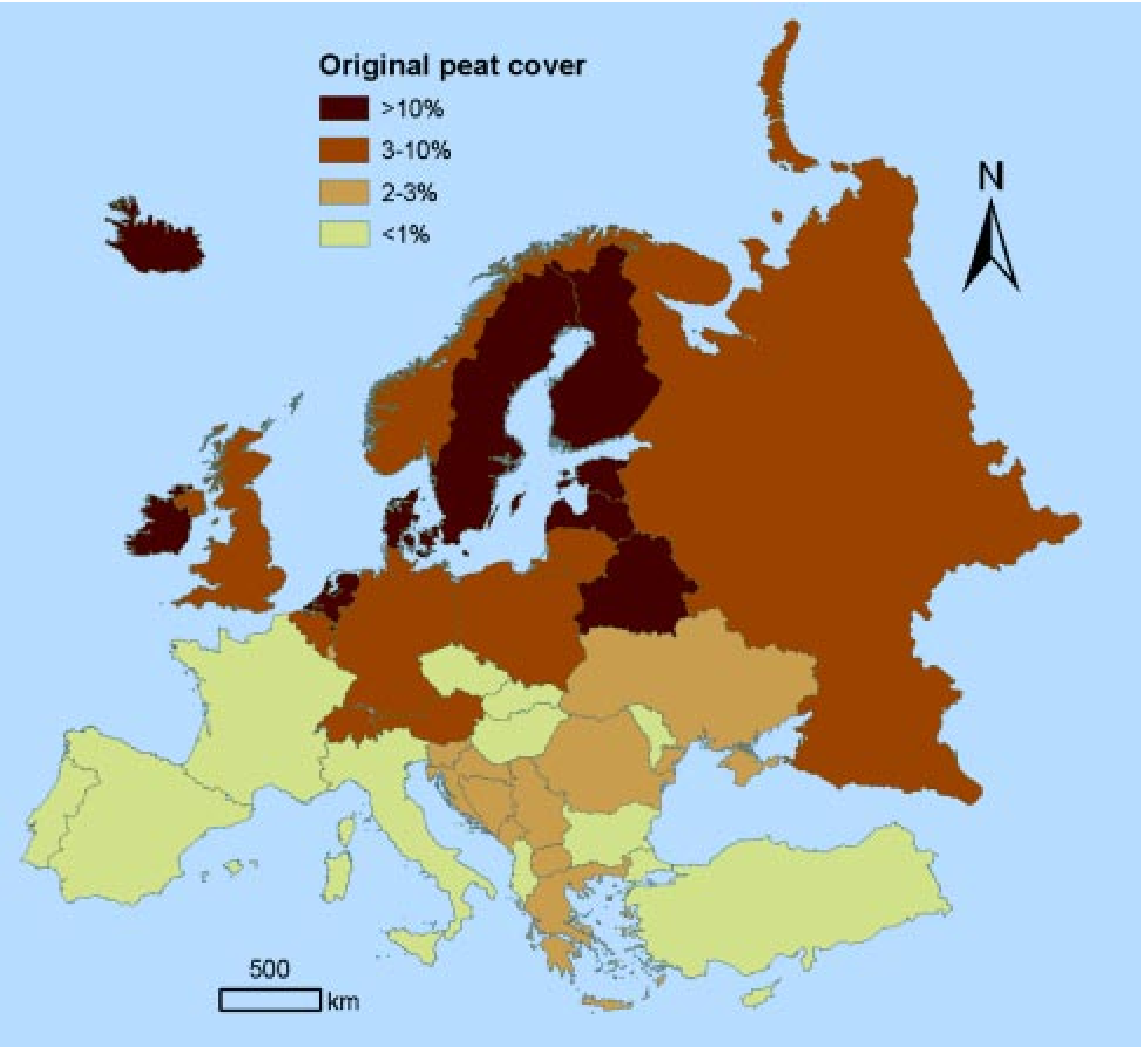
The most obvious point illustrated by Figure 5 is that the majority of the peat in Europe is concentrated in the northern half of the continent. Russia and the Nordic countries alone provide more than 60% of the European peatland resource, and six of the eight CEPP countries fall within the top 20 peat-rich nations.

2.7.3 Peatland losses in Europe

It is important to recognise that Figure 5 does not reflect the current distribution of natural peatland habitat. In most countries, much of the peatland area has been altered and claimed for other land-uses. Examination of available information clearly indicates the considerable scale of peatland habitat loss throughout Europe. Figure 6 displays the pattern of loss, and reveals that those nations having least peatland area originally (essentially the nations of southern Europe) have tended to lose most as a proportion of the original area.

According to these estimates, only five countries have maintained more than 50% of their peatlands in relatively natural condition, and most other countries have lost between 70% and 99% of their natural peatland systems. The most dramatic total losses, however, can be found in

Figure 5. The original extent of peatlands in Europe, shown as a fraction of the total area of each country (data: H. Joosten and J. Couwenberg).



some of the nations with a rich peatland heritage, such as Finland, The Netherlands, Estonia, Denmark and the UK. The Netherlands, once more than one-third covered by mires (15,000 km^2), has lost virtually all of its peatland resource during two millennia of human impact (Joosten 1994). Finland destroyed the majority of its 96,000 km^2 mire area, largely by drainage for forestry since the 1950s (Paavilainen and Päivanen 1995). Ireland, where mires once covered 17% (14,000 km^2) of the country, has lost 93% of its raised bog and 82% of its blanket mire resource (Foss 1998).

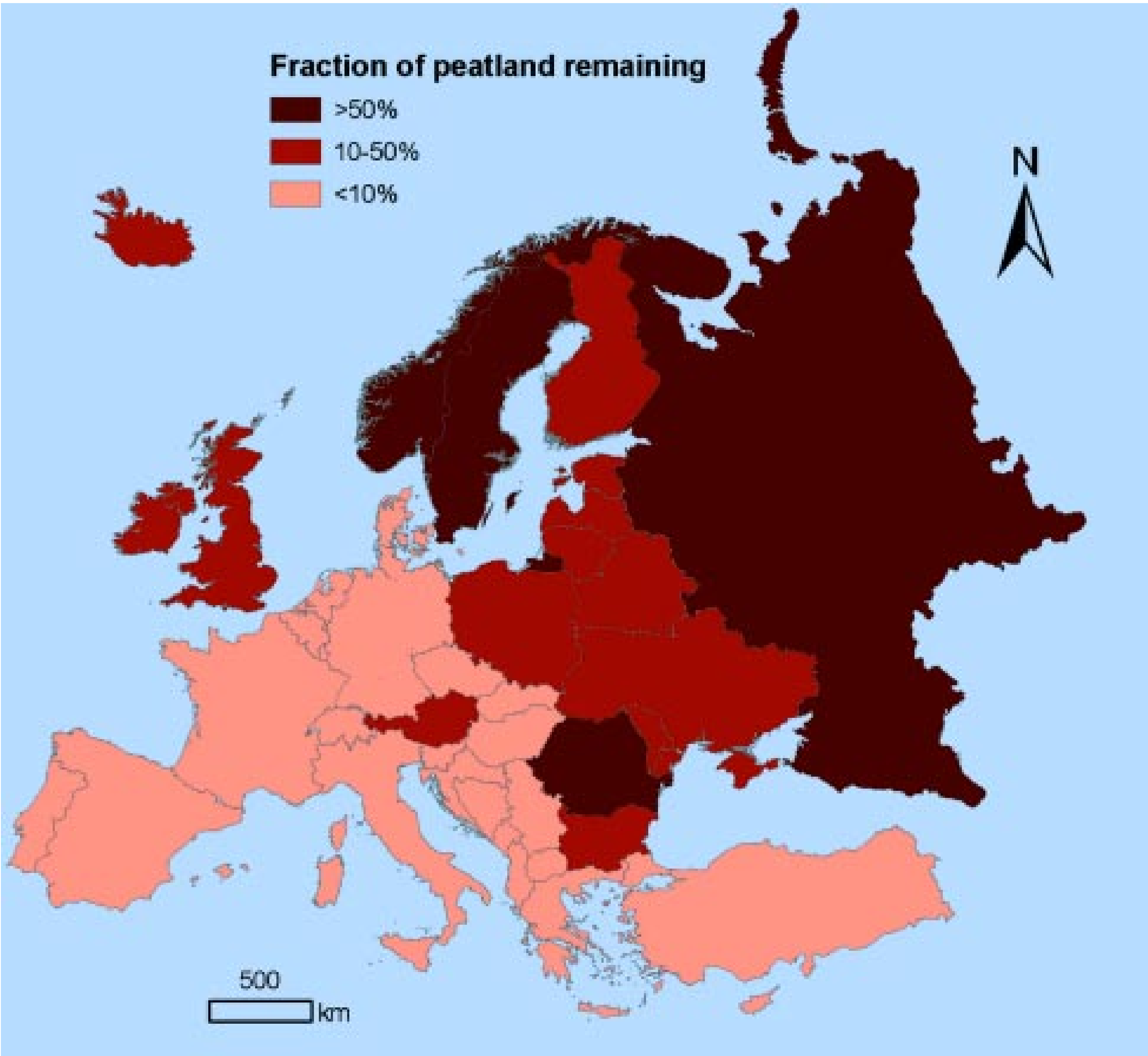
The phrase "according to these estimates" is important, because it is not easy to obtain reliable and consistent data for the present area of relatively natural peatland habitat. Some recent national surveys, such as the Estonian Wetland Inventory (Paal *et al.* 1998), provide reliable, up-to-date figures, but in other countries the data are very old, are only partially available, or are estimates made by specialists based on their knowledge of the national resource. A revised set of figures has been gathered specifically for the CEPP (Section 3.2), and these show some variation from the data presented in Figure 6, largely reflecting differences of interpretation and improved knowledge of the resource.

Despite such differences, the overall pattern of change throughout Europe is consistent and shocking: more than half of the countries in Europe have lost 90% or more of their original natural peatlands.

2.8 Land-use change and peatland conservation

Peatlands form where the natural conditions of landform, climate, geology and water create an environmental template that encourages peat formation. In other words, given such a template, the natural tendency for such areas will always be towards peat formation. This will change only if one or more of the template factors is altered. Three of the four key factors – landform, climate and geology – are not generally capable of being altered as part of a

Figure 6. The present extent of natural peatlands in Europe (data: H. Joosten). *The area of natural peatland is shown as a fraction of the original peatland area for each country.*



development proposal, which leaves water as the sole factor susceptible to significant manipulation. This explains, of course, why so much peatland development involves drainage.

However, the behaviour of water itself is largely controlled by climate, landform and geology. As a result, the potential for significant and sustained change in the water regime of a peatland is in fact constrained by these same unchangeable factors. The consequences for peatland development and nature conservation are profound.

In addition, peatlands provide a range of functions and services that are of considerable value (see Section 2.3). If these are lost, the cost of providing them by other means can be extremely expensive or even technically impossible. Here again, a significant part of the argument in favour of conserving peatland areas is based on the costs resulting from the loss of these natural functions and services, thus going well beyond the traditional view of conservation simply as a protector of wildlife.

The peat template and land-use change – the price to pay

In general, development proposals for peatland sites assume that it is possible to alter the basic environmental template sufficiently to transform the area into a non-peat-forming environment on a permanent basis. This is rarely the case. The peat-forming template is generally so dominant that any attempts to convert the land into another type of system will require constant and often substantial intervention. As soon as this input ceases, the land will tend to revert back to a peat-forming system. Indeed, in many cases, even with sustained and substantial input, the system will steadily revert or re-assert itself from time-to-time, sometimes with catastrophic results. Very considerable sums of money from public and private sources have been lost, and will continue to be lost, because this basic characteristic of peatland ecosystems is not sufficiently recognised. The cost may not be felt for one or two generations, but ultimately the price must be paid by someone.

Changing needs for peatlands in Europe

An important function of mires, which largely contributed to the preservation of some large undrained areas, was their defensive role. Thanks to their inaccessibility, the valley of the Biebrza river and part of the Narew river valley (NE Poland), until the 20th Century, almost constantly constituted borders of the influence of various nations (Jacvings, Polish, Russian, Prussian). This prevented the development of populated settlements in these areas and their intensive use. Indeed, in most parts of Europe, until the 20th Century, the countryside was made up of meadows, grazing land, arable land and outfields, forests and peatland. Fertile soil above the flood limit was the most intensively used and fertilised land, and there was forest on the less fertile land. Peatland was not used for any specific purpose because it could not be drained.

An early technological innovation was organic fertiliser, which enabled higher yields to be obtained with less effort. As a result, relatively small areas were fertilised at the cost of impoverishment of 60 to 90% of the land, leading to extensive areas of common land throughout Europe. When transport by wheel or by boat became possible, the distance to markets and the cost of transport became limiting. Intensive agricultural land-use thus became concentrated close to markets, whilst extensive forms of agriculture including trans-humance animal husbandry were found in the remote parts of Europe. This model was first described by the German economist Von Thünen (1783–1850).

The economic position in terms of market opportunities is indeed a clue to the reasons for development of waterlogged, inaccessible peatlands from war-preventing zones towards productive agricultural lands and sources of energy; drainage became a profitable option. Extensive drainage of peatlands, providing excellent yields of cereals and cheap energy for heating, began in the region between Antwerp and Amsterdam, which was a major trade area in the 17th Century. In fact, the enormous wealth of Holland in that era was founded on the availability of peatland in combination with the introduction of windmills. Despite water control using polder technology, subsidence could not be prevented entirely, and eventually cereals could no longer be cultivated and were replaced by cheap imports to Amsterdam from the Baltic countries. Peatland use then changed towards dairy production.

Over the last 50 years, space for urban development has been at a premium, so that areas with 10-metre peat layers have been developed for housing. Within the last 20 years, open space has become scarce and The Netherlands has focused on the environment. Indeed, environmental issues have become fundamental to the future economic development of The Netherlands; the national income will increase through conversion of agricultural land into nature and recreation areas. Thus, agricultural peatland in the polders is destined to be designated as “green space” or to be flooded for recreation and water control purposes and is not available for extraction. With the loss of the domestic peat supply, The Netherlands has become a major importer of Central European peat, particularly from the Baltics.

Although many people do not regard nature conservation as a land-use in the sense that agriculture, forestry or peat extraction are land-uses, it can nevertheless provide a basis for development (e.g. for tourism) or support development elsewhere (e.g. through natural flood control).

Nature conservation can thus be seen as a strategic approach to the use of land, based largely on a philosophy of working *with* the natural template rather than against it.

In principle, it seeks to minimise land-uses that are environmentally and financially unwise, and to promote forms of land-use that are sustainable and compatible with the natural characteristics of the environment.

It is the *prevention* of such potentially unwise land-use change – whether stimulated by subsidies, other financial incentives or expansionist policies within various land-uses – that forms the heart of most peatland conservation activity.

Adoption of this principle has important implications for the way that the peatland resource is conserved. In the traditional view of nature conservation, based on the protection of ‘special’ sites with little conservation action beyond these sites, there is an implicit assumption that all necessary aspects of biodiversity and function can be contained within a network of protected special sites. The usual result of this approach, however, is that those trying to conserve sites are obliged to justify the specific value of each site, while the logical conclusion is that all sites outside the network may eventually be destroyed. Considerable energy is spent arguing the relative value of individual sites, and this generally leaves little in the way of time or resources to argue for the maintenance of sites in the wider countryside.

In contrast, if conservation is instead seen as a strategic, sustainable approach to land-use, the debate shifts to one that considers all aspects of a proposed change to the use of a peatland site, including, for example, the cost-benefit of the proposed change. This definition of conservation shifts the onus of proof onto the developer. It thereby becomes incumbent on the developer to demonstrate that those responsible for the development scheme have considered not just the expected economic benefits, but also the relationship of the scheme to the environmental template and the natural characteristics of the site.

Instead of attempting to justify the selection and ‘protection’ of a particular site as a preserved specimen in a collection, **the wise use (including conservation) principle**[8] recognises that:

- ***all* peatland areas are important because of their characteristics and functions**
- **any proposal to change the current land-use should be subject to assessment** in terms of:
  - compatibility with the natural environmental template
  - compatibility with the natural characteristics of the site
  - off-site implications
  - full economic cost-benefit analysis.

Nonetheless, although in principle it is possible to regard conservation as a planning tool rather than as a land-use *per se*, the existing legacy of human impact means that it is possible to highlight a range of practical conservation activities that are now required to undo the damage resulting from the efforts of past and present land-use practices. These activities could be viewed as “nature conservation land-use” but are really no more than transient activities that will eventually be replaced by the dynamics and functions of the natural system as it recovers.

Thus, for example, a raised bog with an active drain cut across it will be undergoing slumping and oxidative wastage of the peat, which will affect the bog’s overall shape and character. By installing a series of dams along this drain, the water table can be encouraged to rise in the ditch and become relatively stagnant. In time it could be expected, on the basis of existing research evidence, that the drain will be colonised by bog vegetation and the site will begin to undergo increasingly self-induced recovery – e.g. growth of *Sphagnum* vegetation and re-establishment of a living surface layer (acrotelm) capable of forming peat.

By way of contrast, the abandonment of traditional land-uses in some peatlands – e.g. regularly-mown sedge beds and grazed floodplain valleys – means that nature conservation activities will need to duplicate these former land-uses in a type of ongoing conservation land-use, because normal farm economics can no longer support such activities.

Given the right social and economic structures, however, many of these activities could be reinstated as viable land-uses in their own right; so that the creation or maintenance of environmental value would be a consequence of, rather than the sole purpose of, human activity.

Sustainable land-use on peat soils – not just a modern idea. The unique approach of the Polish land reclamation authorities

In Poland, as in other countries of Central Europe, reclamation of wetlands for agriculture was part of the State’s economic policy between the 1950s and 1980s, and the majority of fens (as well as other wetlands) were drained. In contrast to the situation elsewhere, however, very few of Poland’s fens were converted into ploughed arable fields, thanks to the influence of Prof Henryk Okruszko of the Institute for Land Reclamation and Grassland Farming in Falenty. Long-term comparative experimental research on peat decomposition by Polish peat scientists, initiated before the Second World War, had shown that the rate of peat mineralisation is much higher under cropping than under grassland. On this basis Okruszko argued that, in order to minimise the loss of organic matter through mineralisation, peatlands should be used only as permanent grassland with moderate drainage. Despite international criticism, this approach to the management of peatland agriculture was adopted by the Polish Ministry of Agriculture.

In many cases, the principle was not implemented correctly. The main shortfall in practice was failure to maintain appropriate moisture conditions. Although most of the land reclamation projects included provision for both drainage and irrigation, the latter was usually neglected or destroyed. This caused extensive changes in the soils and plant communities of the majority of sites, reducing their value for both nature and agriculture. Nonetheless, in comparison with other countries of the region, Poland still retains a large number of meadow communities on peat soils, and many of them have high biodiversity value.

2.9 Restoration

There are two distinct approaches to the restoration of damaged natural habitats, namely renaturalisation and rehabilitation. Renaturalisation involves full restoration of all

8 See Joosten and Clarke (2002).

Restoration of the Yelnia peatland: a best-practice example from Belarus

In 2001 and 2002, the restoration of the Yelnia peatland was undertaken by the National Union "Birdlife Belarus" (APB), funded jointly by Wetlands International through the Global Peatland Initiative (GPI) and the Belarussian government. The 23,200 ha Hydrological Zakaznik (reserve) of National Importance at Yelnia was established in 1961. The protected area includes one of the largest bogs (19,984 ha) in Belarus – and indeed in Central Europe. It is an internationally Important Bird Area (IBA) and a potential Ramsar Site. The mire was under severe threat from drainage and ensuing fires.

The project's budget amounted to €33,500, and it aimed to improve the ecological situation by restoring the hydrological regime of the area and thus preventing the recurrence of fires. It focused on the construction of special dams to curtail excessive outflow of groundwater from the canals that cross the mire, and thus to raise the water table.

The restoration work followed a very detailed plan, and the target of damming 17 drainage channels was achieved. This proved to be highly effective in preventing the destructive fires that had previously swept across the area each year, and not a single fire was registered in Yelnia during 2001 and 2002.

Yelnia peatbog with drainage canals. Dam numbers correspond to those in the report.

Now that the hydrological damage has been repaired, it is expected that the flora and fauna of previously burned areas will recover their natural diversity in the foreseeable future; although complete recovery of the ecosystem will be a longer-term process.

An independent specialist review (N. Schaffer, RSPB) concluded that the restoration work had been very successful, and that this was an important demonstration project.

The project has been well documented. Financial administration and management were provided by UNDP. Ownership of the dams has been transferred from the Belarussian Ministry of Natural Resources and Environmental Protection to the Disna Forestry Agency, who will monitor and maintain them. The Ministry has also approved a ban on spring and autumn hunting of migratory waterfowl within the zakaznik.

the natural components of the ecosystem, together with their interactions and self-regulatory functions. This option is not always available. For example a worked-out peat deposit cannot be renaturalised because it is impossible to regenerate the peat that has been removed within the foreseeable future.

Unlike renaturalisation, the process of rehabilitation does not require restoration of all components of the initial system. The main aim is to restore the ability of the components to perform their ecological and economic functions. The most important objective of ecological rehabilitation is to restore the biological functions that ensure ecological stability, maintain environmental parameters, and support plant and animal variety (biodiversity) – for example reproductive capacity and preservation of the gene pool. In the course of ecological rehabilitation, economic functions may recover as the pertinent biological functions are restored. During the process of rehabilitation, it is acceptable for a new ecosystem type to replace the one that was destroyed. The main criteria are that its composition and structure should be capable of performing, as closely as possible, the same functions as the system that has been replaced; and that ecological character is restored.

2.10 International action: opportunities from a growing peatland awareness

2.10.1 Global environmental agreements

Several global agreements, conventions and directives have a significant bearing on current and potential future peatland conservation actions. Of these, the most important are:

- the *Ramsar Convention* which is concerned with the conservation and wise use of the world's wetlands
- the *Convention on Biological Diversity (CBD)* which commits contracting parties to maintaining and enhancing the natural biodiversity of their territories through a series of specific actions; and
- the *UN Framework Convention on Climate Change* (*UNFCCC*) and the associated *Kyoto Protocol* which are relevant to the peatland carbon store.

Additional biodiversity-related initiatives that are interlinked with the Ramsar Convention and CBD are:

- the *Convention on the Conservation of Migratory Species* of wild animals (*CMS*), also known as the

Bonn Convention, which is concerned with the conservation of wildlife and wildlife habitats on a global scale, aiming to conserve terrestrial, marine and avian migratory species
- the *Convention on International Trade in Endangered Species* of wild fauna and flora (*CITES*), which aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival; and
- the Convention Concerning the Protection of the World Cultural and Natural Heritage, also known as the *World Heritage Convention* (*WH*), which was adopted by the General Conference of UNESCO in 1972 and, with 170 countries as adherents, is one of the most universal international legal instruments for the protection of cultural and natural heritage.

Participation of the focal countries in these multilateral initiatives is summarised in Table 3. Five of the focal countries subscribe to all of these conventions. Belarus, Estonia and Ukraine are not involved in CMS and Lithuania subscribes to neither CMS nor CITES.

The Ramsar Convention

The CEPP focuses on the conservation of peatlands in Central Europe. It is supported at a broader scale by the Guidelines for Global Action on Peatlands (GGAP – see box), together with several associated commitments initiated and ultimately approved by the Contracting Parties to the Ramsar Convention. Many current peatland conservation initiatives stem from the sixth Ramsar Conference of Parties (CoP6) held in Brisbane in 1996, which acknowledged the significance of peatlands within the global wetland resource. Delegates to CoP6 also acknowledged that the programmes and actions of the Ramsar Convention had so far obviously failed to reflect this significance. Having recognised the urgent need to promote peatland conservation, the Ramsar Convention began the process of drafting a Global Action Plan for Peatlands (GAPP). This led to the development of several proposals designed to enhance peatland conservation, including an initiative from Wetlands International to promote peatland conservation action in Central Europe, which was later to become the CEPP.

The Ramsar Peatland Task Force Working Group subsequently developed specific guidelines for the identification and designation of peatlands as Ramsar Sites (Selection Guidelines for Peatlands Document 11), which were adopted at CoP8 in 2002. These aim to:

- highlight the importance of peatlands as important wetlands locally, regionally and globally
- advise contracting parties of the range of values that are unique to peatlands or to which peatlands are major contributors, and
- provide contracting parties with the tools to ensure that the Ramsar List reflects more closely the ecological character, extent and pattern of peatland distribution around the world.

Other Ramsar initiatives that may have a bearing on peatland conservation are the CoP8 Resolution VIII.3 on climate change, and CoP8 Doc. 14 relating to groundwater.

Guidelines for Global Action on Peatlands (GGAP)

During the 1990s a series of international meetings focused global attention on the urgent need for global action to encourage wise use and conservation of peatlands. These meetings included the 1994 Trondheim Meeting of International Mire Conservation Group (IMCG) and the 1997 Peatland Convention organised by the Scottish Wildlife Trust. Subsequently it has been recognised that peatlands are an under-represented wetland type on the list of Ramsar Sites. Through the Ramsar Convention, the co-operative efforts of governments, industry and NGOs have now developed the GGAP which focuses on wise use of peatland ecosystems, and was adopted at Ramsar CoP8 held in Spain in 2002 (Resolution VIII.17).

The vision statement of the GGAP is: “Recognition of the importance of peatlands to the maintenance of global diversity of ecosystems and species, the conservation of carbon vital to the world’s climate system, and the wise use, conservation and management of natural resources for the benefit of people and the natural environment.”

This statement is followed by eight themes to further its objectives with supporting action in each case:
1. Knowledge of Global Peatland Resources.
2. Peatland Education and Awareness.
3. Policy, Management Guidelines, and Legislative Instruments.
4. Wise Use of Peatlands.
5. Research Networks and Regional Centres of Expertise.
6. Institutional Capacity.
7. International Co-operation.
8. Implementation and Support.

The Central European Peatland Project can be viewed as a contribution to the GGAP, and in its strategy development attention has been given to all eight themes.

The GGAP will enhance awareness of peatlands and the importance of these ecosystems for a range of other important functions (hydrology, climate etc.). This has already led the IMCG and the International Peat Society (IPS) to collaborate on the publication of *Wise Use of Peatlands* (Joosten and Clarke 2002).

CBD and Agenda 21

The text of the *Convention on Biological Diversity* (CBD), also known as the *Rio Convention* (1992), was developed under the auspices of the United Nations Environment Programme (UNEP), and was opened for signature in June 1992 at the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro.

The objectives of the Convention are the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources. Within the European Union, the Natura 2000 network forms the EU’s contribution to biological diversity under CBD.

Various Articles within the CBD are of direct or potential relevance to the CEPP focal countries and their activities in conserving and restoring peatland ecosystems. These include:

- identification of sites possessing high diversity value, in terms of species assemblages, as staging-posts in migratory flyways, or on other natural or cultural grounds
- *in-situ* conservation of important areas and species, including (where necessary) the restoration of damaged systems
- use of incentive measures to encourage biodiversity-related actions
- encouragement of research and training
- promotion of public education and awareness
- impact assessment and minimisation of adverse impacts
- technical and scientific co-operation
- financial systems designed to support the goals of the Convention.

Agenda 21 recommends promotion of terrestrial and marine resource utilisation and appropriate land-use practices that contribute to reducing and/or limiting anthropogenic emissions of greenhouse gases. It promotes the sustainable management and co-operative conservation and enhancement of sinks and reservoirs of greenhouse gases, including biomass. It also points out that the loss of biological diversity may reduce the resilience of ecosystems to climatic variation and pollution damage. CBD and Ramsar have now established a (third) Joint Working Plan.

UNFCCC-Kyoto Protocol

Through the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol, efforts are under way to start controlling and reducing greenhouse gas emissions. On 9th May 1992, Parties signed the Convention, in which they stated their resolve that greenhouse gases should not exceed dangerous levels (see http://unfccc.int/). Article 4 states that Parties will:

"*Promote and co-operate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases not controlled by the Montreal Protocol in all relevant sectors, including the energy, transport, industry, agriculture, forestry and waste management sectors*".

No definition of "dangerous levels" was given, but this statement was important as a political signal; the greenhouse problem had become a political issue.

Various Conferences of the Parties (CoP) followed the UNFCCC, and the Kyoto Protocol was agreed at CoP4 in 1997. The Kyoto Protocol embodies the commitment of 38 industrialised countries to reduce their annual carbon dioxide emissions by 5% between 2008 and 2012, taking mean emissions in 1990 as the baseline.

The reduction of 5% is to be achieved either by limiting emissions, or by introducing measures to protect and enhance sinks and stores of greenhouse gases including "direct human-induced activities" that will sequester carbon within the biosphere. Prior to CoP4, storage in the biosphere was a much-debated but unresolved issue. There were three possible options for taking account of biospheric sinks in setting emission reduction targets: gross/net, gross/gross and net/net, where "gross" stands for emission and "net" stands for emission minus extra carbon stored in the biosphere. This was an important issue for timber-producing and peat-exploiting countries, who faced the risk that carbon released through peat or timber harvesting would become an additional negative term on their national carbon balance sheets. Moreover, the problems of accurate assessment of carbon reservoirs in the biosphere introduced many opportunities for loopholes which NGOs feared would be used to avoid taking action on CO_2 emissions. The compromise solution embodied in the Kyoto Protocol (Paragraph 3.3) is that stock changes resulting from direct human-induced activities since 1990 (i.e. afforestation, reforestation and deforestation – ARD) shall be *reported* by countries to meet their commitments in the period 2008–2012. However the principle that, where Annex I countries have initiated carbon emission taxes, sequestration should be rewarded at a similar rate, has been suggested.

Paragraphs 7 and 12 of the Protocol deal with the Joint Implementation and Clean Development Mechanisms, which introduce possibilities for Annex I countries to achieve their commitments through (forestry) projects in other countries. Subsequent developments have been rapid, and some countries have begun planting forests in order to produce "certified carbon". Agencies such as SGS Forestry – which has set up a Carbon Offset Verification (COV) service – issue the carbon certificates, and these are now being traded in clearing houses such as Lloyds of London. The carbon value thus placed on forestry is equivalent to €19 per cubic metre of wood; although it is speculative to expect that this type of "income" could replace revenue from timber harvesting in the future. It is clear that extra storage of carbon in biomass can offset only part of the annual combustion of fossil carbon (6GT)

Table 3. International conventions and memberships relevant to peatland protection in the focal countries.

Context				Global					European
	CBD	CITES	CMS	Ramsar	WH	UNFCCC	Kyoto	Bern Convention	EU accession imminent
Estonia	27/7-94	20/10-92		29/7-94	27/10-95	27/7-94	3/12-98	1/12-92	yes
Latvia	14/12-95	12/5-97	1/7-99	25/11-95	10/1-95	23/3-95	14/12-98	1/5-97	yes
Lithuania	1/2-96			20/12-93	31/3-92	24/3-95	21/9-98	1/1-97	yes
Poland	18/1-96	12/3-90	1/5-96	22/3-78	29/6-76	28/7-94	15/7-98	1/1-96	yes
Czech Republic	3/12-93	1/1-93	1/5-94	1/1-93	15/11-90	7/10-93	23/11-98	1/6-98	yes
Slovakia	25/8-94	1/1-93	1/3-95	1/1-93	15/11-90	25/8-94	26/2-99	1/1-97	yes
Ukraine	7/2-95	29/3-00	1/11-99	1/12-91	12/10-88	13/1-97	15/3-99	5/1-99	no
Belarus	8/9-93	10/8-95		25/8-91	12/11-88	11/5-00			no

The date on which each of the focal countries began to participate in each initiative is indicated, except in the case of EU membership, where the accession countries are distinguished.

and other human-induced carbon release (1–2 GT), but also that carbon trading has the potential to significantly affect forest management at global scale.

The conservation and protection of peatlands is a particularly important issue in terms of global carbon dynamics. The Intergovernmental Panel on Climate Change (IPCC) estimates that newly planted forest will accumulate carbon for 20–50 years (IPCC 2000), whereas certain peatland types, in the absence of major disturbance, are capable of accumulating and storing carbon for thousands of years, or even on geological timescales. The carbon now stored in the world's peatlands amounts to 3–3.5 times the volume of carbon stored in the world's tropical rainforests. If this carbon store, which has accumulated over many millennia, were to be destroyed and oxidised, the resulting volumes of carbon released could have a profound impact on the greenhouse process (Immirzi *et al*. 1992, Maltby and Proctor 1996; see also Section 2.4.2). Drained peatlands are already important sources of carbon dioxide, and the global rate of peat extraction is equivalent to around 200 million tonnes of carbon release per year. At current levels of use, the total annual CO_2 emission from peatland ecosystems around the world is estimated to be at least 225 million tonnes.

Although the Ramsar Guidelines for Global Action on Peatlands (GGAP) recommend that the carbon stored in peatlands should be used as an essential tool in reviewing and negotiating implementation of the Kyoto Protocol under the UNFCCC (GGAP 1.6 and 1.7), the UNFCCC has so far followed the pattern of history in failing to recognise the significance of peatlands in relation to climate change mitigation. However, the Parties are beginning to realise the potential importance of this omission, and some have begun to research it – for example, through the UNEP-GEF *Peatlands and Climate Change* project.

In due course, peatlands and peatland-related issues should be fully incorporated into the strategy of the UNFCCC. If, as seems logical, the carbon dynamics of peatlands are eventually accounted in the same way as those of forests for Kyoto Protocol purposes, the wise use of peatlands will increasingly be viewed in terms of its cost-benefit value to the climate change issue. This will provide additional incentives for countries to initiate large-scale peatland restoration programmes.

2.10.2 The European context

Of the eight focal countries, Poland, Estonia, the Czech Republic, Slovakia, Lithuania and Latvia are accession countries to the European Union (EU). The main opportunity for protection of peatlands that will result from accession will be through the Natura 2000 network. The EU Habitats and Species Directive imposes a range of obligations on Member States, one of which is the conservation "*in favourable condition*" of several peatland types found within Central Europe. However, the tendency of the EU Common Agricultural Policy (CAP) to encourage intensification of agriculture in Member States may give rise to increased pressure on certain peatland types in the accession countries. Other initiatives that potentially include peatlands are the Bern Convention, the Pan European Ecological Network (PEEN), the Pan European Biological and Landscape Diversity Strategy, the Water Framework Directive and the Sixth Framework Programme for Research and Technological Development.

The Bern Convention: the Convention on Conservation of European Wildlife and Natural Habitats (Council of Europe)

The Convention represents a common endeavour by European and African States as well as the European Community as a whole. All the focal countries are contracting parties. The objectives are twofold:

- to conserve wild flora and fauna and their natural habitats;
- to promote co-operation between states and to give particular emphasis to endangered and vulnerable species, including endangered and vulnerable migratory species.

In June 1989 the Standing Committee to the Bern Convention resolved to "set up a network (*EMERALD Network*) which would include Areas of Special Conservation Interest designated following recommendations". Recommendation No. 16 provides the basis for designating Areas of Special Conservation Interest, but the responsibility to designate such areas lies with the governments of the States concerned.

Areas protected under the Bern Convention as the Emerald Network will be transferred, at accession to the European Union, to the Natura 2000 Network of the Habitats Directive. Thus, the Emerald Network could be viewed as pre-Natura 2000 network in that the Habitats Directive is more legally binding on member states than is the Bern Convention.

EU-Natura 2000

Prior to EU accession, countries are required to identify areas for protection under the Natura 2000 regulations. Natura 2000 embraces the Habitats Directive (Council Directive 92/43/EEC) and the Birds Directive (Council Directive 79/409/EEC), and will establish a network of special areas designed to ensure that favourable conservation status is achieved for all of the EU's most threatened habitats, plants and animals.

Within the EU, much work has been done to develop a common parameter-based European habitat classification framework. The aim has been to develop a common language for the description of habitats throughout Europe, based on sound science with clear definitions and principles. Habitat classification in the accession countries should follow the EUNIS system, which is based on the Palaearctic habitat classification. Examination of the EUNIS classification in relation to peatlands makes it clear that it suffers from the same problems as virtually all attempts at regional or global descriptions of peatlands, as already discussed in Section 2.2 – namely, the lack of both an agreed and consistent set of terminology, and a coherent system of classification.

The scale of the resulting confusion can be judged by the fact that many peatland ecosystems lie outside the official EUNIS section "*D: Peatland, bog and fen habitats*". For example, in "*C: Inland surface waters habitats*" it is possible to find many peatland habitats, especially under "*C1: Surface standing waters*" *(e.g. peatmoss and* *bladderwort communities of oligotrophic (C1.1), mesotrophic (C1.2) and dystrophic (C1.4) waterbodies)*. Perhaps most remarkable of all is the fact that the bog pools found scattered across the deepest parts of a bog should be listed as an entirely separate habitat entity – "*C1.4 Raised bog pools and lagg*" – a type which surely should have been included in "*D1.1 raised bogs*". Meanwhile riverine and fen scrub are listed under "*F: Heathland, scrub and tundra habitats*", while swamp woodland is listed under "*G: Woodland and forest habitats and other wooded land*".

Oddities such as the separation of bog pools from their bogs can be explained by the fact that the EUNIS system is essentially a phytosociological approach, and the terrestrial parts of a bog lie in one phytosociological Class (Oxycocco-Sphagnetea), while the bog hollows belong to a completely different Class (Scheuchzerio-Caricetea fuscae). Although this is entirely logical and sensible in terms of plant sociology, it results in the separation of ecosystem components that have an intimate functional relationship. It is impossible to conserve one of them in isolation – both must be conserved as a functional entity. Other confusions and illogical dispersal of the peatland habitat across many different habitat types arise because the EUNIS classification uses tree species as major criteria for the classification key whereas the concepts of "peat" and peat formation are not used in the key at all. It is mentioned only under some specific peatland types. If peatlands had been accorded the same status as forest, the classification could have looked quite different, but then this consistent failure to acknowledge peatlands as a major habitat type is precisely why the GGAP seeks to bring about change in perceptions and actions concerning peatland ecosystems, specifically though its Theme 1 (*Knowledge of Global Peatland Resources*).

It is important that peatland links are clearly understood despite the confusion resulting from the EUNIS approach, because under Natura 2000 those habitats that are regarded as priorities within the EU may receive LIFE funding for, amongst other things, management plans. Several peatland types are recognised as having such *priority status*, including *active raised bogs*, *active blanket bogs*, and *bog hollows*. Indeed, considerable opportunity exists within the Natura 2000 programme for financial support linked to a wide range of other mechanisms to promote the conservation of peatlands within accession countries. Peatlands under agricultural uses may also be entitled to funding through European Union Common Agricultural Policy (CAP) agri-environment measures.

The EU Water Framework Directive

Adopted on 23rd October 2000, the EU water Framework Directive's purpose (as stated under Article 1) is to "…establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater" which:

(a) prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems
(b) promotes sustainable water use based on a long-term protection of available water resources; and
(c) contributes to the mitigating effects of floods and droughts

(*Only the most relevant sub-clauses are cited here*).

The Directive is to be implemented using river basins as the basic administrative unit, and a classification based on water quantity and quality to establish the character and status of water bodies. This information is to form the basis of decisions concerning water management that meet the more specific requirements of the Directive and others which now fall under the umbrella of this framework (e.g. the EU Nitrates Directive).

The degree to which peatlands are to be included within this rather broad Directive is difficult to ascertain because it does not deal specifically with non-aquatic and non-terrestrial ecosystems, and implementation in current EU States is still at an early stage. The degree to which peatlands will or should be included under the provisions of the Directive is currently a matter for interpretation, although there is considerable scope for this.

The most powerful argument that peatlands should be included in actions under this Directive is found in the provisions for groundwater. Groundwater is defined as "all water below the surface of the ground, in the saturation zone and in direct contact with the ground or subsoil". A body of groundwater is a distinct volume of groundwater within an aquifer or aquifers; and an aquifer is a subsurface layer or layers of geological strata of sufficient porosity and permeability to allow a significant flow of groundwater (Article 2; 2,11,12). Assuming that peatlands can be regarded as 'geological strata' (as is common practice amongst geologists), then it is reasonable to assume that peatlands should be covered by the Directive.

Assuming that this logic is accepted, there is a range of implications for peatlands. Articles of the Directive require that, in compiling river basin management plans, the locations and boundaries of all groundwaters (and therefore peatlands) be mapped and that the impact of human activity on their status should be assessed. This could lead to extensive monitoring of water level regimes in peat aquifers; inclusion of summaries of drainage, peat extraction and forestry on peat within river basin management plans; and the implementation of measures to prevent further ditching and peat cutting.

Since the linkages between peatlands and the satisfactory implementation of the legislation may not be immediately obvious to non-specialists, it will be important that the agencies responsible for integrating the Water Framework Directive into the national legislation of accession countries are made aware of the rationale for inclusion of peatlands.

EU-CAP; Common Agricultural Policy, Agri-environment measures

Under the EU Common Agricultural Policy (CAP, Regulation (EEC) No 2080/92), measures have been taken to promote farming practices that maintain biodiversity and reduce the negative pressure of farming on the environment (EC 1998). These agri-environment measures are likely to form an increasingly significant part of the EU-CAP in the future, as the EU struggles to balance mechanisms designed to reduce over-production against the pressing social need to maintain rural communities.

The availability of EU-CAP subsidies for planting on meadow and permanent grassland may inadvertently encourage forestry on peatland soils that have already been drained. Indeed, there is already ample evidence of the potential problems. More than half a million hectares were afforested throughout the European Union between 1993 and 1997. Of this area, 60% was permanent pasture and meadow – the very same ecosystems whose conservation is the subject of another part of the same policy. On the other hand, the agri-environment measures available within the CAP may also provide real opportunities for areas that are in need of conservation management – or at least management that is sympathetic to the needs of conservation. Both Natura 2000 and the Agri-Environment Programme are initiatives created by the EU to support and implement the Convention on Biological Diversity (CBD, or the Rio Convention). There are thus fundamental cross-linkages between these various initiatives. It is important to recognise these links because actions that follow only the letter of each of the various initiatives individually, rather than acknowledging the spirit of the complete inter-linked package, are unlikely to achieve the targets set for any one of these initiatives. This type of approach is promoted by Ramsar Resolution *VIII.34* (CoP8, 2002) on "agriculture, wetlands and water resource management", which urges Parties to "identify and enhance positive incentives for the conservation and sustainable use of wetlands, including sustainable agricultural systems related to these wetlands".

The 2001 outbreak of foot-and-mouth disease, coming so soon after the BSE crisis, and before that the economic burden and political embarrassment of over-production, has led to increasing signs within the European Commission and the European Parliament that a radical re-think is needed in relation to the CAP, and perhaps to agricultural practices generally, throughout Europe. Such a re-think is more likely to be positive than negative in terms of environmental thinking and support for environmentally sustainable practices in the future structure and mechanisms of the CAP. Intensification is now being seriously questioned as the long-term future for agriculture. Indeed, the question that is now becoming prominent in political debate is whether food production should continue to be seen as the major land-use of the countryside.

Agri-environment schemes (AES), based on Regulation 1257/99, represent an important source of revenue for farming that takes account of nature. However, circumstances in existing Member States offer only limited opportunities for AES to be combined with the requirements of nature protection directives (e.g. the Habitats and Birds Directives). In Central and Eastern Europe, on the other hand, it is likely that extensive areas of land that is used for (low-intensity) agriculture will be incorporated into Natura 2000 sites. At these locations, properly designed AES could be appropriate instruments for the conservation of whole peatland ecosystems as hydrological units, and of species-rich fen meadows whose conservation value persists only under extensive agricultural management. The key to success would lie in designing appropriate AES. This may fall within the remit of the Special Accession Programme for Agriculture and Rural Development (SAPARD), but since it is now very late to begin new SAPARD projects, it might be more realistic to set-up a "stand-alone" project which could involve most of the EU accession countries.

The EU Sixth Framework Programme

The EU Sixth Framework Programme for Research and Technological Development (FP6) was established principally to integrate and strengthen European Research. The programme is divided into thematic areas. The strategy and activities in this report seem to fit best within Thematic Area Six "Sustainable Development, Global Change and Ecosystems", in particular the sub-priority "Global Change and Ecosystems".

The Global Change and Ecosystems sub-priority addresses seven areas, including the following:

1. impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks
2. water cycle, including soil-related aspects
3. biodiversity and ecosystems
4. mechanisms of desertification and natural disasters
5. strategies for sustainable land management, including coastal zones, agricultural land and forests
6. operational forecasting and modelling including global climatic change observation systems; and
7. complementary research.

In the Work Programme for this sub-priority, it is stated that:

"*Global change can exert severe impacts on the ecology of aquatic and wetland ecosystems, on the filter and transport functions of soils and on water quality. Assessments of these changes requires a better understanding of the consequences of major hydrological changes, to identify and quantify the key biogeochemical processes and to predict the consequences of global change at different scales. The integrated management of soil-water systems requires a detailed understanding of the properties and the functional role of soils, and the behaviour and fate of pollutants, in order to allow the development of risk-based management approaches. The research will focus on impacts of global change on the ecology of surface water bodies, and on water-soil system functioning and management.*"

Wetlands are also the focus of a Specific Support Action: "***Consolidating knowledge on the role of wetlands in the water cycle.*** *There is a need to synthesise the results of concluded and on-going research activities, both at European and national level, for giving guidance on the hydrological, ecological and socio-economic role of wetlands.*"

These topics are highly relevant to peatlands, and since countries and international organisations may take part in all activities under this thematic research sub-priority, the EU Sixth Framework could be a useful instrument for furthering peatland research as promoted by this report.

3. The peatlands of Central Europe: regional overview

This Section reviews current knowledge of the peatland resource of the Central European region, and compiles a "best-possible" regional overview of its extent, characteristics and condition. The overview has been prepared from three types of information. First, available spatial data on the peatlands of the eight focal countries have been drawn together into a single GIS database and this has been used to construct maps showing the distribution of peatlands across the region. Secondly, various types of information were obtained from published literature and from sources in the target countries. Finally, certain standardised information has been taken from the written accounts prepared by national co-ordinators for their respective countries.

3.1 The Baltic-Black Sea Corridor: regional context of the CEPP

The eight countries involved in the CEPP (Figure 7) occupy a discrete geographical feature within Europe. Much of Western Europe is strongly deformed by tectonic activity caused by movement of the African continental plate northwards against the Eurasian plate. In other parts of Western Europe other periods of uplift or volcanic activity have also contributed to the highly varied and undulating terrain. This has given rise to such dramatic features as the Alps, the Balkans and the Pyrenees. One of the most striking features of Europe, however, and in complete contrast to such geomorphological upheavals, is the Eastern European Plain. In effect, it forms a wide, low-lying corridor that connects the Baltic basin with the Black Sea basin.

The Baltic-Black Sea Corridor is between 600 km and 800 km wide and approximately 1,500 km long. The major part of this feature lies below 150 m a.s.l., interrupted only by the narrow band of central Belarussian uplands, which rise to less than 350 m. The corridor is bounded to the east by the Central Russian Uplands and to the west by the Carpathians, the Sudetes and the northern European Highlands. A large proportion of the corridor forms the drainage basin for the Dniepr River. North of the Belarussian watershed, much of the area forms the catchment for the Daugada.

Although the CEPP countries do not extend into the eastern margins of the corridor, a significant part of the western margin of the CEPP territory contains substantial parts of the boundary watersheds. Ukraine and Slovakia between them include much of the northern Carpathians, with Slovakia extending across the watershed divide so far that it includes the northern fringes of the Pannonian Plain. The Czech Republic consists entirely of the Sudetes and Bohemian Forest mountain ranges, together with the Bohemian Basin that lies within the embrace of these two massifs.

Nonetheless, whatever proportion of actual watershed boundaries are included, there is no doubt that the territory of the CEPP programme involves a very large part of the Baltic-Black Sea Corridor (except e.g. Romania and Bulgaria). The fact that this landscape feature has such relatively limited topographic variability leads to two further important characteristics of relevance to the CEPP strategy. Firstly, provided enough water is available through rainfall and surface or groundwater supplies, such a flat landscape is extremely conducive to peatland development. Secondly, the very flatness and relative uniformity of the terrain means that the variety of biogeographical conditions which occur here is likely to be limited – at least when compared to the complexity found across Western Europe.

The sheer size of the area addressed by the CEPP programme to some extent mitigates against the apparent uniformity of the region, because the effects of both latitude and longitude have an opportunity to play a significant part across such a large territory. An overview of this effect can be obtained from maps of potential vegetation, which illustrate the fact that the CEPP territory extends from the southern taiga zone of Estonia in the north, to sub-Mediterranean conditions along the southern shores of the Crimea in the south. There is also a clear longitudinal gradient of oceanicity-continentality, extending from the western nemoral conditions of the Polish coastal plain to the eastern continental steppe conditions of southeast Ukraine. Inclusion of the watersheds themselves along the western margin of the CEPP territory also means that the altitudinal range within the territory extends from sea level along the Baltic and Black Sea coasts, up to alpine regions of more than 2,500 m within the Tatras Mountains of the northern Carpathians. On the basis of these trends, 43 possible biogeographical areas can be distinguished, and these correspond fairly well with national mire region maps where these are available (Appendix 2).

Figure 7. Boundaries of the eight focal countries.

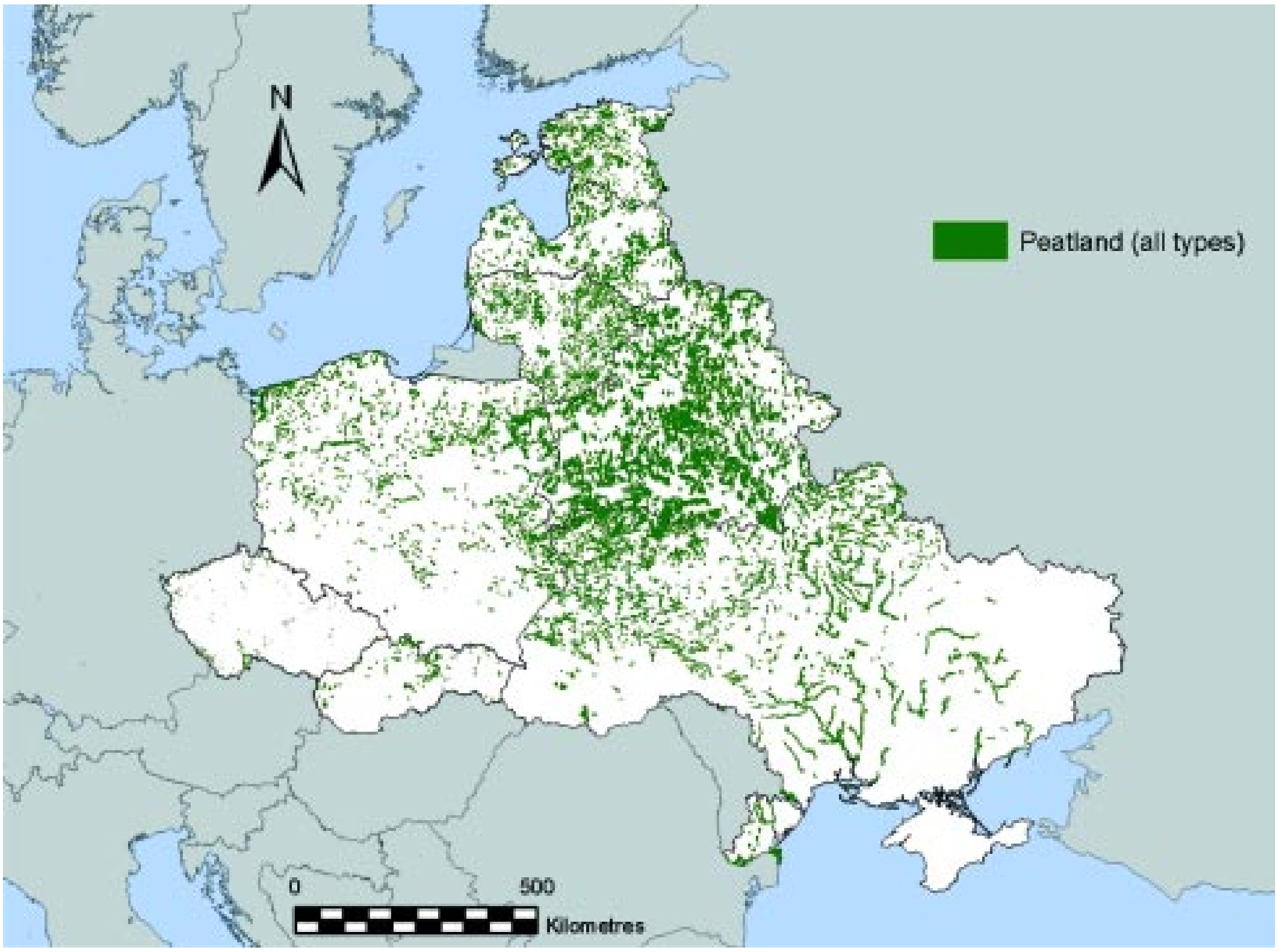
3.2 The extent and condition of the peatland resource

3.2.1. Extent and biogeography

Natural peatlands include some of the last wilderness of Europe and of the world. At global level, their limited accessibility has long protected them from human intervention. Agriculture, forestry, and peat extraction have, however, damaged 20% so severely that they no longer accumulate peat. By contrast, in Europe the long history, high population pressure, and climatic suitability for agriculture have made it the continent with the largest losses of natural peatlands. Here, peat accumulation is believed to have ceased on some 60% of the original 50 million hectares of mires, and an estimated 10–20% of this area is no longer peat-covered (Joosten 1999). However, such assessments have been made on the basis of incomplete data, and are biased towards Western Europe. Now, for the first time, it is possible to begin to assess the status of peatlands in the Baltic-Black Sea corridor as a separate geographical unit. At the outset of the project, the intention was to obtain comparable data on the extent and status of peatlands from existing national archives within each of the participating countries, and to use this information to assemble a coherent regional overview. The data were collected, converted as necessary to GIS format, and various regional analyses attempted. However, the most striking outcome of this exercise was that it demonstrated significant differences between countries in the types of data available (Appendix 3). The internal consistency of the combined dataset is, therefore, rather limited, and it must be interpreted with care. Accordingly, although the GIS data have been used to prepare indicative maps of peatland distribution across the region, summary information on the extent and quality of the resource have been obtained separately for individual countries. These data can be found in Appendix 4, and form the basis for most of the analyses that follow in this Section and in Section 5.

Figure 8 shows the result of combining all the GIS data to give an indicative map of the extent of peatland across the region. The estimated area of peatland in each country is shown in Table 4, and the total of the national estimates indicates that just over 5% of the focal area is peat-covered. Table 4 also confirms the northern concentration of the resource, especially in Estonia and Belarus, and its rarity in the southernmost countries (Czechia, Slovakia and Ukraine), as indicated by Figure 8. Figure 9 and Table 5 give a preliminary overview of peatland types, derived from the GIS data. For most countries, the areas recorded as bog, transitional mire and fen are the remaining near-natural peatlands (mires) only, and therefore account for only part of the peatland area given in Table 4. For Lithuania and Czechia, however, all peatlands – whether or not they are still in near-natural condition – have been assigned to mire type classes within those countries' national datasets.

Figure 8. Extent of peatland in the eight focal countries.



Nonetheless, these data give a broad overview of the relative abundance of bog, transitional mire and fen within the focal area. Overall, fen is by far the most widespread mire type within the region; fens occur not only as large ecosytems in their own right, but also as components of bog systems in the northern parts of the region. Towards the south, and especially in the more continental steppe climate-zone of southern Ukraine, fens become more markedly associated with major watercourses and take on strikingly sinuous, linear characters. Belarus is clearly the centre of distribution of mires as a whole within the CEPP region, but here the fens are of a less confined nature, spreading extensively across the flat landscape. Although bogs are found in all eight CEPP countries, and in many of them are scattered throughout the country, there is a marked gradient that runs from the north – where bogs are both abundant and extensive, to the south and east – where bogs become quite rare.

3.2.2 Cultural use and condition

Peatlands in Central Europe have been developed principally for *in situ* use of the peat for agriculture and forestry, and for peat extraction.

The most widespread human land-use on peatlands is agriculture. This type of use tends to be concentrated on fens because they are less acid and have higher nutrient status than bogs. The intensity of agricultural use ranges from the intensive cropping with continuous drainage now familiar in Western Europe, to long-established "traditional" grazing and mowing of the natural vegetation. Under natural conditions, vegetation succession occurs on fens so that sites representing earlier successional stages are gradually lost. Since intensive land-use now precludes *de novo* origin of peatlands, this natural succession represents a threat to peatland diversity. The extensive agricultural management of fens as pastures and hay meadows that has been carried out for centuries involves mowing and grazing which halts natural succession, creating stable systems with high biodiversity value. Recent economic and social changes in Central Europe have rendered this type of farming unprofitable, leading to abandonment of pastures and meadows and thus to rapid disappearance of their typical plant species. Therefore, agricultural abandonment constitutes a threat to the biodiversity values represented in semi-natural peatland systems, and these urgently require active traditional management as a conservation measure.

In the Biebrza Mires (NE Poland), where a large population of ruff *Philomachus pugnax* used to nest in sedge moss fens, abandonment of mowing led to the complete disappearance of these birds within 20–30 years. Similarly, spontaneous succession of sedge fens after cessation of mowing may lead to a losss of suitable habitats for the vulnerable aquatic warbler *Acrocephalus paludicola* in Belarus.

On the other hand, more intensive agriculture and forestry involving drainage and ploughing followed by crop growing and/or arable farming results in subsidence and oxidation of peat that can amount to several centimetres per year in the drier climates of Central Europe. The associated lowering of the ground surface renders drainage progressively more difficult and expensive, and if drainage can be continued the peat may disappear within a few decades.

In Poland, agriculture (with ploughing) is not considered to be consistent with wise use of peatland because of the accompanying subsidence and mineralisation of peat. At present, 70% of Polish peatlands are used as grasslands and lack of management of the most valuable of these areas constitutes the major threat to fen peatlands, whilst peat extraction is the major threat to bogs.

Development for forestry has occurred mostly since 1950. Opening up of new peatland areas for forestry is now unlikely because wood production has proved to be uneconomic due to waterlogging and technical problems.

Table 4. **The extent of peatland in each of the focal countries, arranged in descending order of percentage peat cover.**

Country	Country area (ha)	Peatland area (ha)	% of country area
Estonia	4,522,700	1,009,100	22.3
Belarus	20,760,000	2,939,000	14.2
Latvia	6,463,500	672,204	10.4
Lithuania	6,530,000	352,000	5.4
Poland	31,268,000	1,254,800	4.0
Ukraine	60,355,000	1,000,000	1.7
Slovakia	4,903,600	26,000	0.5
Czechia	7,886,400	27,000	0.3
Total	**142,689,200**	**7,280,104**	**5.1**

These data are best estimates from each country of the national total area of peatland, including natural peatlands (mires) and peatlands that are used for all other purposes including agriculture and peat extraction.

Table 5. **Estimates of the extent of bog, transition mire and fen within each country and for the Central European region as a whole, derived from the GIS data.**

	Areas (ha)				% of total area		
	Bog	Transition mire	Fen	**Total**	Bog	Transition mire	Fen
Estonia	93,000	36,000	171,000	300,000	31.0	12.0	57.0
Belarus	258,299	123,573	1,494,852	1,876,724	13.8	6.6	79.7
Latvia	133,019	28,504	155,189	316,712	42.0	9.0	49.0
Lithuania*	77,440	24,640	249,920	352,000	22.0	7.0	71.0
Poland	8,885	6,664	186,591	202,140	4.4	3.3	92.3
Ukraine	4,759	7,701	567,539	580,000	0.8	1.3	97.9
Slovakia	157	580	1,839	2,575	6.1	22.5	71.4
Czechia*	15,500		11,500	27,000	57.4		42.6
Totals	**591,059**	**227,662**	**2,838,429**	**3,657,151**	**16.2**	**6.2**	**77.6**

* These data refer to the entire national peatland resource, whatever its condition; for all other countries, the data presented here indicate only surviving mires. See text and Appendix 3 for additional information on data sources and quality.

In the 1960s and 1970s, shallow drainage channels were dug in large areas of peatland forest in Belarus in order to enhance timber production. The drainage caused accelerated mineralisation of the surface peat and increased availability of nutrients to the vegetation. Accelerated growth of the trees was achieved until the additional nutrient source was exhausted, after 5–7 years. The soil water regime recovered gradually over approximately 15 years. Amelioration of peatland forest by drainage is no longer practised in Belarus.

The principal uses of extracted peat are in agriculture and horticulture, and as fuel. The large-scale agriculture of the Soviet period consumed significant quantities of peat for soil conditioning. Although this use declined sharply after 1989, a new and international market was already available for slightly humified *Sphagnum* peat to support the expansion of gardening and horticulture throughout Europe. Peat from Estonia and Lithuania in particular has been diverted to meet this demand, but no data are available on the resulting impacts on the peatlands of these countries.

The international peat trade deals almost exclusively in peat for horticultural purposes. A central issue is the imbalance between peat accumulation and peat extraction; the global peatland carbon balance is shifting towards increasing net emissions. Declining domestic peat resources in Western Europe and political changes in central and Eastern Europe have resulted in a rapid increase in exports of horticultural peat from the former Soviet Union, and especially from the Baltic countries. In 1992, sales of peat products in the European Union and its applicant countries exceeded ECU 700 million, and direct employment was over 10,000 person years. The Netherlands, which has lost almost 100% of its own peatland resources, is now the biggest peat trader in Europe. This international trade, which promotes concentration of peat extraction near markets and transport, may seriously interfere with the conservation of peatlands (Joosten 1995).

In future, the demand for both horticultural and fuel peat is expected to fall (for both practical and environmental reasons) in favour of alternatives.

Plate 6. *Traditional haymaking in Ukraine.*

Grigoriy Parchuk

Peat-free targets for the UK
At a conference in the north of England during the summer of 2002, the UK Environment Minister acknowledged that demand for growing media continues to rise, and thus that the use of both peat and other growing media is increasing rather than decreasing in the UK. Nevertheless, he re-affirmed the UK Government's commitment to peat-free targets, and emphasised that these targets had three objectives: firstly to protect a habitat of European importance; secondly to help solve UK waste management problems; and thirdly, to ensure that the problem of peat extraction is not simply exported to other countries – as may be happening at present.

No new mire areas for peat extraction in Latvia
The Latvian Strategy for Mire Conservation (approved in 2000) is part of the National Programme for Biodiversity. It includes a statement that no new sites can be opened for peat extraction. There are already many peatlands for which peat excavation has been planned but not completed, and peat extraction is to be carried out only on these sites. There are no plans for peat extraction on the remaining natural peatlands.

However, some western and Central European countries appear, in practice, still to be working against this trend. For example, Estonia, Lithuania and Ukraine have announced plans to increase their usage of fuel peat; whilst the horticultural market in Western Europe (including Britain, despite the Environment Minister’s words reported above) appears now to be actively promoting large-scale extraction of Central European peat.

Of the three Baltic Countries, **Lithuania** has the least wetlands and the smallest resources of peat, but the heaviest pressure on peatlands. Peat extraction is a major threat. More than 60% of the total mineable area has been prepared for peat extraction or is currently being cut. In 1998 more than 1,000 ha of peatland protected by the Law on Protected Areas were extracted. In 1999 the government decided to close the first reactor of Ignalina nuclear power plant before 2005 (although the second reactor will remain in service). This decision indicates an intention gradually to reduce nuclear energy generation in Lithuania. It will inevitably promote a search for new energy sources and also increase the usage of local fuel resources including peat. The Lithuanian Energy Law regards peat as a primary energy source, and favours the extraction of peat for fuel. Peat is also identified as biomass, and thus as a renewable energy source, by the same law.

In **Estonia** a loan from the World Bank has financed conversion of several municipal power supply plants to run on local fuels (peat and wood) instead of heavy oil and natural gas imported from Russia. This activity forms part of the new State energy programme, which aims to increase the contribution of peat to the energy budget from 2.6% to at least 5–6%, consuming approximately 5 million tonnes per year. However, a condition imposed by the World Bank is that the peat is to be extracted principally from drained peatlands and existing milled-peat fields.

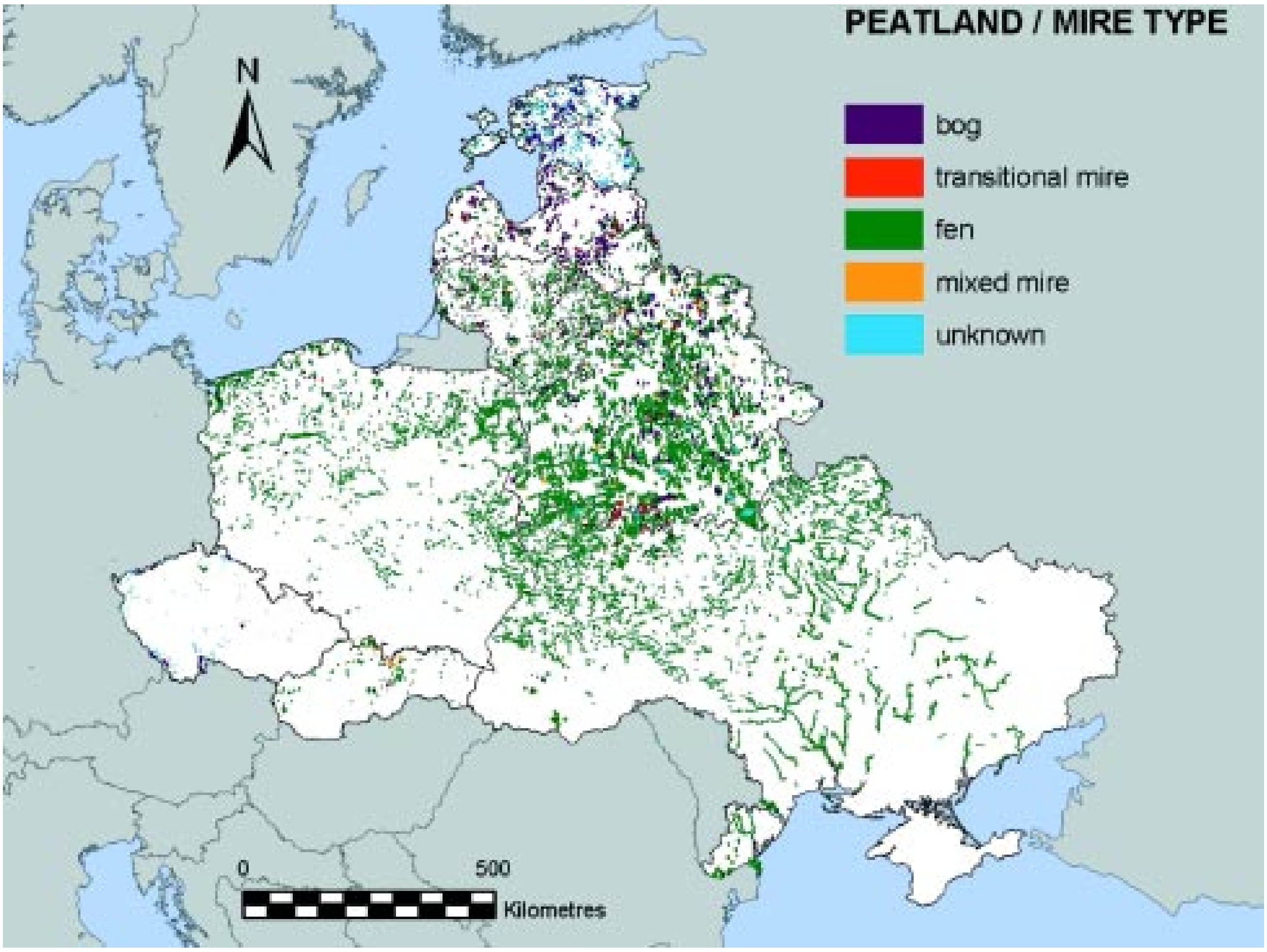


Figure 9. Peatland types in the focal countries.

In June 2003, about 60% of the 1.5 million tonnes (6 million m^3) of peat extracted annually from **Estonian** peatlands was reported to be destined for the horticultural market in Western Europe (principally The Netherlands, Germany and the UK), "a good percentage of it for nice British gardens". Moreover, the Estonian Peat Association is welcoming the "queue of foreign companies" investing in their 26 members' shares, which will enable them to obtain machinery to begin large-scale peat extraction (Brown 2003).

The first shock waves resulting from industrial expansion eastwards are already being felt in Estonia. On the one hand, Estonian peat extraction companies are enjoying considerable injections of hard currency through heavy investments from their western counterparts. On the other hand, increasing disquiet is being expressed by scientists, church leaders and politicians at the prospect of large-scale destruction of the bogs that form such a distinctive part of Estonia's natural heritage. Already, echoes of the early phases of the UK Peat Campaign can be seen here. An article published by the UK newspaper *The Guardian* (Brown 2003) presents both sides of the argument that is currently gathering momentum, whilst at the same time emphasising to British gardeners the impact that their purchases are having on Estonian wildlife. The current situation in Estonia, and the views increasingly being expressed by both sides in the debate, have all the makings of a major issue that is likely to draw in planners, politicians, scientists, developers and the public, in much the same way as happened in the UK during the 1990s.

Other local uses of peat and peatlands include the creation of fishponds in Poland, and extraction for medical purposes (balneology) in the Czech Republic.

Fishponds: threats change over time
In the Czech Republic, mires have developed in some of the large fishponds that were excavated in Mediaeval times. Although excavation of the fishponds may originally have destroyed vast areas of peatland, fishpond mires are now threatened by acidification. In Poland, on the other hand, creation of fishponds currently poses a threat to peatlands. So whilst Polish peatlands are threatened by excavation of fishponds, peatlands in naturalised Czech fishponds are threatened by air pollution.

Various types of pollution affect peatlands. The traditional perception of peatland as waste ground has led to their use as dumps for garbage and sewage, introducing local pollution. On the other hand, air pollution may give rise to widespread vegetation change. Heavy metals, acidification and nitrogen deposition will influence practically all ecosystems to some degree, but bogs and fens are amongst the most sensitive. For example, long-term changes in species composition on bogs are to be anticipated on the exceeding of critical loads of nitrogen in the range 5–10 kg N ha^{-1} y^{-1} (UN ECE Convention on Long-range Transboundary Air Pollution (UN ECE-LRTAP) (Werner and Spranger 1996).

In some parts of **Estonia**, peatlands are used as garbage dumps, while more than 3,000 ha of peatland has disappeared due to urban development, mainly near Tallinn. Another 2,000 ha have already been destroyed as a result of opencast mining of oil shale in northeastern Estonia, and destruction continues at the rate of 100 ha per year. A special problem arises within a 30 km radius of the associated power plants, which emit flue gas containing calcium-rich alkaline compounds. Deposition of the calcium on peatlands causes disappearance of Sphagnum, arresting peat accumulation and promoting decomposition.

In recent decades, the impact of heavy deposition of airborne acidifying pollutants on **Czech** mires has become apparent. The shift in chemical environment caused by excessive nutrient inputs (e.g. NOx and lime) and by airborne acidifying pollutants has been followed by invasions of non-indigenous species.

In May each year, the fish farm "Selets" releases vast amounts of water into the river Jaselda near Bereoza in **Belarus**. At this time of year the aquatic warbler *Acrocephalus paludicola* is already nesting in the Jaselda flood plain, and nearly all the nests are destroyed by the flush of highly eutrophicated water.

Special mention must be made of the after-effects of the 1986 Chernobyl accident on peatlands. Around half of the 40,000 km^2 area that was significantly contaminated with nuclear fallout is occupied by woods, meadows and mires. Whilst adverse effects of radioactivity on the flora and fauna have been reported, the subsequent lack of human activity in the exclusion zones, especially in Ukraine and Belarus, might be considered beneficial to the previously over-exploited peatlands. However, the radioactivity that was initially absorbed by the vegetation continues to cause problems. Caesium-137 (^{137}Cs, which has a half-life of 30 years) is held immobile in soils containing clay or sand, but remains highly mobile in acid peats. Here, the radionuclide moves from the rooting zone into the foliage of plants and thence into the digestive systems of herbivores such as sheep and reindeer, then passes back into the soil as dung, so that it is continuously recycled.

Thus, birds and other animals feeding on vegetation in the Chernobyl exclusion zones continue to be highly contaminated with radioactivity, and can transport the contaminants to other areas. Moreover, drained peatland and abandoned peat workings frequently catch fire, and the fires release radioactive smoke and dust into the atmosphere.

Effects over a much wider area within Europe that can be specifically associated with peat are vividly illustrated by the continuing problems in the UK. When the Chernobyl accident occurred in 1986, the UK Government forbade the movement or sale of livestock in those areas of England, Scotland and Wales that were affected by fallout. This restriction applied to 8,900 farms and affected 4.25 million sheep, but it was anticipated that the restrictions would be in place for only a short time, until the ^{137}Cs became bound to the soil matrix. This did indeed happen in many places, but levels remained dangerously

Plate 7. *Exploitation of peat in Ukraine.*

Grigoriy Parchuk

high for much longer than anticipated in areas with peat-dominated soils. The legal limit of radioactivity for a carcase entering the human food chain is 1,000 Bq kg^{-1}. This level is still exceeded, almost 30 years later, by 230,000 sheep on 388 farms with peat soils in northwest England, north Wales and southern Scotland (Food Standards Agency, 2000). Officials say that they expect such restrictions to remain in place for a further 10–15 years.

Perhaps the last word on this should go to Ned Williams, who farms near Trawsfynydd in North Wales: "The professors who should know said that it would all be washed away in about six weeks. But the radiation is still here, all these years later – so that shows you how much they know about it." (BBC web-site)

In the Chernobyl 30-km exclusion zone, peatlands are the most heavily contaminated habitats, due to the combination of runoff convergence in mires with the process of peat formation. Despite the recycling problem, some radioactive material is incorporated into the peat layer, and will eventually be buried by newly formed peat, although the plant-rooting layer (20–60 cm thick) will not be clear of the radioactive peat for 400–1,200 years. Thus, in the long term, peatlands can be expected to perform a cleaning function by accumulating radioactivity in the peat layers. In the absence of human interference, beaver dams have been instrumental in promoting new peat formation and thus in accelerating the cleaning process.

Scientists have recommended active blocking of ditches in order to promote peat accumulation on previously drained peatlands, thus establishing these areas as additional depots for radioactivity. However, further research on the ability of peat to "clean" or rehabilitate nature after radioactive pollution is needed.

In order to conduct a spatial assessment of the intensity of human activities on peatlands in Central Europe, quantitative information on land-uses was sought from each of the focal countries. This proved, however, to be generally unavailable. The extent of agricultural use is known only for Belarus, Slovakia and Lithuania; and of forestry for only the first two of these countries (Appendix 3). Peat extraction is more widely recorded, although no information was forthcoming from the Czech Republic, Latvia and Poland. Unfortunately none of the data supplied were sufficiently compatible to enable comparison between countries. Consequently, in order to arrive at a regional assessment of peatland use, it was necessary to adopt an alternative approach. Estimates were requested for the original extent of mire, and of the area that now remains in near-natural condition, within each country.

Estimates of the original mire area are included within each of the national accounts given in Section 4. For most countries, the original extent of mire is assumed to be equal to the present area of peat soil. The exceptions are Lithuania, the Czech Republic and Slovakia. For Lithuania, an estimate made in 1953 exceeds the present area of peat soil, suggesting that 27% of the 1953 resource has now completely disappeared; whilst for the Czech Republic, 33% of the roughly estimated original mire area appears no longer to retain any peat soil. For Slovakia, the only means available for estimating the original mire area is through modelling (Section 4.7). Therefore, the Slovakian model estimate has been combined with the peat soil areas reported by the remaining seven countries[9] to give a "best conservative estimate" of the original mire area within the CEPP region.

National interpretations of the term "near-natural condition" varied widely. Whilst Estonia returned data on only untouched virgin areas, the Latvian estimate represented the area where peat-forming conditions prevail. Elsewhere, areas with enhanced biodiversity associated with low-intensity agricultural management were included. The resulting estimates of near-natural peatland area (Table 6) are, therefore, inconsistent between countries. Comparison of the mire areas given in Table 6 with those in Table 7 (which were derived from the GIS data) indicates that there are also inconsistencies between countries in the time of last update of the GIS datasets supplied. Apart from the large differences between the GIS- and expert-based mire-area totals for Lithuania and Czechia shown in Tables 4 and 5 (see above), there are discrepancies for Belarus, Poland and Slovakia that are attributed to inventory work carried out since the GIS data were collated. Indeed, ongoing inventory in Czechia and Slovakia means that even the figures that were finally used in the calculations reported here are already out of date (see footnote to Table 16, Appendix 4). Nonetheless, these data give a relatively close representation of the best information available at the present time on the extent of the region's mire resource.

The fractional loss of mires that has already occurred in each of the focal countries is calculated from the "best-estimate" data on original and present extent of mire in Table 6, and shown graphically in Figure 10. On this basis, it appears that all of the focal countries have lost at least 40% of their original natural peatlands, and that Poland and Slovakia have lost more than 80%. The peatlands of Ukraine, Belarus and the Czech Republic are proportionally the least altered; those of Poland and Slovakia are the most disturbed; and those of the Baltic countries occupy intermediate positions. It is noteworthy that the result of

Table 6. **Estimated loss of mires for each of the focal countries, arranged in descending order of percentage loss.**

Country	Peatland area (ha)	Present extent of near-natural mire (ha)	Estimated loss of mire (%)
Slovakia	26,000	2,575	90
Poland	1,254,800	201,938	84
Lithuania	352,000	75,000	79
Estonia	1,009,100	300,000	70
Latvia	672,204	316,712	53
Czechia	27,000	14,742	45
Belarus	2,939,000	1,634,800	44
Ukraine	1,000,000	580,000	42

9 Although unquantifiable inaccuracies arising from the known differences between countries in soil/peat survey protocols (especially in terms of thresholds for site size, peat thickness and organic content – see Section 2.2 and Appendix 3) are incorporated, this approach should yield generally conservative estimates of original mire areas, and therefore of peatland losses derived from them.

this exercise suggests that the peatlands of Belarus, the Czech Republic and Ukraine are less extensively degraded than indicated by the data used to construct Figure 6.

The data for the region as a whole are shown in Figure 11. The pie chart shows the estimated extent of former peatland habitat that originally occurred in the CEPP focal countries, and the fraction of that area that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportion of the three major mire types – bog, fen and transition mire – that occurs within this surviving extent of mire habitat.

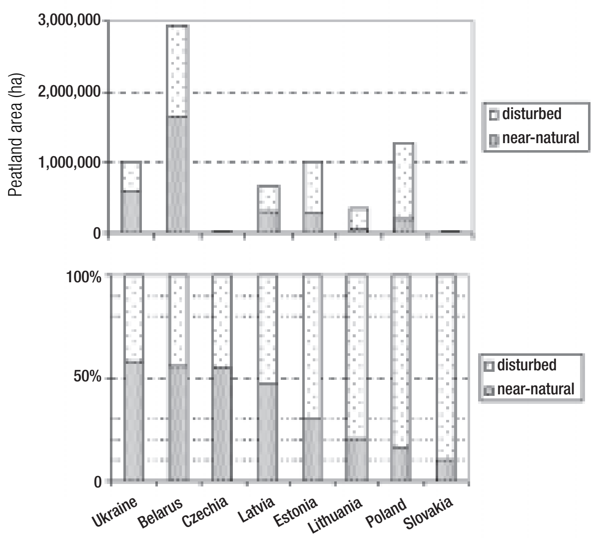
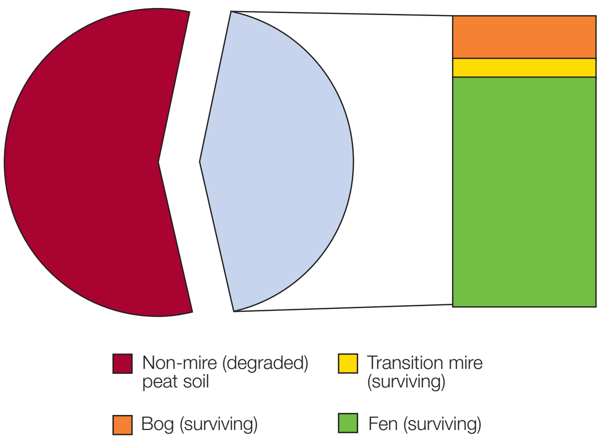


Figure 10. Estimates of the extent of peatland in near-natural condition for each of the focal countries, shown as area in hectares (upper diagram) and as percentages of total area (lower diagram).

Figure 11. Original and current extent of mires in the CEPP region (pie chart) and the proportions of bog, transition and fen types represented within the remaining resource (bar chart); based on the GIS data.



3.3 Peatland carbon store in the CEPP focal countries

The Kyoto Protocol, agreed in 1997 by the United Nations Framework Convention on Climate Change (UNFCCC – see Section 2.10) recognises the value of carbon sinks as a means of helping countries to meet their targets for cutting net emissions of greenhouse gases over the next decade. This pertains particularly to planting of forests to remove carbon dioxide from the atmosphere. So far, the Protocol and its Clean Development Mechanism have not recognised the carbon storage functions of peatlands. However, other fora, such as the Ramsar Convention and the Convention on Biological Diversity, are increasingly calling for research on the importance of peatlands in global carbon storage and sequestration.

The contribution of peat fires to global carbon emissions and the promotion of peatland conservation to limit these should warrant consideration at future Kyoto Protocol discussions. Research and other projects are currently being undertaken in various parts of the world with a view to building the case for peatland conservation in this context. These include the UNEP-GEF Project being implemented by Wetlands International/Global Environment Centre on *Integrated Management of Peatlands for Biodiversity and Climate Change*, the "SEPS 108"[10] project on *Local Environmental Action Programmes for Protection and Restoration of Peat Bogs in Central Russia*; and the UNDP-GEF project on renaturalisation and sustainable management of peatlands in Belarus[11].

Article 3.1 of the Kyoto Protocol[12] states that

> "*the Parties … shall, individually or jointly, ensure that their aggregate anthropogenic carbon dioxide equivalent emissions of greenhouse gases … do not exceed their assigned amounts … with a view to reducing their overall emissions of such gases by at least 5% below 1990 levels in the commitment period 2008 to 2012.*"

Not all Central European countries are subject to this 5% target, but it is useful to look at the amounts of carbon stored within the focal countries' peatland systems and to consider these quantities in relation to their carbon-dioxide-equivalent emission targets. It is possible to arrive at general estimates for the amounts of CO_2 represented by the peatlands in these focal countries by applying accepted peat carbon density estimates[13] to these countries' respective peatland areas. In this context, it is the area of peatland (whatever the condition of its surface layer), rather than the extent of mire habitat, that is of interest. This is a particularly important issue where extensive tracts of peatland have been used for purposes – such as conversion to agricultural land – that lead to progressive oxidative wastage of the peat matrix, releasing the stored carbon. Reduction of carbon fluxes from peatlands to the atmosphere would undoubtedly be an indirect environmental benefit arising from restoration of peatland ecosystems. The question is, how much of a benefit?

10 Administered by the British Council on behalf of two UK government departments (DFID and DETR).

11 Full title: *Renaturalization and Sustainable Management of Peatlands in Belarus to Mitigate Climate Change, Combat Land Degradation, and Ensure Conservation of Globally Valuable Biodiversity.*

12 Quoted from <http://www.sdinfo.gc.ca/docs/en/kyoto/kyoto_3.cfm>

13 Immirzi *et al*. (1992) provide a figure of 733 tonnes of carbon per hectare where the average peat depth is one metre, but observe that a number of studies have estimated the global average peat depth to be closer to 1.5 metres.

Table 7 provides estimates of the amount of carbon stored in the CEPP peatlands, based on current best estimates (Section 3.2 and Appendix 4) of both the total extent of peat and the area that currently supports mire habitat. In order to accommodate uncertainty about peat thickness, figures are calculated for average peat depths of 1 m, 1.5 m and 2 m. It is clear from Table 7 that these peatlands represent considerable potential CO_2 sources. However, the apparently large absolute figures must be considered in an appropriate context. First, the calculated amounts of CO_2 would be released only if *all* of the peat in the CEPP focal countries were to be destroyed. Clearly this is not going to happen instantaneously or even over a few decades, and it is more realistic to anticipate slow oxidation over an extended period of time. Secondly, the Kyoto Protocol deals in *annual* emission rates rather than absolute quantities of CO_2. Finally, it is important to recognise that even intact peatland ecosystems release greenhouse-active gases. Scientific discussion continues about this particular issue, but the general consensus at present seems to be that fens typically emit more greenhouse-active methane than bogs but, overall, natural peatland systems are relatively greenhouse neutral in terms of active gas exchange (Joosten and Clarke 2002). They do not, however, remain greenhouse neutral when they are drained and utilised, because these activities cause relatively rapid release of carbon that was previously sequestered over a very long period of time.

Bearing all these points in mind, the data from Table 7 were used as the basis for a series of calculations that considered the significance of the Central European peat carbon store in terms of the CO_2 emission targets set by the Kyoto Protocol. In order to incorporate the concept of loss-over-time, the calculations assumed that complete oxidative wastage of all peatland not designated for conservation would occur steadily over a period of 100 years, and compared the resulting CO_2 flux with the annual release of greenhouse gases (expressed in CO_2 equivalents) that would occur if all of this peatland were to be conserved. Figure 12 (see over) illustrates the results, in terms of Kyoto Protocol targets, for the six CEPP countries for which annual emission targets have already been set.

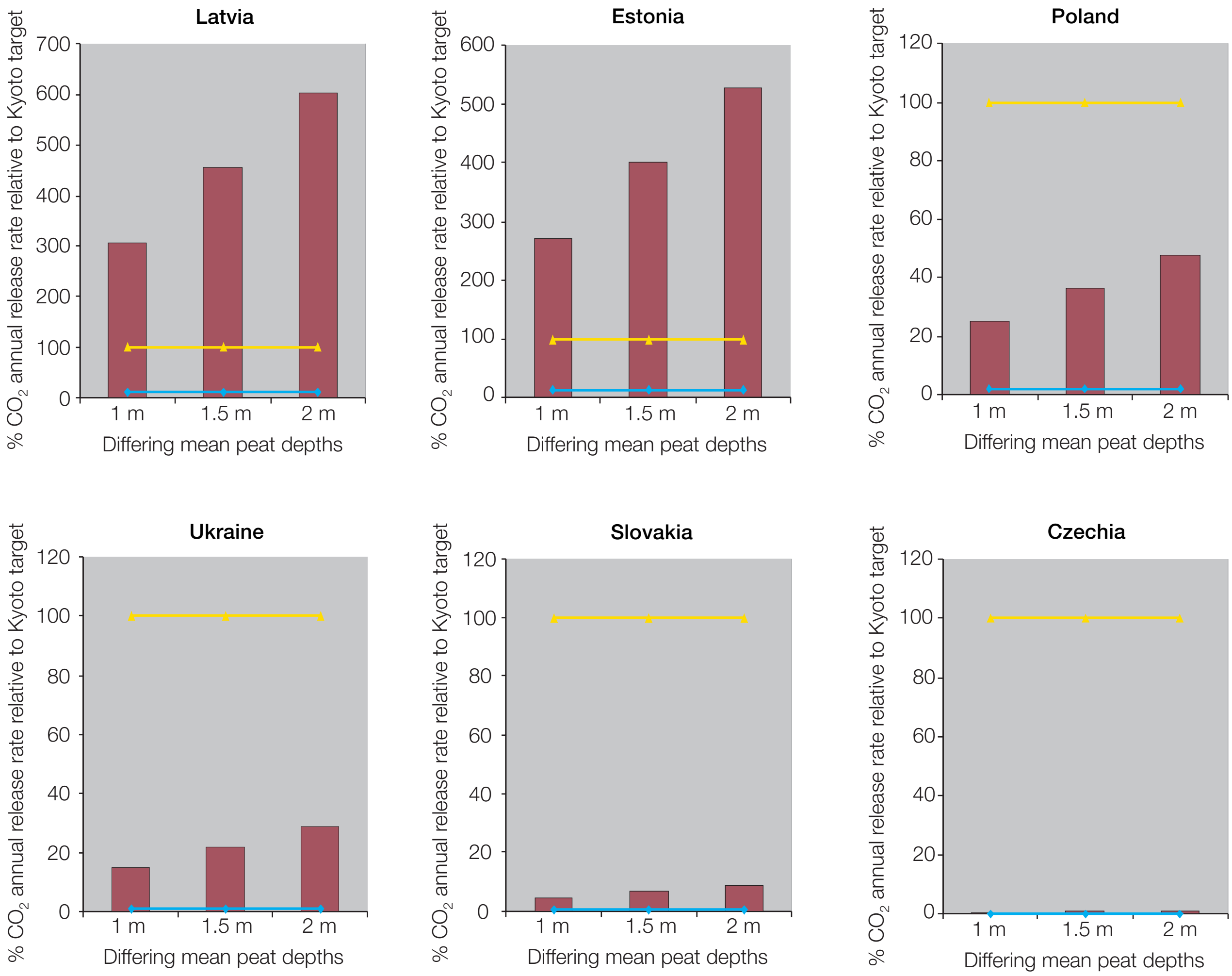
It can be seen from Figure 12 that the amount of carbon likely to be released from the scarce peatlands of Czechia and Slovakia is small when compared with those countries' total CO_2 emissions. By contrast, the calculated CO_2 yields from peatlands in Latvia and Estonia, which are currently peat-rich and committed to low Kyoto targets, are two to six times their annual CO_2 emission limits; whilst for Poland and Ukraine, peatlands could contribute one-tenth to one-half of the target annual emissions. Thus, extensive destructive exploitation of Central European peat resources in the course of the next century has the potential to cause annual CO_2 releases that exceed, from this source alone, the total annual Kyoto emission targets for some of the CEPP countries.

In other words, the indication of this analysis is that **any substantial expansion of peat use** – such as the up-scaling of peat extraction that now seems likely to occur in Estonia (Section 3.2) – **could have significant negative consequences for the effectiveness of the Kyoto Protocol in reducing atmospheric CO_2 levels**, and should be carefully monitored.

Table 7. Peat carbon data for the CEPP countries, calculated respectively for the peatland and mire areas within each country, and for three estimates of average peat depth, using bulk density estimates derived from Immirzi *et al.* (1992).

			Total extent of peat soil			Current extent of mire habitat		
Country	Total peat soil area (ha)	Remaining mire habitat (ha)	Carbon stored in peat (tonnes) assuming mean depth of 1 m	Carbon stored in peat (tonnes) assuming mean depth of 1.5 m	Carbon stored in peat (tonnes) assuming mean depth of 2 m	Carbon stored in peat (tonnes) assuming mean depth of 1 m	Carbon stored in peat (tonnes) assuming mean depth of 1.5 m	Carbon stored in peat (tonnes) assuming mean depth of 2 m
Belarus	2,939,000	1,634,800	2,154,287,000	3,231,430,500	4,308,574,000	1,198,308,400	1,797,462,600	2,396,616,800
Poland	1,254,800	201,938	919,768,400	1,379,652,600	1,839,536,800	148,020,554	222,030,831	296,041,108
Estonia	1,009,100	300,000	739,670,300	1,109,505,450	1,479,340,600	219,900,000	329,850,000	439,800,000
Ukraine	1,000,000	580,000	733,000,000	1,099,500,000	1,466,000,000	425,140,000	637,710,000	850,280,000
Latvia	672,204	316,712	492,725,532	739,088,298	985,451,064	232,149,896	348,224,844	464,299,792
Lithuania	352,000	75,000	258,016,000	387,024,000	516,032,000	54,975,000	82,462,500	109,950,000
Czechia	27,000	14,742	19,791,000	29,686,500	39,582,000	10,805,886	16,208,829	21,611,772
Slovakia	26,000	2,575	19,058,000	28,587,000	38,116,000	1,887,475	2,831,213	3,774,950
Totals	**7,280,104**	**3,125,767**	**5,336,316,232**	**8,004,474,348**	**10,672,632,464**	**2,291,187,211**	**3,436,780,817**	**4,582,374,422**
CO_2 Equiv.	**26,717,982**	**11,471,565**	**19,584,280,571**	**29,376,420,857**	**39,168,561,143**	**8,408,657,064**	**12,612,985,597**	**16,817,314,129**

Figure 12. **Comparison between conservation and 100-year extinction of the non-designated peatlands of Latvia, Estonia, Poland, Ukraine, Slovakia and Czechia, in terms of percentage contribution of CO_2-equivalent emissions to each country's Kyoto target.**



Annual rate of CO_2-equivalent emission, expressed as a percentage of the 2008/12 Kyoto annual target, for Latvia, Estonia, Poland, Ukraine, Slovakia and Czechia, assuming that all non-protected peatland habitat and peat soil is lost within a 100-year period. The Kyoto target is shown as a yellow line. The blue line indicates the relative annual rate of CO_2-equivalent emissions that would occur if the remaining peat-soil resource were to be conserved.

Key: Annual CO_2 emission rate if all unprotected peat is lost over 100 years; Target annual CO_2 emissions (2008/12) set by Kyoto Protocol; Emissions assuming that all existing peat is protected

4. The peatlands of the focal countries

This Section gives a separate account of the peatland resource and peatland conservation issues for each of the CEPP focal countries. The accounts were written principally by national co-ordinators, and each follows a similar format to facilitate comparison and review.

4.1 Belarus

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General information
Area: 20,760,000 ha (207,600 km^2)
Population: ~10 million (0.48 inhabitants per ha)
Former extent of mire: *2,939,000 ha (or 14.2% of the country)
Present area of mire: 1,634,800 ha (7.9%)
Mire loss: 44% (estimate)

The landscape of Belarus is predominantly flat with some hills rising to 345 m a.s.l. in central and northwestern areas. The annual precipitation is 500–600 mm, increasing from south to north. There is wide variation in mire formation and peat accumulation across Belarus, due to differences in climate, geology and hydrology. The peatlands of Belarus are important for biodiversity conservation, climate regulation and water regime. They are used for a wide range of purposes, and natural peatlands (mires) are often found as islands in the landscape, surrounded by areas of amelioration and peat extraction.

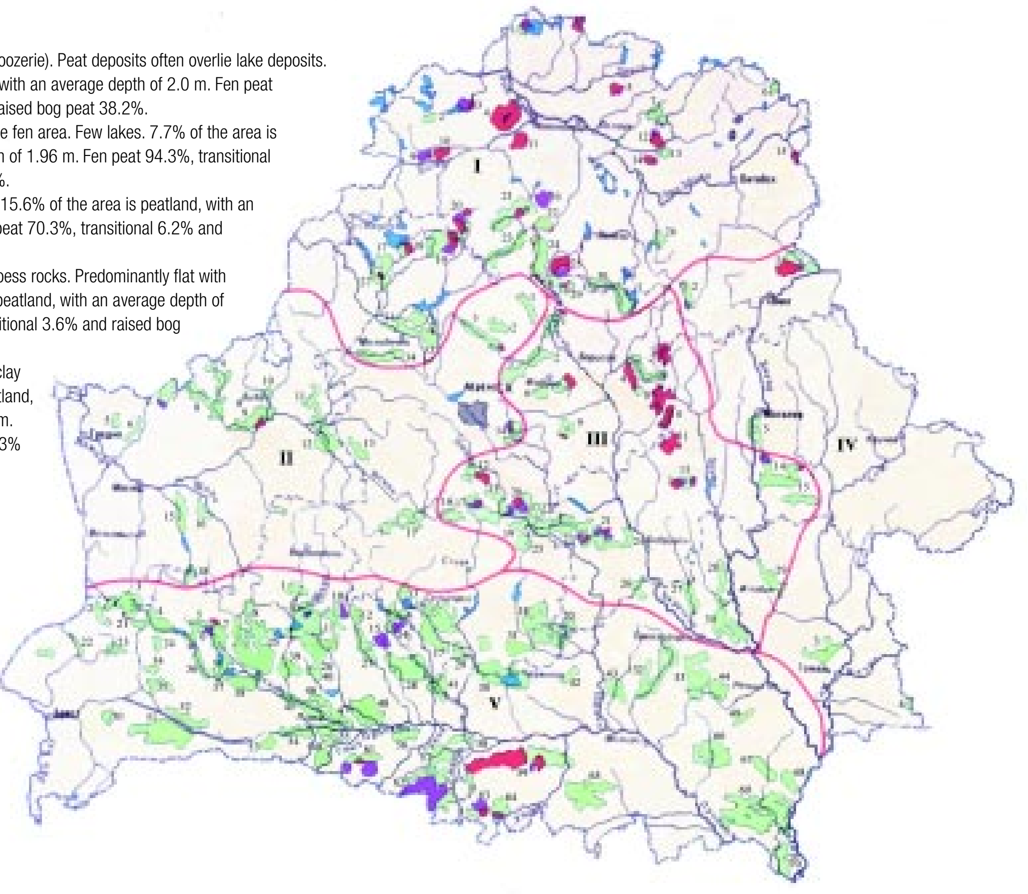
*based on peat deposits

Peatland biodiversity

A total of 267 plant species are considered to be peatland species. More than 50 species of valuable medicinal plants grow on peatlands, such as valerian *Valeriana* sp., Labrador tea *Ledum palustre*, butterbur *Petasites hybridus*, bog bean *Menyanthes trifoliata* etc. The important berry plants are: cranberry *Vaccinium oxycoccos*, lingonberry/ cowberry *Vaccinium vitis-idaea* and blueberry/bilberry *Vaccinium myrtillus*. At least 29 peatland plant species are listed in the Red Data Book. Animal species diversity is comparatively low due to the very low productivity of bogs and poor fens, but peatlands are important for a number of rare birds including osprey *Pandion haliaetus*, short-toed eagle *Circaetus gallicus,* golden eagle *Aquila chrysaetos,*

Figure 13. Peatland zones in Belarus and distribution of large peatlands.

Key to geomorphological zones:
I. Hill-lake landscape bog area (Poozerie). Peat deposits often overlie lake deposits. 10.6% of the area is peatland, with an average depth of 2.0 m. Fen peat 54.5%, transitional 7.3% and raised bog peat 38.2%.
II. Western end-moraine landscape fen area. Few lakes. 7.7% of the area is peatland, with an average depth of 1.96 m. Fen peat 94.3%, transitional 3.7% and raised bog peat 2.0%.
III. Alluvial plain bog and fen area. 15.6% of the area is peatland, with an average depth of 1.93 m. Fen peat 70.3%, transitional 6.2% and raised bog peat 23.5%.
IV. Small bog and fen area in the loess rocks. Predominantly flat with few lakes. 5.5% of the area is peatland, with an average depth of 1.59 m. Fen peat 85.5%, transitional 3.6% and raised bog peat 10.9%.
V. Large Polessie fen area. Sand/clay plain. 18.3% of the area is peatland, with an average depth of 1.55 m. Fen peat 86.4%, transitional 7.3% and raised bog peat 6.3%.



bog
transitional
fen
borders between geomorphological peatland zones

merlin *Falco columbarius*, black grouse *Lyrurus tetrix*, willow grouse *Lagopus lagopus*, golden plover *Pluvialis apricaria*, wood sandpiper *Tringa glareola*, greenshank *Tringa nebularia* and curlew *Numenius arquata*. Aquatic warbler *Acrocephalus paludicola*, the short-eared owl *Asio flammeus* and the crane *Grus grus* are all highly dependent on fen conditions. Significant fractions of the European populations of the following birds nest in the peatlands of Polesie: black stork *Ciconia nigra* (15%), white stork *Ciconia ciconia* (9%), lesser spotted eagle *Aquila pomarina* (45%), spotted crake *Porzana porzana* (46%), corncrake *Crex crex* (59%), great snipe *Gallinago media* (7%), redshank *Tringa totanus* (23%) and aquatic warbler *Acrocephalus paludicola* (57%).

Plate 8. *Peatland “Dikoe” in the Buffer Zone of the National Park “Belovezhskaya Pushcha”.*

Dr V. Rakovich

Plate 9. *The Belmonty wooded swamp, under natural conditions.*

Dr V. Rakovich

The aquatic warbler *Acrocephalus paludicola*
The fens of Polesia, which cover parts of Ukraine, Belarus and Poland, are extremely important for conservation of a number a of globally endangered bird species. Due to large scale peatland drainage in Poland and Ukraine, most of the natural and near-natural fens that remain are located in Belarus. The aquatic warbler *Acrocephalus paludicola* is now globally threatened, but still nests in some isolated areas in Belarus. Now, 57% of the known world population of 14,000–20,000 adult males (and maybe the same number of females) nest in the fens of Polesia, with 34% in the Pripyat peatland-river system and 21% in the Yaselda system.

Extent and trends

The current extent of mire habitats is shown in relation to the original area in Figure 14. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Most of the peatlands of Belarus have been allocated to one of four Funds according to their intended use, as indicated in Table 8.

There are plans to add 394,000 ha of peatland to the Nature Protection Fund, but the sites to be added have not yet been identified.

Policies

The National Strategy and Action Plan for Biodiversity was adopted by the Belarus Government in 1997. Aspects that are relevant to peatlands are:

- *Priorities for conservation of ecosystems and communities:* main types of natural complexes; rare and sensitive species; landscapes of natural origin. Amongst the top priorities are:
  - marshes and fens in Polesia
  - mesotrophic (transitional) bogs in Zone I (Poozerye, Figure 13).
- *Special attention to ecosystems with low anthropogenic impact*, which reflect the natural biological diversity within the country. Priority is given to pristine areas, but also to habitats with human intervention that are characterised by rich flora and fauna.
- *Drainage is especially harmful to biological diversity.* The catastrophic consequences of large-scale peatland reclamation in Belarus during the 1960s and 1970s are attributable to disregard of scientifically-based requirements to preserve pristine refugia within reclaimed areas, as elements for maintenance of biological diversity.
- *Interdepartmental contradictions* seriously impede implementation of the National Strategy and Action Plan on Biodiversity. Improvement of land-use and town planning is of primary importance – effective conservation of biodiversity is impossible without ecologically sound regional land planning and organisation.
- *Training* is needed to enable practitioners to reconcile the requirements of conservation and wise use of natural resources.
- *Action Plan*: Use of peat deposits with maximum possible rehabilitation of marshlands and re-wetting of peatlands.
- *Up-to-date peat extraction technology* is needed to minimise transformation of natural landscapes.
- *Ecotourism*: development of certificates.
- *Development of the countryside*, including nature reserves, for tourism and recreation.

All peatlands included in National Parks, Biosphere Reserves, Botanical Zakazniks, Hydrological Zakazniks, Berry Zakazniks and local nature reserves are effectively protected from amelioration, peat extraction etc. Protection of peatlands has some priority and the current legislation seems to be adequate, but there is lack of money for implementation. The government has accepted expert recommendations to increase the area of protected peatland by 394,000 ha (from 317,200 to 711,200 ha). It has not yet been possible to identify the areas to be designated due to lack of up-to-date inventory data. The aim is to secure the protection of sites already allocated to the Nature Protection Fund by adding peripheral areas of shallow peat; and to protect peatlands that are important for bird migration, water resources and medicinal plants. The Belarussian *Action Plan for Biodiversity Protection* states an intention to restore peat formation and other natural functions of improved and extracted peatlands.

Figure 14. Belarus: extent of peatland and mire habitats.

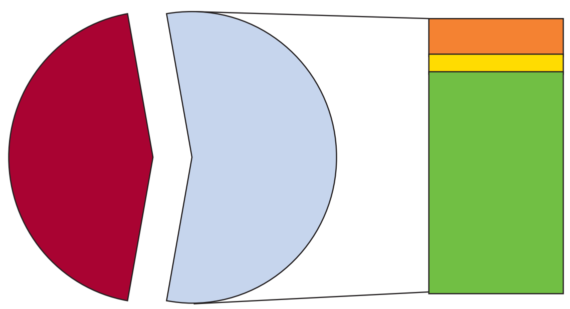


Table 8. Distribution of Belarussian peatlands between different land-use funds.

Name of fund	Current area (ha)	Planned area (ha)
Nature Protection Fund	*317,200	711,200
Agricultural Land Fund inc. recultivated areas	1,085,100	1,085,100
Developing Fund areas under peat extraction	101,000	122,400
Reserve Fund areas reserved for raw materials (e.g. extraction)	30,800	38,900
Peatlands where the use has not yet been defined	*793,800	370,300
Peatlands not included in any fund (too shallow for extraction)	*523,800	523,800
Extracted peat deposits – not recultivated	87,300	87,300[1]
Total (area with peat deposits)	**2,939,000**	**2,939,000**

* are natural peatlands
1 will change as extraction is completed and areas are recultivated

Peatland protection and its effectiveness

Approximately 11% (317,200 ha) of the present peatland area is protected as National Parks, Biosphere Reserves, Botanical Zakazniks, Hydrological Zakazniks and Berry Zakazniks. Besides these large protected areas there are many small peatlands with protection at local level, and some peatlands are designated as Key Ornithological Territories (IBA Birdlife Sites). The biogeographical distribution of peatlands (Figure 13) is very well reflected in the protected areas, and no specific types are under-represented. Belarus has one official Ramsar Site, *Sporovsky*, with 18,869 ha of peatland. Eighteen potential Ramsar areas have been identified, and eight of these include significant amounts of peatland. An additional Red List of about 200 potential Ramsar Sites or peatland areas with significant value for biodiversity has been compiled. The sites have been selected according to Ramsar criteria, as rare or unique for the biogeographical region, and some are already included in Nature Reserves, National Parks or Zakazniks. National Parks are zoned, and management regimes vary widely between zones. However, alteration of the water regime is forbidden in all floodplain peatlands and in peatlands which are part of lake-mire or floodplain-mire complexes.

Threats and impediments

Peat extraction and land improvement are the principal direct threats. 1,085,100 ha of improved peatland, including previously extracted areas, are used for agriculture (peat has completely disappeared from 224,000 ha of this area through mineralisation and degradation); 101,000 ha are currently under extraction; 87,300 ha have been extracted but not recultivated; and 38,900 ha are to be extracted in the future (Table 8). Elsewhere, unwise use of peatlands occurs, for example:

- *early mowing of fens* leads to destruction of significant numbers of birds' nests, including those of the globally threatened aquatic warbler
- *intensive grazing* near villages destroys the structure of the vegetation
- *burning of fens* intended to improve growth conditions has serious repercussions for plants and animals because, under dry conditions, the surface peat burns and habitats for plants and animals are destroyed
- *felling of mature peatland forest* disturbs the rare fauna, which is specifically adapted to this habitat
- *construction of roads*, power lines and pipelines (oil and gas) disturbs the hydrological regimes of mires, seriously affecting both flora and fauna
- *oil spills* from pipelines affect considerable mire areas; and
- near Minsk, 20 peatland areas have been *developed for urban use*
- *Pollution, eutrophication and tourism* (gathering of natural products such as berries and medicinal plants) are additional threats.

Opportunities

The surviving natural peatlands of Belarus (1,634,800 ha) are of significant international value. It is incumbent on the international community to assist in conserving these precious areas for European and world natural heritage.

The government has adopted expert recommendations for long-term conservation of peatland biodiversity in Belarus, by increasing the area of peatland assigned to the Nature Protection Fund to a minimum of 711,000 ha.

Land abandonment creates the opportunity to restore low-yielding improved and extracted areas. There is a high fire risk, particularly on extracted areas, and drained areas produce 6–25 tonnes of carbon dioxide ha^{-1} year^{-1} through peat mineralisation.

Priorities and recommendations

Priorities

1. *An updated inventory* will provide knowledge of the peatland resource (biodiversity, depth of peat, threats, hydrological function etc.), which is seen as the primary tool in decision-making on all important issues concerning peatlands.
2. *Management and monitoring* will be required as new peatland areas are designated Ramsar and World Heritage Sites.
3. *Introduction of wise use principles* should remove some of the most vulnerable peatland areas from agriculture and forestry. These principles must be promoted by raising public awareness of the importance of peatland functions for water supply, biodiversity, world climate etc.

National recommendations

- Application of wise use principles to land-use planning and legislation concerning peatlands.

International requests

- International financial support for a peatland inventory.
- Support for preparation of management plans for potential Ramsar Sites.
- Support for preparation of Wise Use Guidelines.
- International assistance in achieving the target of doubling the peatland area allocated to the Nature Protection Fund. Two hundred suitable areas have already been identified; a national inventory will reveal new/additional areas.

4.2 Czech Republic (Czechia)

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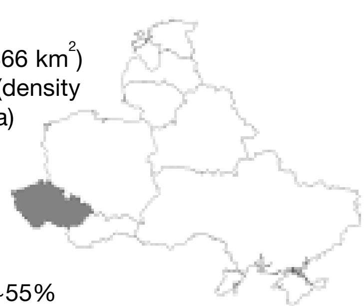
General information
Area: 7,886,600 ha (78,866 km^2)
Population: 10,282,784 (density 1.30 inhabitants per ha)
Original area of mire: 40,000 ha (rough estimate)
Present area of mire:* 27,000 ha
Estimated loss of mire: ~55%



The Czech Republic is densely populated, and includes three historical regions – Bohemia in the west, Moravia in the east, and part of Silesia in the northeast. Rising from 115 m a.s.l. (Labe River) up to the highest point of 1,602 m (Sněžka Peak in the Giant Mts), this land-locked country is a

* estimated from peat deposits larger than 0.5 ha and deeper than 0.5 m.

main European water divide from which watercourses flow down to the Black, Baltic, and Northern Seas. The country's topography is quite varied with plains, hills, highlands and mountains. Forests occupy 33% of the country, 54% of the land is used for agriculture (arable land 40%, grasslands 11%, horticulture 3%) and the remaining 13% is built-up or occupied by water reservoirs. Mires cover 0.35%. The present climate is transitional between Subatlantic and Subcontinental, with mean annual temperature between 0.2 and 9.5°C and precipitation between 410 and 1,705 mm. A variety of vegetation zones, accompanied by different natural peatland types, evolved along the gradient from warm lowlands and dry calcareous regions to the cold and windy mountain summits (Figure 15).

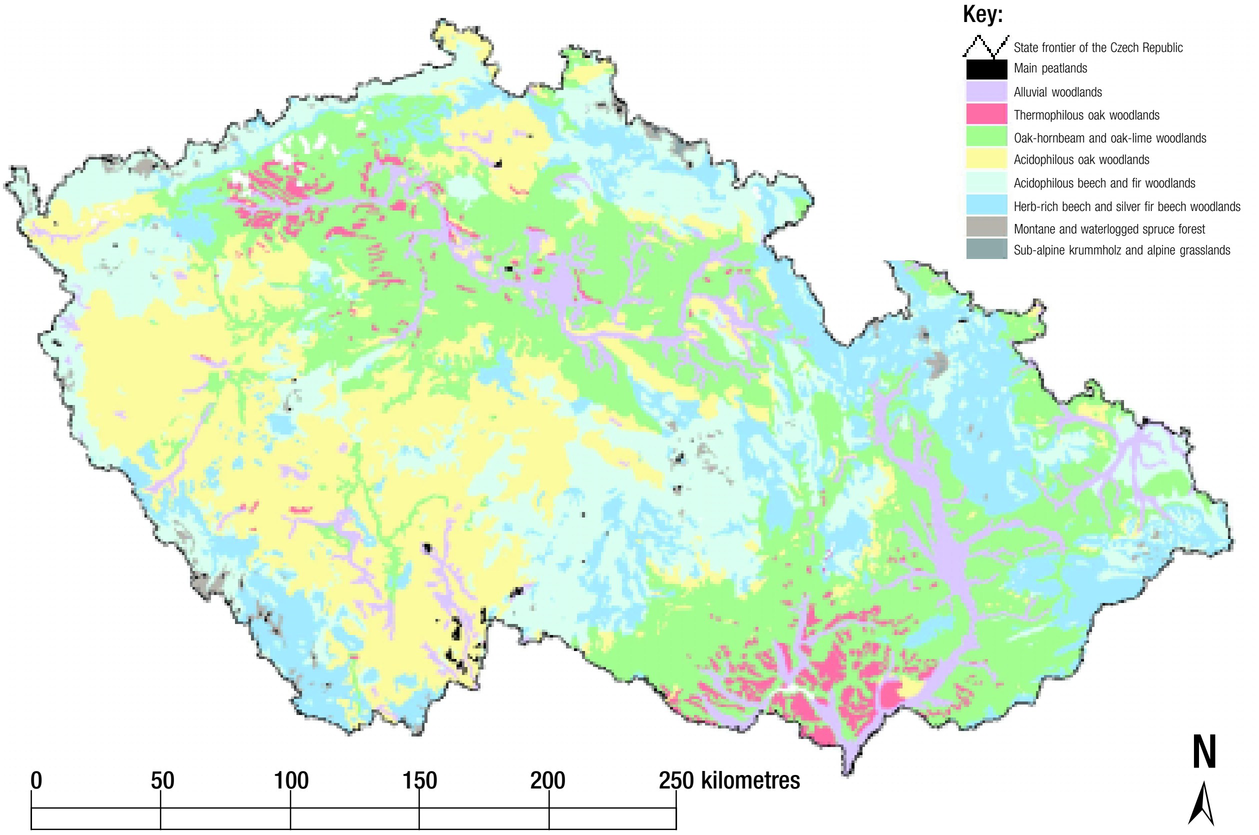
Peatland biodiversity

The peatlands of Czechia display remarkable biodiversity, from forested bogs and calcareous fens to open patterned mires with blanket and palsa-like structures and mixed kettle-hole bogs in glacial cirques. Below 500 m a.s.l., large raised bogs and rich fens occur in poorly drained basins. At middle altitudes, valley mires occur mostly along river systems. Patterned mires prevail on summit plains between 900 and 1,450 m, which are exposed to high precipitation and long-lasting snow cover. These habitats, with their long (15,000 years) Late Glacial and Holocene history and their position on the European migration crossroads, are occupied by unique biota. The most remarkable endemic plant is the bog pine *Pinus rotundata*, a tree occurring on Central European lowland bogs. Other endemics are associated with fens – *Pinguicula bohemica* in Central Bohemia, *Dactylorhiza bohemica* in North Bohemia, *D. carpatica* in areas linked with the West Carpathians, and *Aconitum callibotryon* in the Bohemian Massif. Endemic communities also occur. For example, the *Chamaemoro-Pinetum mughi* in the Giant Mountains includes populations of mountain pine *Pinus mugo* at its northern distribution limit, and of cloudberry *Rubus chamaemorus* at its southernmost European location. Endemic invertebrate species are rare. *Chaetonotus heideri* (Gastrotricha) occurs in northwestern Bohemia and numerous species of boreo-alpine to subarctic distribution are found on Central European mire islands, where they have become adapted to their long–term isolated existence, as so-called tyrphobionts. Amongst the latter, glacial relics are of great biodiversity value, especially *Rhynchomesostoma rostratum* (Turbellaria); the spiders *Arctosa lampertii, Pardosa hyperborea pusilla, Pardosa hyperborea saltuaria* and *Pardosa prativaga sphagnicola*; the heteropters *Lamproplax picea, Salda sahlbergi* and *Ligyrocoris sylvestris*; the beetle *Patrobus assimilis*; and ecomorphs of the moth *Eugraphe subrosea*. The birds that are most typical of mires are the dotterel *Charadrius morinellus,* the bluethroat *Luscinia svecica svecica,* the redpoll *Carduelis flammea,* the water pipit *Anthus spinoletta spinoletta,* the wheatear *Oenanthe oenanthe* and the black grouse *Lyrurus tetrix*. For amphibians, the presence of the palmate newt *Triturus helveticus* at the westernmost limit of its European distribution is valuable.

Extent and trends

The current extent of mire habitats is shown in relation to the original area in Figure 16. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of

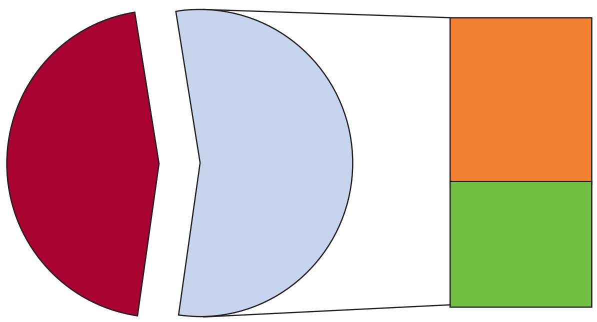
Figure 15. Potential vegetation map of the Czech Republic, with locations of the main peatlands.



Map: Institute of Botany, Czech Acadamy of Science GIS Laboratory the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Bogs represent 57.5% (15,500 ha) and fens 42.50% (11,500 ha) of the peatlands of the Czech Republic. In the absence of an up-to-date mire inventory, a very rough assessment suggests that around 60% of the bogs and 15% of the fens are in near-natural condition. Peatlands are extremely scarce in North Moravia and most numerous in South Bohemia, whilst the largest and deepest sites are located in Central and West Bohemia. Small, vulnerable peatlands (<10 ha) prevail, and only 50 sites are larger than 100 ha. Near-natural peatlands are almost entirely confined to mountainous border areas, and most are ombrotrophic bogs. In the lowlands, many fens have been either completely transformed to arable land or substantially degraded due to hydrological change and eutrophication.

Figure 16. Czech Republic: extent of peatland and mire habitats.



Policies

Czech legislation is adequate for the protection of peatlands. The protection measures outlined below have been in force since 1992.

- *Act No. 114/1992 Coll. on the Protection of Nature and the Landscape* (the most important one) states that all mires in the country are generally protected as so-called Important Landscape Elements, which means that each mire must be registered by a local or regional government office. Peatlands in National Parks, Protected Landscape Areas, National Nature Reserves, National Nature Monuments, Nature Reserves and Nature Monuments are subject to the protection conditions and restrictions that apply for each respective reserve type. Executive guidelines for the protection of endangered species and their habitats, including biological evaluation, are covered in detail by Decree No. 395/1992.
- For particular construction works and other activities, EIA is required under *Act Nos. 244/1992 Coll.* and *100/2001 Coll. on Environmental Impact Assessment.*

Although the legislation is sound, its application is now being monitored because practical obstacles have been encountered (e.g. land privatisation, ineffective operation of regional authorities, deficiencies in management). From the report *National Biodiversity Conservation Strategy and Action Plan of the Czech Republic*, natural peatlands emerge as the most endangered ecosystems with the greatest numbers of extinct and immediately endangered communities (i.e. 60% of 52 peatland associations in Czechia). However, up-to-date information on the condition of individual peatlands is not available.

Plate 10. *Novohutský mocál in Šumava, Czech Republic. Patterned mires in the Czech mountains are notable for their complicated surface morphology, with abundant cyanophytes and algae in bog lakes, mud sedge* Carex limosa *in flarks, extensive deer grass* Trichophorum caespitosum *lawns, and pine krummholz (mostly* Pinus × pseudopumilio*) on ridges and rands.*

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The peatlands of Czechia are incorporated into international networks for the protection of nature, biodiversity and landscape functioning. The five most important peatland complexes (7,701 ha of mires) are designated as Ramsar Wetlands of International Importance; eight Important Bird Areas designated by BirdLife International include peatlands as important biotopes; and peatlands are characteristic landscape elements of five UNESCO Biosphere Reserves. Although the real executive role of international protection is trivial due to the lack of legislative rules, such designations played an important role in saving several Czech peatlands under the totalitarian system.

Peatland protection and its effectiveness

About 19,000 ha (i.e. 82%) of peatlands are protected in National Parks, Protected Landscape Areas, Nature Reserves and Nature Monuments. The remaining 18% are protected as Important Landscape Elements. The implementation of protection is sometimes insufficient, and status revision and management plans are often lacking. Conservation, research, monitoring and management are of high quality for peatlands in National Parks and Protected Landscape Areas due to the presence of administration authorities. Management of Nature Reserves and Nature Monuments is carried out by the Agency for Nature Conservation and Landscape Protection of the Czech Republic. However, its quality varies between the different regional offices of the Agency. Control of activities by regionally focused non-government organisations (NGOs) would be helpful, especially with regard to peatlands designated as Important Landscape Elements.

Threats

Peatlands were traditionally used for grazing, hay and bedding; their peat for fuel and balneology; and some have been flooded to form fishponds since the Subatlantic Period (5th to 12th Centuries AD). With the development of modern technologies, deep drainage and intensive mining have caused large-scale destruction of mires, especially fens. In recent decades, the impact of enormous deposition of airborne acidifying pollutants has become apparent in the most exposed mires. The principal current threats are:

- disturbance of the hydrological regime
  - extensive drainage within peatland catchments (agriculture)
  - deep drainage of mire margins and laggs (forestry)
  - large-scale forest decline in areas surrounding mires (air pollution, outbreaks of bark beetles)
  - construction of roads and tracks across mires
- changes in chemical environment
  - excessive input of nutrients (NOx, limestone pavements, liming of peatlands to improve the quality of drinking water in reservoirs downstream)
  - airborne deposition of acidifying pollutants
  - eutrophication of water supply (mainly affects fens)
  - subsequent invasions of non-indigenous (ruderal) species
- degradation of surface patterning
  - following drainage
  - caused mechanically (e.g. by scrapers in creating unnatural plantations of forest trees in bogs, use of inappropriate mowing techniques in fens)

Plate 11. *Malá Niva in Šumava, Czech Republic. Forested raised bogs with prominent hummock-hollow microtopography and stands of the bog pine* Pinus rotundata *on the mire expanse are characteristic of river valleys and poorly drained lowland basins.*

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  - due to trampling (by enlarged herds of red deer and cattle, through inappropriate recreation activities)
  - burning
- reduction of natural biodiversity
  - disturbance of island-like population development of peatland biota
  - dying off and retreat of natural peatland biota (Black and Red lists)
  - decline of forested peatlands supporting the subendemic bog pine *Pinus rotundata*
  - inappropriate plantations (e.g. mountain pine *Pinus mugo,* downy willow *Salix lapponum,* mountain ash *Sorbus aucuparia,* Norway spruce *Picea abies* and/ or re-introduction of alien populations
  - undesirable succession after cessation of traditional management in fens
- peat extraction
  - is permitted on sites previously disturbed by large-scale industrial mining, and for balneological purposes
  - is carried out by some agricultural enterprises without permit
- privatisation of land
  - is occurring in association with Czechia's change to democratic development and accession to the European Union
  - the process of securing the protective functions of National Parks, Protected Landscape Areas, nature reserves, monuments and Important Landscape Elements may be less transparent and even compromised by privatisation of such land
  - exploitation of mires as private property (after restitution)
  - enhanced productivity for neighbouring landowners associated with peatland degradation.

Despite their protected status, the degradation of many natural peatlands is ongoing. Support for legislation, and sound management based on expert advice, are both necessary.

Opportunities

At the beginning of the 20th Century the territory of the present Czech Republic was one of the most economically developed parts of Europe, and between the two World Wars Czechoslovakia was amongst the ten most developed countries of the world. From 1948 until 1989 the economy, trade and industry experienced a long destructive period under the communist regime. After ten years of economic recovery, Czechia successfully joined the OECD countries and is now preparing for accession to the European Union (EU). Since 1995, a comprehensive re-alignment of the environmental legislation of the Czech Republic to that of the EU has been in progress. The overlap between EU and Czech legislation is about 70%, and in some aspects, the Czech nature conservation legislation exceeds EU standards. In establishing the Bern Convention EMERALD Network as a precursor to the EU NATURA 2000 Network, special attention has been paid to harmonising Czech nature conservation laws with EU directives, especially with the Birds and Habitats Directives. The principal challenges of this process are the following:

- An updated peatland inventory is of primary importance and will be prepared within the Programme for Landscape Management, through co-operation between the Czech Ramsar Committee, Agency for Nature Conservation and Landscape Management, and Institute for Soil Research and Melioration. Without the updated inventory, regional authorities cannot effectively achieve protection of peatlands as Important Landscape Elements. Knowledge of current ecological status (including hydrology, eutrophication, surface morphology) is necessary for management of future NATURA 2000 peatland sites.
- Establishment of modern approaches to the conservation of seriously endangered peatland ecosystems in Czechia is needed (e.g. ecological evaluations, guidelines for differentiated mire protection, expert systems), and in most cases their implementation will require new site data. Management guidelines should be prepared in accordance with *Wise Use of Mires and Peatlands* (Joosten and Clarke 2002). At present, mire protection is under-funded because the importance of mires to society has not yet been recognised.

Priorities and recommendations

1. *National strategy for the conservation of peatland biodiversity in Czechia.*
   Key components to be addressed by such a strategy would be:
   - Information database and state-of-the-art knowledge (information about diversity and distribution, scientific and management expertise, guidelines for ecological and multi-disciplinary assessment, monitoring and disturbance of peatlands).
   - Principles of conservation management (guidelines for nature management, site assessment, recommended restoration techniques, appraisal of management success, long-term monitoring of changes).
   - Supportive and destructive economic activities (public awareness, research, forestry, agriculture, balneology, etc.), networking of programmes and sources of funding.
   - Alignment of legislation with the EU (in preparing amendments according to EU directives for NATURA 2000, the effectiveness of retaining rules from existing legislation should be appraised and adequate feedback control included).
2. *An expert system for peatlands* should be prepared on the basis of international expertise, for use by mire managers and non-governmental organisations. Its preparation is especially urgent for the management of peatlands designated as Ramsar Sites and those included in the NATURA 2000 network.
3. *Implementation of the National Strategy on Peatland Biodiversity* within NATURA 2000. In planning the NATURA 2000 network, peatland values should be recognised and a representative network of peatlands and their species should be included. Comparison and amalgamation of existing databases followed by ecological classification is required to initiate appropriate protection of peatlands in Czechia.

National recommendations

- Regular sharing of experience amongst mire scientists, managers, conservationists, NGO representatives, regional administration and local decision makers from

all important peatland regions within the country at two to three-year intervals.
- Raising public awareness about the biodiversity and ecological functioning of peatlands.
- Responsibility for implementation of legal protection by non-governmental organisations should be devolved from national to regional level.
- Establishment of an effective monitoring network to assess changes in peatland biodiversity (effect of global change, regional and local impacts on hydrology, temperature regime, environmental chemistry, species invasion, community changes) linked with monitoring of all NATURA 2000 sites (which is an obligation according to EU directives).

International requests
- Research on topics including:
  - palæoecology;
  - nature values and ecological functions;
  - fen dynamics; and
  - the effect of climate change on peatlands.

4.3 Estonia

Agu Leivits
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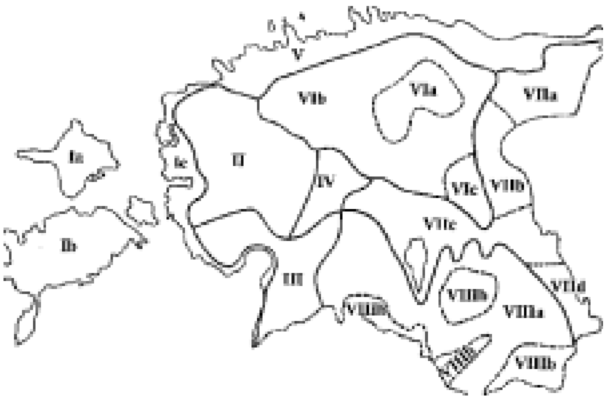
General information

Area: 4,522,763 ha (45,228 km^2)
Population: 1,370,052 (0.30 per ha)
Original extent of mire: 1,009,100 ha, based on peat deposits
Present extent of *untouched* mire: ~300,000 ha (6.6% of the country area)
Estimated loss of mire: 70%*

Estonia is characterised by flat surface topography; more than 50% of the country lies at 0–50 metres a.s.l. and only 10% above 100 metres a.s.l. The climate is temperate, with average temperatures ranging from -5.8°C in February to 20.9°C in July. The economic decline that followed re-structuring ended in 1994 and there has since been strong growth based on oil-shale energy, telecommunications, textiles, chemical products, banking, services, food and fishing, timber, shipbuilding, electronics and transport. Estonia straddles an important biogeographical boundary. The northern and western parts of the country with their calciphilous plant communities of alvars, fens, wooded meadows and broad-leaved forests belong to the Mid-European Province; whilst the eastern part, with acidophilous plant communities and pine forest, belongs to the East-European Province. The country's eight mire districts are shown in Figure 17.

Figure 17. Mire districts in Estonia.



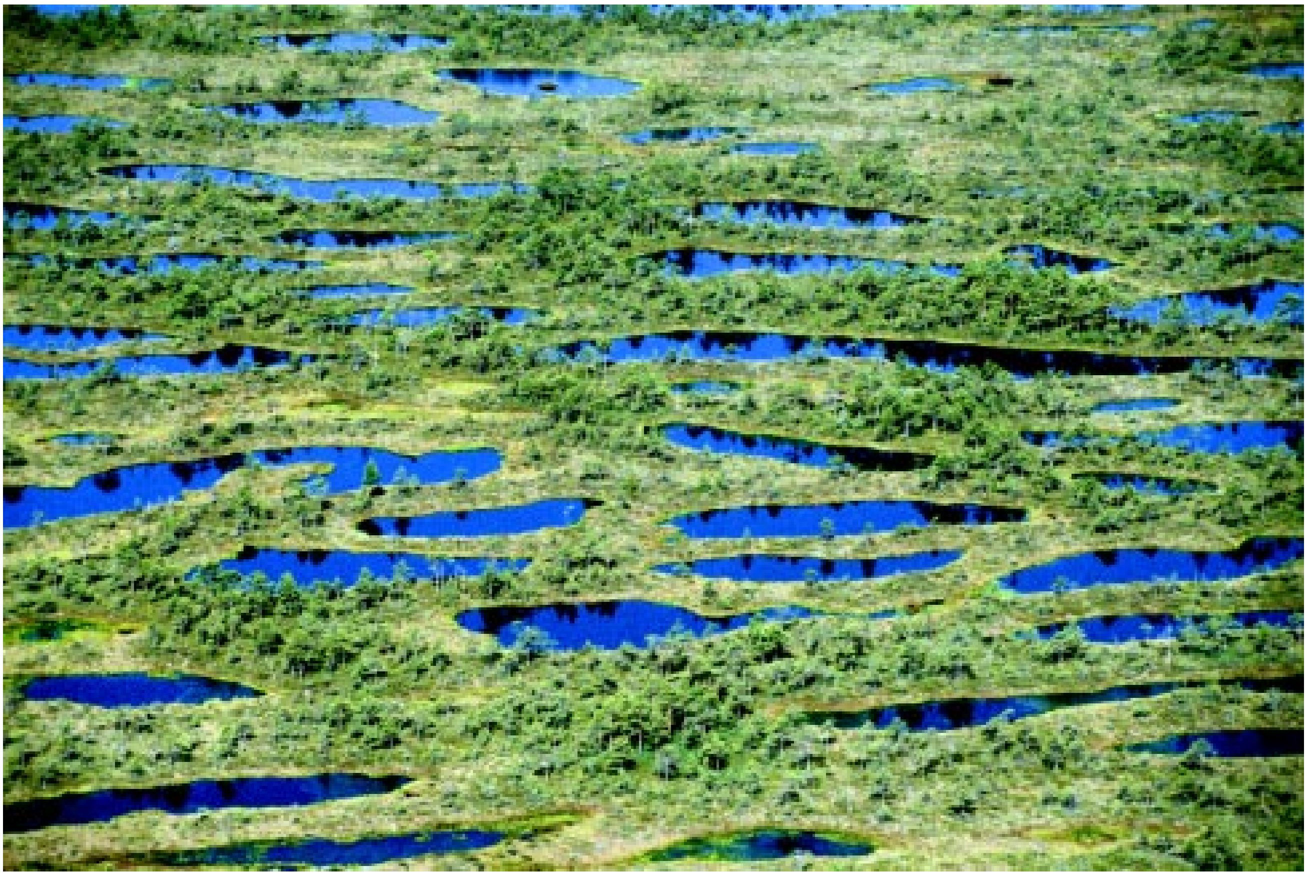
Key: Solid lines: district boundaries; broken lines: subdistrict boundaries.
I. District of small and medium-sized fens in West Estonia: (a) Hiiumaa Island; (b) Saaremaa Island; (c) the western coast of the mainland.
II. District of large and medium-sized mires in West Estonia.
III. District of large bogs in Southwest Estonia.
IV. District of small bogs in Central Estonia.
V. District of small and medium-sized mires on the North Estonian Plain.
VI. District of large mosaic mires in the North Estonian Uplands: (a) the central part of the Uplands; (b) the marginal part of the Uplands; (c) the Vooremaa area.
VII. District of large mires in Central and East Estonia: (a) the northern part of the Lake Peipsi depression; (b) the northwestern part of the Lake Peipsi depression; (c) the Võrtsjärv depression and the central part of the Lake Peipsi depression; d) the southern part of the Lake Peipsi depression.
VIII. District of small mires in the South Estonian Uplands: (a) uplands dissected by valleys and depressions; (b) Haanja, Otepää and Karula Uplands.

Biodiversity of peatlands
The vascular plant list for Estonia includes *ca.* 1,400 species, of which approximately one quarter occur on natural peatlands. The stability of these habitats contributes to the occurrence of many relict plant species that once colonised the tundra-like landscape which emerged from beneath the withdrawing ice. Nesting birds include some relict tundra species such as the golden plover *Pluvialis apricaria* and the whimbrel *Numenius phaeopus*, but many once-characteristic species including the willow grouse *Lagopus lagopus*, the peregrine falcon *Falco peregrinus* and the black-throated diver *Gavia arctica* have declined or disappeared over the last few decades. Peat accumulation has ceased on approximately 70% of Estonian peatlands due to drainage, and the extent of untouched or virgin peatland is currently less than 300,000 ha. The most endangered natural peatland types are spring fens, species-rich calcareous fens and transitional bog forests, of which less than 10% remain more or less intact hydrologically. On the other hand, 60–65% of bogs are in natural untouched condition, mainly due to nature conservation efforts during the 1970s.

Extent and trends
Due to its abundant precipitation and slow rate of runoff, Estonia is rich in wetlands. The total area of peatlands (including peatland forests) is 1,009,101 ha – more than one fifth (22.3%) of the country's territory. If waterlogged areas with peat deposits less than 30 cm thick are included, 31% of Estonia can be regarded as peatland. The Vällamäe kettle-hole mire has the deepest (*ca.* 17 m) known peat deposit. Minerotrophic fen is the most widespread peatland type (57% by area), whilst mixotrophic (transitional) mires comprise 12% and bogs 31% of the total peatland area. There are more than

* This figure indicates the extent of mire that has suffered any disturbance at all, since it is calculated on the basis of virgin or untouched mire which is practically non-existent in most other countries.

Plate 12. *The ridge-pool bog site typical for eastern Estonia.*



Arne Ader

Plate 13. *Common butterwort* Pinguicula vulgaris *– a carnivorous plant growing in rich fens.*

Arne Ader

16,500 peatlands with an area greater than one hectare, but less than 20% of these exceed 10 ha.

The current extent of mire habitats is shown in relation to the original area in Figure 18. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Policies

Estonia regained its independence from Soviet occupation in 1991, and this marked the beginning of a new era in mire protection characterised by nature conservation reforms and implementation of international legislation. One of the principles of the Estonian legal system is that, in cases of conflict, ratified international conventions and laws take priority over national legislation.

Estonian environmental policy is based on principles of sustainable development, and encourages a shift from consumptive use of natural resources towards more balanced, ecologically oriented production systems. This is reflected in the general principle enshrined in the new Constitution of the Republic of Estonia (1992): “Everyone shall be obliged to preserve the human and natural environment and to compensate for damage caused by him or her to the environment. The procedures shall be determined by law.”

The present *Law on Protection of Nature in Estonia* (1990) is outdated and currently under revision. Meanwhile new laws have been passed in relation to specific environmental problems. The *Act on Sustainable Development* (1995), supporting the Convention on Biological Diversity, stipulates that biological diversity shall be guaranteed through a national programme and action plan approved by the government. Conservation of different types of ecosystems and landscapes, and the establishment of a network of natural and semi-natural communities, shall counterbalance and compensate for the impacts of human settlement and economic activity.

Peatland protection and its effectiveness

At the beginning of 2003, the Estonian Nature Information System listed 363 protected areas with a total area of 484,144 ha (10.7% of the land area). The *Act on Protected Natural Objects* (June 1994; amended February 1998) is the most important legislation for habitat protection. It has provided revised rules for existing protected sites and a basis for establishment of several new protected areas. The sites designated under this Act are: four National Parks (established by Parliament), 47 Nature Reserves and 91 Landscape Reserves. Depending on its type, each protected area is divided into four different management zones: Strict Nature Reserve (IUCN category Ia), Natural Special Management Zone (IUCN category Ib), Semi-natural Special Management Zone (IUCN category IV) and Limited Management Zone (IUCN category VI). Management of these areas is mostly adequate, but falls short of the ideal in some Nature Reserves.

The protection status and rules for some areas that were designated before 1994 have not yet been updated in line with the new Act. For these 221 “protected areas with un-revised protection procedure”, the previous legislation still applies. Consequently their protection is secure, but their management remains inadequate.

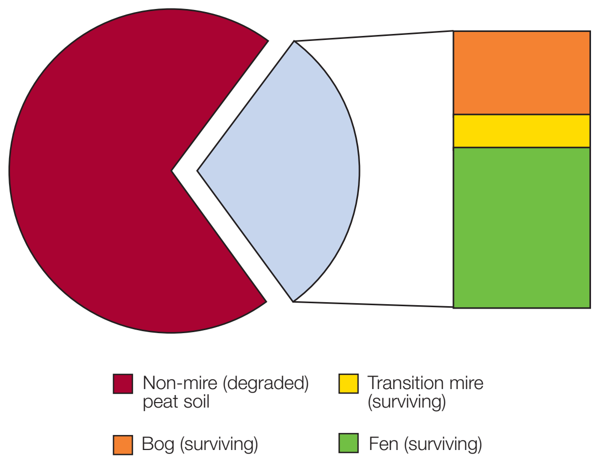
Ten Ramsar areas were designated in 1997; six of these are largely peat-covered (~80,000 ha). Sites designated as Ramsar areas are protected as National Parks or Nature Reserves and six of them have management plans. According to the same regulations, four additional peatland complexes (25,000 ha) are included in the Ramsar shadow list and should be designated before 2010. These are Puhatu mire complex, Avaste fen, Nätsi-Võlla bog and Agusalu mire complex. New areas proposed for designation in 2003 by the National Ramsar Commission include transboundary mire areas between Estonia and Latvia as well as a large fen area (Leidissoo) in northwest Estonia.

It is impossible to calculate accurately the total area of protected peatland in Estonia. However, more than 100,000 ha of land with mire vegetation is protected, and more than three-quarters of this area is bog. Since fens comprise nearly 70% of the peatland area, the protected area does not adequately represent the country’s peatland resource in terms of mire types and biogeographic variation.

Threats and impediments

- *Drainage*. Before the political changes of 1987, the major threat to Estonian peatlands was drainage for agriculture. This threat is now receding, since development of peatlands for agriculture is no longer profitable. Peat extraction is now the principal threat. Spring fens are threatened by groundwater depletion due to drainage of their surroundings. Most floodplain fens have been destroyed by drainage, but several floating fens remain undisturbed.
- *Peat extraction for fuel and horticulture*. Since 1913, when the first peat factory was established, approximately 30,000 ha of natural peatland have been destroyed directly by peat extraction and another 30,000 ha have been affected indirectly by drainage resulting from peat extraction. The industry and associated infrastructure are now developing rather rapidly, and many west European companies are looking with great interest towards Estonia’s high

Figure 18. Estonia: extent of peatland and mire habitats.



quality peat resources. The peat fields close to harbours will be exhausted during the next ten years, so that demand for new areas will arise very soon. Consequently the Estonian government and regional authorities are under considerable pressure from developers to permit peat extraction on virgin peatland. However, there are only 25–30 bogs (total area *ca.* 10,000 ha) where the slightly humified *Sphagnum* peat preferred for horticultural use can be found outside designated protected areas.

Various other threats. Around 2,000 ha of valuable peatland have been destroyed through *opencast mining of oil shale* in Northeast Estonia, and another 100 ha will be destroyed each year. In some areas peatlands are used as *garbage dumps* and more than 3,000 ha, mainly near Tallinn, have disappeared due to *urban development*. A special problem is the calcium-rich, alkaline *flue gas* released by power plants burning oil shale in northeastern Estonia. The calcium that is deposited over a 30 km radius kills *Sphagnum*, arresting peat accumulation and promoting decomposition.

Opportunities

A preliminary list of Natura 2000 areas must be ready for presentation to the European Commission on Estonia's accession date in 2004. This will be a powerful tool for improving mire conservation. The availability to Estonia of financial support from the EU LIFE Nature and Life-Environment funds offers an important opportunity.

Priorities and recommendations

Priorities are based on the outcome of a national Darwin Initiative workshop *Estonian Mires: Their Exploitation and Conservation* which took place in March 2000 and involved 62 mire scientists, nature conservationists, and representatives of the peat industry and other interest groups.

1. *Completion of the Estonian Wetlands Conservation and Management Strategy* (including a full inventory of mires and updating of the national mire/peatland database) to fulfil the requirements of national interests, international agreements and accession to the EU.
2. *Establishing a long-term education and awareness programme* on the importance of mires and their wise use in Estonia.
3. *Continued dialogue between the peat industry and other interest groups*; addressing issues such as estimation of peat resources, planning, restoration of reclaimed and extracted areas, objective assessment of peat formation and regeneration rates, and certification of peat products.

National recommendations

- Development of wise use guidelines for peat extraction: Wise use principles should be applied as far as possible in peat extraction practice, and restoration must have increased emphasis. These factors must be built into national programmes and supported financially.
- Recommendation to revise Regulation No. 213 about the sustainable use of peat: This regulation does not reflect the true situation for Estonia. Expert assessment (Ilomets 1994) indicates that the average rate of peat accumulation is grossly over-estimated because peat accumulation has ceased on 60–70% of Estonian peatlands.
- Increase emphasis on the protection of fens: Greater emphasis must now be placed on achieving the appropriate balance of protected peatland habitats to represent the full spectrum of mire types present in Estonia (currently, three-quarters of the protected peatland is bog).
- Wise land-use planning acknowledging the value and functions of peatlands.
- Awareness programme.

International requests

Support is requested for:

- peatland and mire inventory
- development of wise use guidelines
- management plans
- awareness-raising
- traditional management of fens (EU subsidies); and
- inclusion of peat in the trading mechanisms of the Kyoto Protocol.

International activities on peatlands in Estonia

Recently completed:

- *Protection of Biodiversity in the Soomaa National Park* (1998–2000) – Ministry of Environment in co-operation with Carl Bro International, Danish Environment Protection Agency.
- *Guidelines for wetland restoration of peat cutting areas – the BRIDGE-project* (1999–2001). Institute of Ecology at Tallinn Pedagogical University in co-operation with the Geological Survey of Lower Saxony, Institute of Soil Technology, Germany.
- *Methane emission from a raised bog and its control by production, transport and oxidation* (1999–2000). Institute of Ecology at Tallinn Pedagogical University in co-operation with the Max Planck Institute for Terrestrial Microbiology, Mariburg.
- *Mire ecology and restoration of damaged peatlands and terminated peat cuttings* (2000–2001). Institute of Ecology at Tallinn Pedagogical University in co-operation with the Swedish University of Agricultural Science.
- *Regional Implementation of the EU Habitats Directive and Birds Directive (79/409) in Läänemaa and Raplamaa Counties* (2000–2002). Ministry of Environment in co-operation with Ramboll, Denmark for the Danish Environment Protection Agency.
- *Pilot study towards a pan-European Wetland Inventory. Remote sensing as a tool for wetland assessment.* Dutch project in Estonia by RIZA and Wetlands International.

Ongoing:

- *Nature Conservation Accession: Preparation for Natura 2000 Implementation.* Ministry of Environment, Estonia. Estonian Natura 2000 projects will focus to a very large extent on mires. Several large unprotected mire areas are included in the lists of pSCIs and pSPAs.
- *Restoration and management of the Häädemeeste wetland complex (2001–2005). EU Life-Nature project. Estonian Ornithological Society.* This includes some activities concerning peatlands, for example neutralising the negative effect of drainage on Tolkuse bog and gaining experience in the restoration of natural

hydrological conditions for peatlands affected by drainage and peat extraction.

- *Integrated Wetland and Forest Management in the Trans-border Area of North Livonia (Estonia-Latvia).* PIN-Matra project 2002/014 funded by The Netherlands Ministry of Agriculture, Nature and Food Quality (2003–2005). International Agricultural Centre (The Netherlands), Nigula Nature Reserve Administration (Estonia) and North-Vidzeme Biosphere Reserve Administration (Latvia). The project's core area is covered mainly by large mires, so that the study and restoration of natural mire hydrology is one of the most important activities within this project.

Planned, but not yet approved:

- *Creating multi-temporal GIS-based datasets for selected Ramsar Sites in Estonia.* Proposal to the Ramsar Small Grant Fund for Wetland Conservation and Wise Use (SGF) in support of a main project: Preparation of management plans (general and administrative component) for Endla, Nigula and Emajõe-Suursoo.

4.4 Latvia

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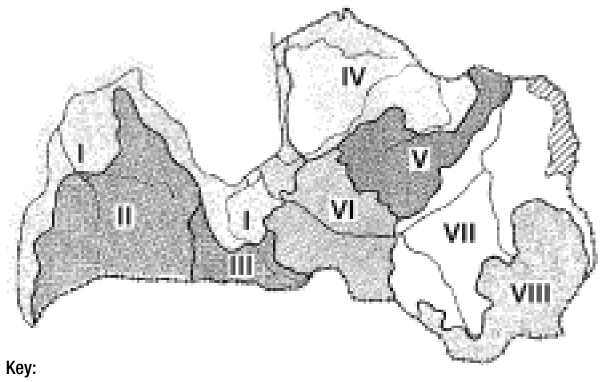
General information
Area: 6,463,500 ha
Population: 2,490,000 (0.39 per ha)
Original extent of mire:* 672,204 ha (10.4% of country area)
Present area of mire:# 316,712 ha (4.9% of country area)
Estimated loss of mire: 53%

Latvia is situated on the Baltic Sea, at the western side of the East-European plain. The coastline is nearly 500 km long with accessible ports. The Baltic Sea has always been of great importance in the political, economic and cultural life of the country.

Latvia belongs to the temperate boreo-nemoral vegetation zone, which is characterised by deciduous-coniferous (mixed) forest. The sizes of peatlands range from less than 1 ha to more than 5,000 ha. Seven peatlands have areas greater than 5,000 ha; these are Teici Mire, Cena Mire, Peikstulnica-Sala Mire, Seda Mire, Sala Mire, Kemeri-Smarde Mire and Krievi-Jersika Mire.

Latvia is divided into eight geobotanical districts on the basis of differences in geological development, vegetation and soil features (Figure 19). There are differences between these districts in terms of mire types, abundance, distribution and floristics. The area covered by mires varies between regions from 8 to 30%, and more than 40% of the mire area is bog.

Figure 19. Geobotanical districts of Latvia.



Key:
I. Coastal Lowland
II. West Latvia
III. Zemgale
IV. North Vidzeme
V. Central Vidzeme
VI. Central Latvia
VII. East Latvia
VIII. Southeast Latvia

Peatland biodiversity

East Latvia is rich in natural peatlands which display great variety. Raised bogs are of the eastern type with leatherleaf *Chamaedaphne calyculata* in the shrub layer. In the Lubana Plain there are undisturbed examples of almost all Latvian wetland types – raised bogs, transition mires, fens, quaking mires, wet forests, river floodplain meadows and lakes.

The North Vidzeme is dominated by vast raised bogs, and this area contains the boundary between the ranges of western and eastern raised bog types. More than 40 rare and protected plant species, included in the Latvian Red Data Book, are recorded in the North Vidzeme Biosphere Reserve; for example strawberry clover *Trifolium fragiferum,* musk orchid *Herminium monorchis,* early purple orchid *Orchis mascula,* Baltic orchid *Dactylorhiza baltica,* early marsh orchid *D. incarnata,* dark red helleborine *Epipactis atrorubens,* common gladiolus *Gladiolus imbricatus*, *Carex ligerica*, *Carex scandinavica* and Davall's sedge *Carex davalliana.*

The Coastal Lowland is covered by various types of peatlands. Rich fens have developed near coastal lagoon lakes including Kanieris and Engure Lakes (which have been Ramsar Sites since 1995). Inter-dune mires occur in the Coastal Lowland with the best examples in Slitere National Park. These represent a rare mire habitat at European level and their unique vegetation includes rare species such as bog myrtle *Myrica gale,* brown-beaked sedge *Rhynchospora fusca,* single-leaved bog orchid *Malaxis monophyllos,* slender cotton grass *Eriophorum gracile, Carex heleonastes* and the bryophyte *Moerckia hibernica*.

Central Vidzeme, *Zemgale* and *Central Latvia* districts possess fewer peatlands than other parts of Latvia.

West Latvia also has few peatlands, but some rare and valuable small spring fens are located on the dolomite slopes of the ancient Abava River Valley. Davall's sedge *Carex davalliana* and brown bog rush *Schoenus ferrugineus* communities occur there.

* estimated from peat deposits; 42% bog peat, 49% fen peat and 9% transitional peat.
# with natural peat forming conditions. The Latvian word for "mire" is "purvi".

Plate 14. *Rich fen vegetation near Dunieris Lake in the Kemeri National Park.*

Mara Pakalne

Plate 15. *Raised bog vegetation in Kemeri-Smarde Mire in the Kemeri National Park.*

Mara Pakalne

In *Southeast Latvia*, peatlands occur in association with lakes that have formed between hills. These are mostly fens developed by successional infilling of lakes.

Extent and trends

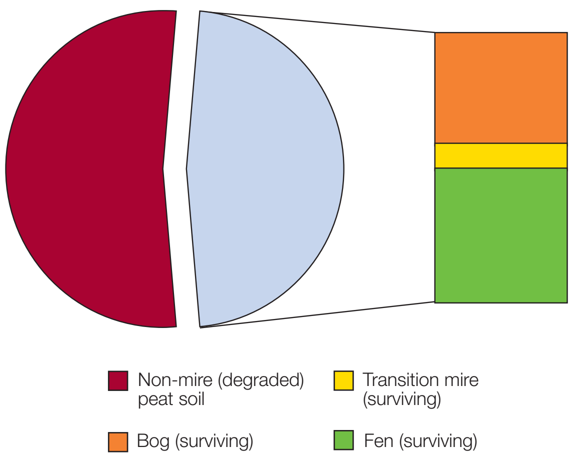
The current extent of mire habitats is shown in relation to the original area in Figure 20. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Policies

The environmental policy goals of Latvia include "to maintain and protect the current level of biodiversity and landscape characteristics". Nature conservation is regulated by the *Law on Environmental Protection*, which aims to ensure maintenance of biodiversity at genetic, species, habitat and landscape levels.

- *The National Programme for Biodiversity* incorporates several aims that are important for peatland conservation, namely conservation, restoration and promotion of structure and species diversity, maintenance of traditional landscapes and sustainable long-term use of wildlife resources. It includes the Strategy for Mire Biodiversity Conservation, the Strategy for Peat Resource Conservation and the Action Plan for Mire Conservation and Management.
- The *Strategy for Mire Biodiversity Conservation* has been approved by the Ministry of the Environment, and has the following general objectives: reduction of the influence of human activities on mire ecosystems; development of criteria to assess the biodiversity values of mires; and completion of the mire inventory, in particular for fens. Mires possessing the highest biodiversity values will be protected, monitored and managed to sustain their specific values.
- The *Strategy for Peat Resource Conservation* contains specific recommendations for development of wise use guidelines for extracted peatlands. This strategy contains the statement that peat extraction is allowed only in areas that have already been prepared for mining, and no new natural peatlands will be released for peat mining.
- The *Action Plan for Mire Conservation and Management* details activities that are yet to be undertaken (e.g. development of management plans for specific areas).
- The *Mire Habitat Management Plan* was produced in 2003. This gives an overview of Latvian mire habitats (including the protected ones) and those of European importance, and establishes conservation and management activities. The sites whose management plans are to be developed first are identified.

Figure 20. Latvia: extent of peatland and mire habitats.



Peatland protection and its effectiveness

The conservation designations that are relevant to Latvian peatlands are shown in Table 9. About 38,000 ha or 12% of the current peatland area is protected by the state, mostly in North Vidzeme Biosphere Reserve, Strict Nature Reserves (Grini, Krustkalni, Teici), National Parks (Slitere, Gauja and Kemeri), 15 Nature Parks, 140 Nature Reserves and six Protected Landscape Areas**.** Six natural peatland areas have been designated as Ramsar Sites. These are Kanieris Lake, Engure Lake, Teici and Pelecare Mires, Lubana Wetland Complex, Ziemelu Mires and Pape Wetland Complex.

The focus has been on bogs rather than fens, partly due to the lack of data about the distribution of fens and their value for biodiversity. Furthermore the protected peatlands do not adequately represent the geobotanical districts.

Threats

Peat extraction. Extracted peat is exported for horticultural use (0.15 million tonnes in 1997) and used nationally as fuel and in agriculture as soil conditioner/fertiliser and litter (0.1 million tonnes in 1997). Areas prepared for peat extraction cover 0.4% of the country and about 25% of this area is currently under extraction. About 9% of Latvia's raised bogs (37 bogs with a total area of 70,000 ha) are affected by peat extraction and 20,000 ha are nearly exhausted.

Drainage. Drainage is the other major threat to Latvian peatlands. The most intensive drainage projects were conducted in Soviet times, between 1960 and 1980. More recently, drainage of wetlands has practically ceased. In

Table 9. Conservation designations that apply to Latvian peatlands.

Designation	Details
Ramsar Sites	
Strict Nature Reserves	Zapovednik type; no economic activity or visitors
National Parks	Management regimes vary, from strong (as for Strict Nature Reserves) to weak (Landscape Zones).
Nature Monuments	
Biosphere Reserves	Management regimes vary, from Nature Reserve to Landscape Zone/Buffer Zone
Nature Reserves	Zakaznik type; changing the level of underground, ground and surface water, making new quarries etc. forbidden.
Nature Parks	
Protected Landscape Areas	

total 1,457,100 ha (14,571 km^2) of drained wetland are used for agriculture and 400,000 ha (4,000 km^2) support wet forest. Drained peatlands cover a total area of 186,200 ha (1,862 km^2).

Other threats. Land improvement and forestry can be mentioned here. Also, recreational activities can threaten vulnerable sites through trampling and careless lighting of fires.

Impediments

- There is lack of focus on protection of fens
- A national peatland inventory is needed. The most recent peatland inventory included only 158 of the most valuable peatlands; there are more than 6,000 peatlands in Latvia
- Assessment of the value of peatlands for biodiversity/ conservation
- There is a lack of funding for peatland inventory, research and awareness raising.

Opportunities

Latvian peatlands are of considerable biodiversity value, often supporting rich and varied plant communities. Surveys suggest that Latvia also has a rich diversity of peatland types, many of which are internationally significant. Consequently, new specially protected nature areas are to be designated.

Priorities and recommendations

Priorities

Designation, conservation and management of peatlands to fulfil obligations related to the EU Habitats Directive. Latvia is currently in the process of assigning sites to the EMERALD network. These sites will become Natura 2000 Sites when Latvia accedes to the EU.

National recommendations

- Implementation of the Mire Habitat Management Plan
- A national peatland inventory including all of the country's peatland types
- An awareness campaign is necessary to inform the public about the values and functions of peatlands, and thus to secure their support for mire conservation.

International requests

- Support for a detailed peatland inventory, including assessment of value for conservation of biodiversity
- Support for research activities e.g. on optimisation of management for fens and raised bogs, and hydrological functioning
- Support for awareness raising at different levels.

4.5 Lithuania

Pranas Mierauskas *and* ***Julius Taminskas***
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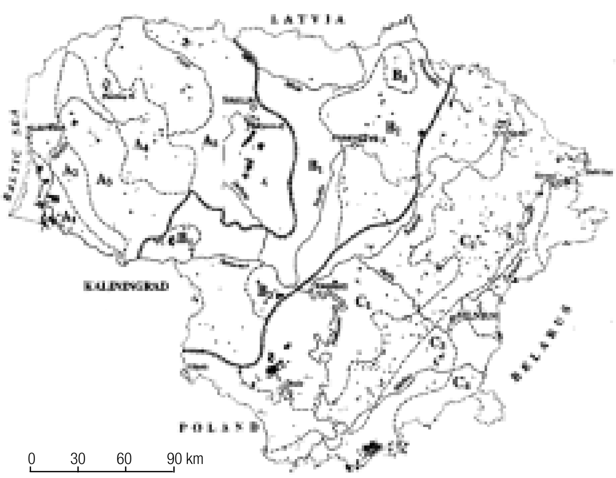
General information
Area: 6,530,000 ha
Population: 3.7 million
Original extent of mire:*
482,600 ha
Present extent of mire:#
352,000 ha
Mire loss: 70–80%

Lithuania is situated on the Baltic coast. It is a predominantly flat country. Principal exports are fuel, mineral and chemical products, textiles, machinery and equipment, live domestic animals, wood and food products. Peatland is one of the most characteristic elements of Lithuania's landscape, and around 40 landscape types have been described for which peatlands are characteristic components. The climate varies little between different parts of Lithuania, but the distribution of peatlands is very uneven due to the relief and geological composition of the substrate. On the basis of peatland distribution, three provinces can be distinguished: Western (29% of country area), Central (27% of country area) and Southeastern (44% of country area). The Western and the Central provinces can be subdivided into five districts and the Southeastern into four districts (Figure 21).

Extent and trends

Before 1992 a peatland inventory was conducted in order to estimate peat resources for industry. 6,685 sites larger than 3 ha were identified, with a total area of 322,000 ha and containing 937 million tonnes of peat. Of the total area, 71% was fen, 22% bog and 7% transitional peatland. An estimate of peatlands smaller than 3 ha indicates that there are between 20,000 and 33,000 sites extending to approximately 30,000 ha. The total area of peatland is thus estimated at 352,000 ha; of this, 75,000 ha are in near-natural condition but are still not protected.

Figure 21. Peatland provinces in Lithuania.



* based on estimate of 1953.
# based on peat deposits and estimates of the areas of small peatlands. This figure includes improved and transformed mires that still retain peat.

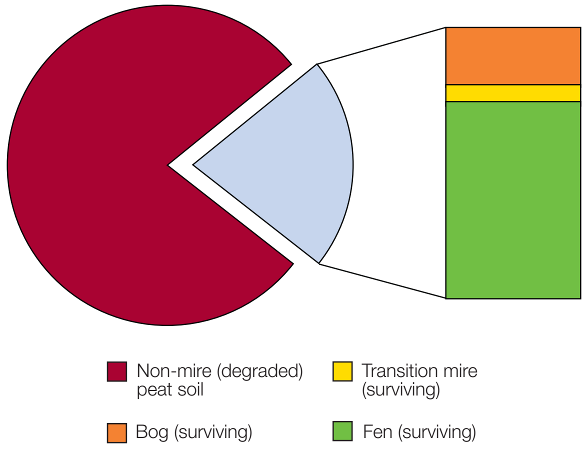


Figure 22. Lithuania: extent of peatland and mire habitats.

The current extent of mire habitats is shown in relation to the original area in Figure 22. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Policies

According to Special Provisions on Land and Forest Use (1992, revised 1997) it is forbidden to drain or transform raised and transitional bogs and their close surroundings, and fens if they are larger than 0.5 ha and have a peat layer thicker than 1 m. It is also forbidden to mine peat from natural raised bogs, transitional bogs and natural fens which are larger than 0.5 ha and have a peat layer thicker than 1 m without permission from the Ministry of Environment.

The Environmental Strategy of Lithuania does not adequately provide for peatland protection. There are no peatland protection objectives within the Strategy, and peatland protection cannot be achieved within the broad definitions attached to some of the environmental protection objectives.

Peatland protection and its effectiveness

The system of protected areas aims to conserve – and where possible to restore – natural and cultural heritage features, the ecological balance of the landscape, biodiversity, and gene pools for the restoration of biotic resources. The Lithuanian *Law on Protected Areas* (1993) makes provision for four categories of protected area:

1. *Conservation areas*: Strict Nature Reserves; Nature Reserves; Culture Reserves; Protected Landscape Features (Nature Monuments, Culture Monuments). Culture Reserves, Protected Landscape Features and Culture Monuments are not relevant to peatland protection.
2. *Protection areas* – protective zones for various purposes.
3. *Restoration (recuperation) areas* – self re-naturalising areas, without human intervention, where natural resources are protected or restored.
4. *Integration areas*: National Parks, Regional Parks and Biosphere Monitoring Areas.

Primary attention is given to Conservation and Integration areas, which cover 728,042 ha (11.1%) of the country, and are known as “Especially Protected Areas”. Recent amendments to the Law (still not adopted) introduce IUCN categories.

All natural peatlands larger than 500 ha are protected, together with areas that are indirectly affected by drainage. 821 peatlands are situated in protected areas (Strict Nature Reserves, National and Regional Parks and managed reserves). They cover a total area of 78,357 ha or 18.9% of the total peatland area. The largest areas of protected peatland are situated in Varena (104 sites: 9,093 ha), Radviliskis (11 sites: 7,394 ha), Alytus (8 sites: 7,196 ha) and Svencionys (75 sites: 5,771 ha) districts. There are no protected peatlands in Jurbarkas, Kedainiai, Pakruojis, Pasvalys and Sakiai districts. Four natural peatlands (17,853 ha) have been designated as Ramsar Sites and there are 6,743 ha of peatland within Nemunas Delta Regional Park, which is Lithuania’s fifth Ramsar Site.

Threats and impediments

The most important threats are:

- *Drainage and related degradation.* Of the 800 peatlands larger than 50 ha in Lithuania, at least 600 are affected by intensive mineralisation and peat degradation.
- *Peat extraction.* Cutting of slightly humified peat now predominates in Lithuania. Most of the peat is extracted for export; for example during the period 1993–1996, 51–57% was exported. Peat extraction limits were set in 1995 by the Ministry of Environment at 1,200,000 tonnes including 400,000 tonnes of slightly humified peat per annum. During the last five years the production achieved has been around 20% of the set limit.
- *Pressure of berry pickers.* Large raised bogs with substantial resources of cranberry attract large numbers of berry pickers as early in the year as August. They leave rubbish and trample paths across the bogs. Exotic plant species then spread along the paths. The shores of bog lakes in managed reserves are severely littered, and fires started here have damaged areas of several tens of hectares.

The *Environmental Strategy of Lithuania* (1996) incorporates no peatland protection objectives. However, an action plan for the protection of peatland ecosystems is included in the *Biodiversity Conservation Strategy and Action Plan* (1997), and peatland research activities have recently been intensified. A mire monitoring programme has been developed but it has not yet been implemented due to financial difficulties. However, some information has been published (e.g. posters) and some peatlands have been designated as local protected areas. A planning scheme for Žuvintas biosphere reserve has been prepared but has not yet been approved. Indeed, for the majority of protected peatlands, no management has occurred since their establishment. A *Wetland Protection Strategy and Action Plan* was devised by the Lithuanian Fund for Nature in 1999/2000, but has not yet been approved by the Ministry of Environment.

Impediments

- *Inappropriate priorities.* Much funding is diverted to the construction of water treatment plants in the Nemunas river catchment. Peatland is a low priority habitat for nature protection and current peatland work focuses on re-naturalisation of fully extracted peatlands rather than on restoration and management of more valuable systems that have been degraded by drainage and exploitation.

- *Lack of funding.* Funding for nature protection (and other sectors) has declined significantly due to current problems in the country's economy and state budget. It is unlikely that peatland protection will receive appropriate attention and funding from the government in the immediate future.
- *Lack of trained specialists in wetland management and restoration.* Few specialists have appropriate expertise and the Ministry of Environment has no trained personnel; thus peatland problems assume low priority because they are not fully understood.
- *Lack of public awareness of the functions and value of peatlands*. Peatlands are still generally regarded as wastelands that can provide berries and peat, and the public are ignorant of their functions and importance. Therefore, in the current climate of depressed economy and low living standard, it will be difficult to mobilise significant funding for peatland management and restoration.
- Lithuania is distinguished amongst the Baltic countries in that it has the least wetlands and the smallest peat resource but the greatest pressure on peatlands. At present 62.9% of the total mineable (economically viable) peat area has been prepared for extraction or is currently being cut. The *Law on Energy* considers peat as a primary energy source, and favours peat extraction for fuel. Biomass, which includes peat, is regarded as a renewable energy source within the same law.
- In 1999 the government of Lithuania undertook to close the first reactor of Ignalina nuclear power plant before 2005, although the second one will continue to operate. This decision indicates gradual *phasing-out of nuclear energy* and will inevitably promote a search for new energy sources as well as local use of fuel peat.
- The *nature protection regime* does not ensure protection of wetlands from exploitation. In 1998 1,049 ha of protected peatland were under exploitation. Moreover, the Law on Protected Areas requires that institutions proposing the establishment of a protected area should, at least six months before designation, inform landowners and land-users of the proposal and the planned restrictions on land-use. This procedure provides an opportunity for peat extraction and other destructive activities to be stepped up during the period of notice.
- Interest in sapropel[14] has recently increased. Investigation of 154 deposits indicated the presence of 836,000,000 m^3 of sapropel and on this basis there should be approximately 4,000,000,000 m^3 of sapropel beneath Lithuania's peatlands. At present there is no extraction of sapropel.

Opportunities

- The process of accession to the European Union
- Low intensity of farming

14 Sapropel is a form of silty ooze found at the bottom of water bodies. It is a "modern" geological deposit originating from water plants and residues of animal origin in combination with fragments of higher plant tissue, pollen, sand, clay and various mineral solutions brought from land.

Plate 16. *Berzalotas bog in Zemaitija National Park in spring time.*

Selemonas Paltanavicius

Selemonas Paltanavicius

Plate 17. *Cepkeliai bog, Lithuania's largest and most beautiful bog, in Cepkeliai Strict Nature Reserve.*

- No funding from the state budget for new drainage projects. Minimal funding is provided only for maintenance and repair of existing agricultural drainage systems
- The protected areas system was implemented before land reform. Consequently good preconditions for the conservation of landscape and biodiversity have been created. However, some habitats that are especially valuable for biodiversity (wetlands, peat-bogs, meadows etc.) are still unprotected.

Priorities and recommendations

Priorities

At least 25% of all Lithuanian peatlands should be conserved. More than *ca*. 75,000 ha of natural or near-natural peatland is still without protection. It is recommended that at least one natural peatland of minimum area 50 ha should be conserved in every physical-geographical microdistrict.

National recommendations

- Increase public awareness and understanding of the functions, values and importance of wetlands
- Increase the area of protected peatland to 25%, taking into account identified deficiencies of protected areas
- Initiate management of protected wetlands, aiming first to minimise or exclude the influence of regional drainage
- Amend the Law on Energy to exclude peat from the lists of renewable and primary energy sources
- Implement renaturalisation projects on the most valuable damaged wetlands and abandoned peatlands.
- Initiate regular wetland monitoring activities.

International recommendations

- Further develop public education and information about peatland values, functions and importance
- Strengthen international co-operation and funding for conservation and management of transboundary peatlands
- Improve international legislation and conventions to ensure peatland protection.

4.6 Poland

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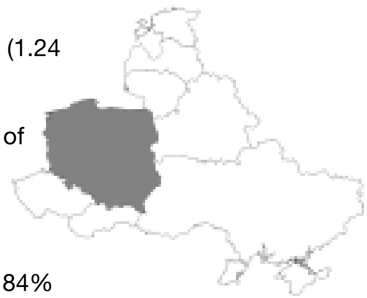
General information



Area: 31,268,000 ha
Population: 38,700,000 (1.24 inhabitants per ha)
Former extent of mire:* 1,254,800 ha (4.01% of the country area)
Present area of mire:# 201,938 ha (0.6% of the country area)
Estimated loss of mire: 84%

Poland is a lowland country, with only 10% of its area above 300 m a.s.l. The climate is temperate with a transitional (and highly variable) maritime-continental character. Almost the whole of the country is drained by two rivers, the Wisła (Vistula) and the Odra. The

* Estimated from peat deposits >0.3 m and >1 ha; 92.4% fen peat, 4.4% bog peat and 3.3% transitional peat.
\# Defined as peat deposits with hydrogenous vegetation types (usually peat-forming).

predominant land-uses are arable (45.0%), meadows and pastures (13.2%) and forest (28.4%). Most Polish peatlands are used as hay meadows and pastures (70%). Forests cover 12% of the peatland area, peat extraction has occurred on 4% and arable land occupies 0.5%. In 1999, peat extraction was in progress on 41 peatlands, and the total exploitation amounted to 580,000 tonnes.

The Polish flora and fauna contain elements of several biogeographical zones, resulting in very rich biodiversity. Forty per cent of Polish plant species reach their geographical limits in Poland. The biogeographical regions of Poland are presented in Figure 23. The distribution and diversity of mires is related mainly to the division and subdivision level.

Fens are the most common mire type and occur throughout the country, with the largest areas in the central lowlands ("belt of large river valleys"). *Spring mires*, some of which have a rare cupola form, occur in the young-glacial landscapes of the belt of coastal plains and uplands. *True raised bogs* (domed and treeless), which are rare and at the limit of their geographical distribution in Poland, are found mainly in the Baltic coastland and in the mountain zone ("Western Carpathians", "Eastern Carpathians" and "Sudeten"). *Continental raised bogs* (with coniferous forests) are more common and occur mainly in the young-glacial zone of northern Poland, together with numerous *transition mires* and *kettle hole mires*. Some mires resembling *blanket bog* are found in the Karkonosze Mountains. *Peatland forests* are also highly valuable; these are scattered sparsely throughout the country and include alder woods, birch forests, pine and spruce forests.

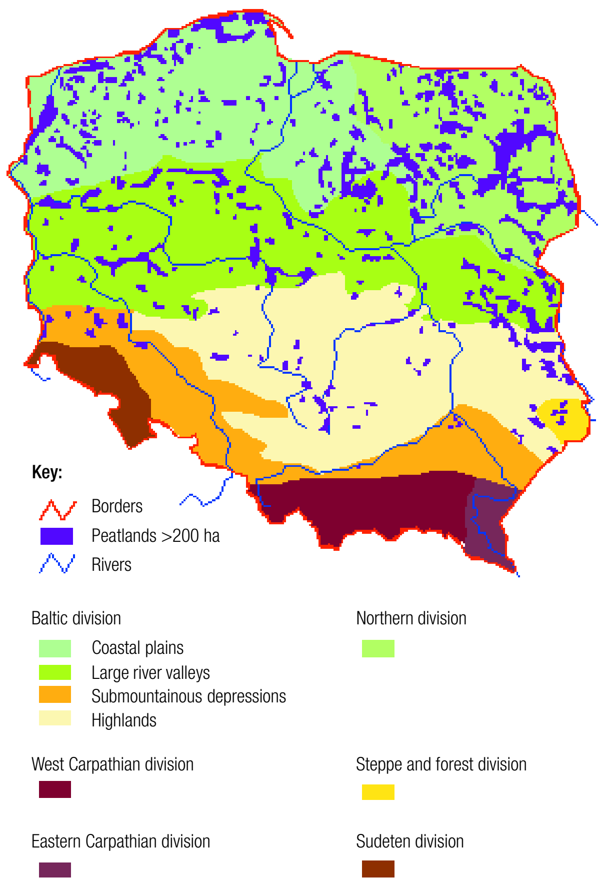


Figure 23. Biogeographical regions in Poland and distribution of peatlands larger than 200 ha.

Plate 18. *Raised bog in the Masovian Landscape Park near Warsaw.*

Zbyszko Pisarski

The total number of peatland vascular plants in Poland is estimated at over 300 (excluding the synanthropic ones). The Polish Red List of plants includes 24 peatland species (12% of protected plant species), for example: dwarf birch *Betula nana*, shortleaf sedge *Carex disperma*, tall bog sedge *Carex magellanica*, musk orchid *Herminium monorchis,* bog orchid *Hammarbya paludosa*, deer grass *Trichophorum cespitosum*, clustered club-rush *Scirpus hudsonianus*, brown-beaked sedge *Rhynchospora fusca*, sudetic lousewort *Pedicularis sudetica*, bird's eye primrose *Primula farinosa*, bog willow *Salix myrtilloides*, cloudberry *Rubus chamaemorus.*

Of the animals that rely on peatlands and peaty wet meadows, the most spectacular and best known are birds. The following species are the most important in terms of percentage of the total European population occurring in Poland: the white stork *Ciconia alba* (largest European population), bittern *Botaurus stellaris*, Montagu's harrier *Circus pygargus*, corncrake *Crex crex*, crane *Grus grus*, great snipe *Gallinago media* and aquatic warbler *Acrocephalus paludicola*. The most typical mammals of Polish mires are elk *Alces alces* and a rapidly growing population of beaver *Castor fiber*.

Extent and trends

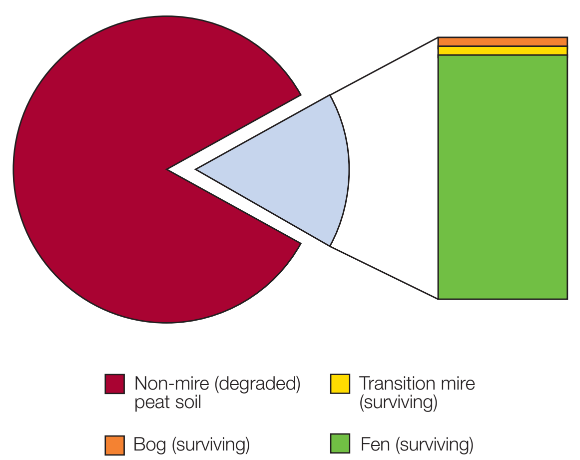
The current extent of mire habitats is shown in relation to the original area in Figure 24. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

Policies

The legal background for nature protection has been safeguarded in the Constitution of Poland. The following legislation is relevant to mire conservation:

- The *Act on Nature Protection* (1991 and later supplements) is the main wildlife and habitat protection law, encompassing protected areas, protection of species and additional regulations. Peatlands and wetlands are specifically mentioned as sites that may be given the status of 'ecologically used area' and as sites whose protection and preservation is vital to protecting the natural flora and fauna. The Act forbids peat extraction on protected areas.
- The *Act on the Protection of the Environment* (2001) requires Environmental Impact Assessment (EIA) for developments that are likely to cause damage to the environment, and in particular to affect the water regime.
- The *Geological and Mining Law* (as amended in 1994) requires EIA as part of the licensing procedure for mineral prospecting and mining of deposits including peat.
- The *Water Law* (2001) regulates water use, and incorporates the catchment-based approach for the management and protection of water resources.
- The *Act on Protection of Agricultural and Forestry Land* (as amended in 1994) mentions the role of peatlands and natural water bodies in the protection of agricultural land, and requires EIA before issue of peat extraction permits. Moreover, plans for the 'recultivation' of excavated peatlands have to be submitted with applications for extraction permits.
- The *Act on Forests* (as amended in 1991) recognises protection of biodiversity and soil resources as integral aims of forest management.
- *Decree No. 11 of the General Director of State Forests* (1995) on ecological forestry management includes a prescription to "maintain in an unchanged form forest 'wastelands' such as swamps, bogs, heathlands, etc., as well as peatlands, together with their flora and fauna, in order to protect biological diversity and their status as areas under ecological use".
- The *Second Ecological Policy of the State* (accepted by the Board of Ministers in 2000) highlights the ecological value of wetlands and identifies the need for a special strategy for their protection.
- *Poland 2025 – a long-term strategy for stable and sustainable development* (accepted by the Board of Ministers in 2000) confirms the goals, tasks and legal instruments of the Ecological Policy of the State.
- The *National Strategy for the Conservation and Sustainable Management of Biological Diversity* (2003) includes proposals for action on inventories and monitoring of biodiversity and threats, removal or limitation of those threats, and preservation and restoration of the elements of biological diversity. It also calls for integration of these activities with other economic sectors, public administration and society, including NGOs.

Figure 24. Poland: extent of peatland and mire habitats.



Peatland protection and its effectiveness

Practical protection of peatlands in Poland is achieved mainly within the established system of protected areas. International (Ramsar) protection status has been given to nine areas, of which two (the Biebrza and Słowiński National Parks) are important peatland regions. Additional peatland areas that will be designated in the near future are: Poleski National Park, Narwiański National Park, calcareous mires near Chełm, and the Middle Vistula Valley. There are approximately 350,000 ha of peatland within the boundaries of areas with nature protection status and for which protection plans are required. However, effective conservation is secured by law only in National Parks and Nature Reserves. Thus of the 350,000 ha of protected peatlands (28% of the total area of Polish peatlands), only around 120,000 ha (25,000 ha in Nature Reserves and around 92,000 ha in National Parks) have satisfactory

Marta Kaczyńska

Plate 19. *Biebrza Valley, Poland.*

protection status. Meanwhile the effectiveness of conservation in Nature Reserves remains limited by their small size. In other protected areas, land-uses such as state forestry, water management and farming often conflict with conservation. This problem is most severe in Landscape Parks and Protected Landscape Areas, but it exists also in National Parks that include significant areas of private land. Consequently a programme aimed at raising awareness of mire issues amongst decision-makers at all levels would be valuable.

Threats

- *Alteration of the natural water regime*, mainly by established water management schemes. New large-scale drainage works are uncommon due to agricultural recession.
- *Changes in land ownership* accompanied by changes in land-use that are altering natural and semi-natural peatland ecosystems.
- *Changes in agricultural practice*. Extensive semi-natural fen and fen meadow ecosystems are threatened both by cessation of traditional management and by intensification of their use.
- *Development of infrastructure* (especially the motorway network); conflicts with peatland conservation have been reported from several locations in the country.
- *Peat extraction and the accompanying drainage*. This encompasses both official peat exploitation sites (mainly bogs) and illegal small-scale peat mining, which is a common practice in some regions.

Opportunities

- Although most Polish peatlands have been drained to some degree, very few areas have been transformed into ploughed arable fields, since national management principles aim to minimise losses of organic matter through mineralisation. The preferred land-use for peatlands is permanent grassland, with the result that Poland has a great number of meadow communities on (mainly decomposed) peat soils, many of which have high biodiversity value. Maintenance of these systems offers a spectacular opportunity to conserve traditional human landscapes as well as rare species and ecosystems.
- New opportunities for the conservation of semi-natural communities on peat arise from the agri-environmental schemes of the European Union, which are already being piloted (from 2003) in selected areas and will be implemented country-wide after accession of Poland to the EU. These include compensation schemes for farmers who introduce management directed towards the protection of nature and the environment.
- Raised public awareness of the problem of water deficit also benefits mire conservation. In general, decision makers support initiatives to enhance the retention of water, which may involve protection and restoration of peatlands.
- With the development of the so-called “citizen society”, NGOs are assuming an increasingly important role in encouraging the public to become involved in nature conservation. The economic and sociological changes occurring in Poland are accompanied by changes in land-use and ownership that may endanger peatland biodiversity, but also enable NGOs to purchase land cheaply. This is often the most effective way to prevent destructive uses, such as peat extraction, on privately-owned mires.

Priorities and recommendations

Priorities

The priorities listed below arise from discussion amongst national experts in mire ecology and conservation, and include suggestions from the Polish Ministry of the Environment.

1. Development of wise land-use scenarios for major peatland areas.
2. Protection of semi-natural peatland communities through subsidising traditional management.
3. Updating of the national mire inventory.
4. Restoration of the water regimes of reclaimed peatlands.
5. Awareness campaign including:
   - mire education programme for schools
   - public awareness activities
   - raising awareness amongst farmers
   - enhancing information exchange amongst mire conservationists; and
   - training for decision makers.
6. Securing effective protection of raised bogs, including the prohibition of peat extraction.

National recommendations

- Improve the implementation of legislation relating to mire protection.
- Raise public awareness of peatland values and functions.
- Update the peatland inventory, incorporating biodiversity values and threats.
- Secure equal protection for all mire types, and safeguard the management of fens.
- Initiate a country-wide project to enhance the protection of open peatland communities.
- Encourage and improve co-operation between the various organisations involved in mire conservation.

International requests

- Support through EU agri-environmental schemes for the conservation of species-rich managed peatlands.
- Support for an updated peatland inventory.
- Support for a public awareness campaign.
- Enhance international exchange of knowledge between mire experts.
- Financial and expertise support for practical conservation and restoration projects.

Ongoing peatland activities

- *Darwin Initiative Peatland Biodiversity Programme (PBP, 1998–2003)*: nine Polish delegates; further possibilities for co-operation with PBP participants are being discussed.
- *GGAP implementation*: Polish experts are involved in development and implementation of the Guidelines for Global Action on Peatlands (GGAP), as representatives of IMCG and IPS.
- *Preparation of digital database*: a comprehensive GIS database for the Polish environment, based on 1:100,000 maps which include information from peat deposit inventories conducted during the 1950s and 1960s, is currently being developed by the Institute of Environmental Protection (IOS) and the Institute of Land Reclamation and Grassland Farming (IMUZ), with support from the Dutch Ministry of Agriculture, Nature and Food Quality.
- *Natura 2000 network for Poland*: numerous valuable mire regions will be incorporated.
- *EU agri-environmental programmes*: special packages for the management of fens, bogs and wet meadows in Environmentally Sensitive Areas have been formulated.
- *Management plans for protected areas*: the legislation for nature protection requires that each protected area should have a management plan, to be developed by appointed specialists.
- *PROM*: the Polish Coalition for Wetland Protection, established in 1998, aims to enhance utilisation of legal and economic mechanisms for environmental protection and to serve as a forum and resource for those interested in the protection of wetlands.
- *Conservation and restoration of wetlands in Western Poland*: a Nature Club project, which started in 2000, aiming to restore and actively protect up to 200 wetlands and mires, especially on State Forestry land; the project includes supporting field training courses on wetland conservation.
- *Multi-functional use of peatlands in Poland as an opportunity for preserving biodiversity*: a project subsidised by the Dutch PIN-MATRA programme, starting in September 2003. Focusing on four case study areas, an attempt will be made to develop integrated management schemes to combine peatland conservation and restoration with economically sound agricultural and hydrological management. The project will be implemented by *Nature Club* and *Save Wetlands Association*, with expert support from the restoration ecology group of the University of Groningen.
- *Various local initiatives on restoration and management*: several scientific centres, NGOs, National Parks and Landscape Parks are active in mire conservation at local and regional scale, for example in developing management plans and conducting restoration projects.

4.7 Slovakia

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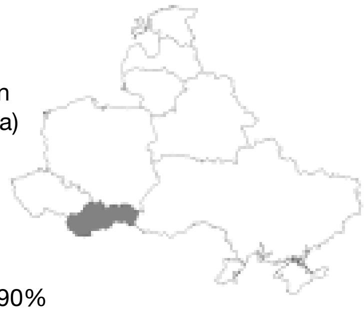
General information
Surface: 4,903,600 ha
Population: 5,324 million
(1.09 inhabitants per ha)

Former area of mire:*
26,000 ha
Present area of mire:#
>2,575 ha
Estimated loss of mire: 90%



Introduction

The main socio-economic activities in Slovakia are agriculture, industry and transport. The country is situated on the boundary of oceanic and continental climatic influences, which result in relatively mild summers *and* winters. The continental influence increases to the east. It also lies on the border between the Carpathians and the Pannonian plain. The Carpathians cover more than 70% of the country, contributing an extremely diverse and

* modelled estimate;
\# rough estimate based on expert judgement

complicated geological structure and contrasting starkly in altitude, relief, temperature, precipitation, soils, flora and fauna with the Danubian lowlands. The ground rises from 94 m (Bodrog) to 2,655 m above sea level (Gerlach peak) over a horizontal distance of only 153 km. This diverse territory supports high biodiversity. The number of vascular plant species exceeds 3,200, and approximately 900 brown bears, 300–400 wolves and 600–800 lynx live in the Slovakian Carpathians.

Biodiversity value of peatlands

Peatlands occur mainly in the sub-mountainous to lower alpine zones of the Tatras, and in the Orava, Liptov, Turiec, Spiš and Pohronie regions. They are very rare in the Záhorie Lowland and the Podunajská Lowland. Raised bogs occur in the mountainous to sub-alpine zones of the Tatras and in the Orava and sub-Tatra hollows, whilst fens descend to lower altitudes. Peatlands are recognised as one of the rarest and most threatened habitats in Slovakia. After the last glaciation, many peatland species from southwest and southeast Europe found refugia in the Carpathian peatlands, where they occur in unique combinations. Carpathian rich fens are unique ecosystems, with a very high level of species diversity and numerous threatened species and community types.

Several of Slovakia's endangered species are restricted to peatland habitats, e.g. bog arum *Calla palustris,* string sedge *Carex chordorrhiza,* mud sedge *C. limosa,* slender sedge *C. lasiocarpa,* great fen sedge *Cladium mariscus,* Labrador tea *Ledum palustre,* great sundew *Drosera anglica,* black bog rush *Schoenus nigricans,* blue moor grass *Sesleria uliginosa,* moor-king lousewort *Pedicularis sceptrum-carolinum,* bog willow *Salix myrtilloides,* fen orchid *Liparis loeselii* and the bryophytes *Bryum marratii* and *Campylium elodes*. Some of the rare glacial relict moss species of minerotrophic fens, e.g. *Calliergon trifarium, Catoscopium nigritum*, *Helodium blandowii, Hypnum pratense, Meesia triquetra, Paludella squarrosa, Scorpidium scorpioides* and *Tomenthypnum nitens* reach their southern distribution limits in Slovakia. The rare *Sphagnum balticum* and some precious vascular plants, e.g. few-flowered sedge *Carex pauciflora,* Rannoch rush *Scheuchzeria palustris,* white-beaked sedge *Rhynchospora alba* and others, are found mainly in ombrotrophic raised bogs.

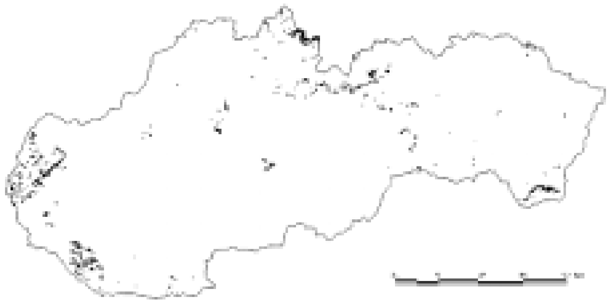


Figure 25. Reconstructed peatland vegetation of Slovakia, according to the geobotanical map of CSSR. (Michalko *et al.* 1986).

Extent and trends

The potential natural vegetation of Slovakia, presuming no human influence, has been reconstructed as a set of maps. The resulting estimate of peatland cover (peat layer >40 cm) is 26,000 ha (260 km^2), or 0.57% of the total area of Slovakia. For the purposes of this project, the present extent of peatlands has been roughly estimated (on the basis of expert knowledge) at 2,575 ha, indicating that about 90% of the country's peatlands have been lost. As the area of peatlands was initially very small, this calculation emphasises the need for protection. Peatland inventory started in 2001, and so far 2,350 ha of mires have been mapped. 41,593 higher plant and 4,041 moss records have been created. Extrapolating from current

Plate 20. *Belianske lúky National Nature Reserve in the foothills of the Tatra Mountains – the biggest fen rich spring system in Slovakia.*

Viera Stanová

knowledge, we estimate that the total area of surviving peatland in Slovakia will be around 3,670 ha, which is nearly 50% more than the present estimate.

The current extent of mire habitats is shown in relation to the original area in Figure 26. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

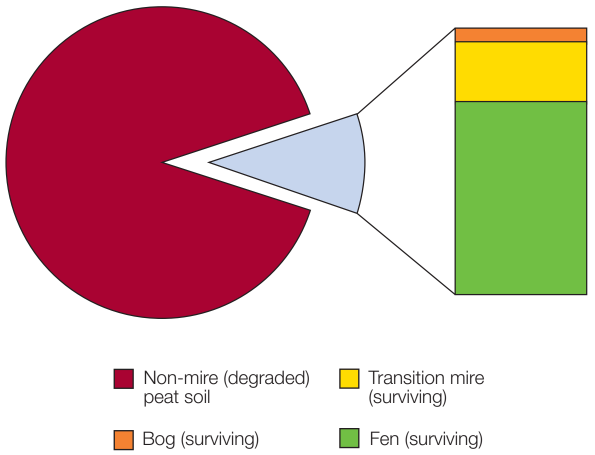


Figure 26. **Slovakia: extent of peatland and mire habitats.**

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Plate 21. *Labrador tea* Ledum palustre *growing in a bog system at Klin National Nature Reserve.*

Plate 22. *White-beaked sedge* Rhynchospora alba *in pools on Sucha hora bog.*

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Policies

There are no specific references to peatlands in the *National Biodiversity Strategy* (approved by Parliament in 1997), but several of its goals and strategic directions are highly relevant to peatlands. These include: “identify biodiversity”; “manage threatening processes”; “strengthen the *in-situ* conservation of biodiversity”; and “promote all forms of education and awareness related to biodiversity”. The new *Law on Nature and Landscape Conservation* (2002) ensures comprehensive protection of nature and landscapes employing five different levels of designation, in accordance with IUCN criteria. For peatland areas with no special protection, changes in land-use (e.g. drainage) must be approved by the Regional and/or District Government Offices.

Peatland protection and its effectiveness

The total network of protected areas in Slovakia, including buffer zones, covers more than 22% of the Slovak territory. Some 2,773 ha of peatlands are protected by law within 115 small-scale protected areas (Protected Sites, Nature Reserves, Nature Monuments). These include 13 bog sites (445 ha), 93 fen areas (1,994 ha) and nine mixed mire sites (335 ha). There are four Ramsar Sites with significant peatland components, namely Šúr, Rudava River Valley, Turiec Wetlands and Wetlands of the Orava Basin. The extent of peatland within these sites is approximately 1,500 ha. Although the most important peatlands are protected by law, in many cases their water regimes are influenced by human activities. There is lack of knowledge about ecosystem functions and management planning so that human activities such as forestry, recreation and intensive agriculture often interfere with the objectives of nature conservation, reducing its effectiveness. Moreover, many protected mires are facing serious management problems because traditional farming (mowing, grazing, cutting of trees and shrubs) is no longer profitable and few landowners are interested in management to promote nature conservation.

Threats and impediments

The main threats to peatland biodiversity are:
- drainage and conversion to arable land
- drainage of fens to increase the area of grassland
- lack of management of protected areas
- extraction of peat for soil improvement, horticulture, medical purposes etc.; and
- eutrophication.

The underlying cause of these threats arises from a general lack of appreciation for peatlands. They are consequently given a low conservation priority. During the last 40 years, nature conservation practice on protected fens has prohibited traditional grazing and mowing, allowing scrub *encroachment* and rapid succession leading to a significant decline in species diversity. Prior to designation, the main threat to these sites was hydrological degradation, but now they are threatened by ineffective management. The overall result is that local farmers have lost grazing and hay-making land and local communities have experienced degradation of the environment because the State Nature Conservation Agency has failed to protect designated areas appropriately.

Opportunities

As an EU accession country, Slovakia is striving to adopt EU legislation such as the Habitats and Birds Directives, and valuable habitats will have to be identified for the Natura 2000 network. This should increase the effectiveness of nature conservation. The *National Biodiversity Strategy of Slovakia* (1997) and the *National Biodiversity Action Plan* (1998) not only stress and promote biodiversity conservation in general, but also make specific recommendations for improvements in conservation management, sustainable use and restoration of the natural environment that are relevant to peatlands. The problem is that there is limited funding in the national budget for implementation of the Action Plan.

Priorities and recommendations

Priorities

Valuable habitats are to be identified for the EU Natura 2000 network. It is vital that these should include the important peatland habitats. Three *priorities* have been identified in this context:
1. *Peatland inventory* to support decision-making in relation to national policy and establishment of the Natura 2000 Network. It is necessary to continue to improve on the present rough estimate of the area of peatlands, and to catalogue their biodiversity and conservation values, threats and management needs.
2. *Management plans* for Natura 2000 sites
3. *Raising awareness* of the values and functions of peatlands, including continuation of the new education programme for teachers.

National recommendations

- Increase the priority afforded to peatland conservation
- Improve restoration and management planning policy
- Develop and adopt wise use guidelines for peatlands.

Requests for international support

- EU support for traditional management of fens (Common Agricultural Policy, Regulation No 2080/92)
- Continued support for peatland inventory, development of management plans and the *awareness* raising campaign
- Transboundary protection of peatlands in the Orava region which straddles the border between Poland and Slovakia.

Ongoing peatland projects

- *Protection and Management of the Turiec Wetlands* – Slovak Environmental Agency in co-operation with Wetlands International.
- *Conservation and Sustainable Use of Peatlands in Slovakia* – DAPHNE in co-operation with NEPCon (Denmark, DANCEE funding).
- *Ecohydrological research as a basis for restoration of calcareous fens in the Slovak Republic* – University of Groningen, DAPHNE and Alterra financed by PIN-Matra.
- *Conservation, Restoration and Wise Use of Rich Fens in the Slovak Republic* – medium size project of DAPHNE Institute for Applied Ecology funded by UNDP/GEF.

4.8 Ukraine

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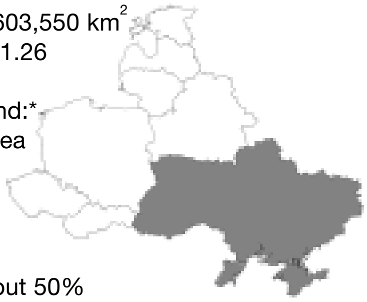
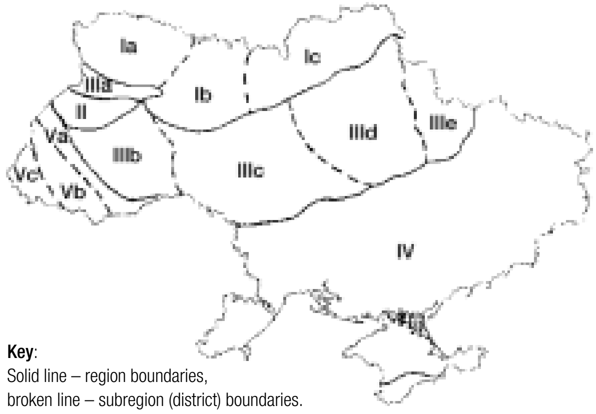
State Agency for Protected Areas of Ukraine
Ministry of the Environment and Natural Resources
1 Tyminyazevska Str., 01014 Kyiv

General information

Area: 60,355,000 ha or 603,550 km^2
Population: ~48 million (1.26 inhabitants per ha)
Current extent of peatland:* 1,000,000 ha (1.7% area cover)
Current extent of mire: 580,000 ha (~1% area cover)
Estimated mire loss: about 50%





Key:
Solid line – region boundaries,
broken line – subregion (district) boundaries.
I. Polissian Peat-Mire Region: Ia: Western Polissian District; Ib: Central Polissian District; Ic: Eastern Polissian District.
II. Small Polissian Peat-Mire Region.
III. Forest-Steppe Peat-Mire Region: IIIa: Volynian Forest-Steppe District; IIIb: Podilian Forest-Steppe District; IIIc: Right-Bank Forest-Steppe District; IIId: Left-Bank Forest-Steppe District; IIIe: Eastern Forest-Steppe District.
IV. Steppe Peat-Mire Region.
V. Carpathian Peat-Mire Region: Va: Pre-Carpathian District; Vb: Carpathian District; Vc: Over-Carpathian District.

Figure 27. **Ukrainian mire regions.**

Introduction

Ukraine has large resources of raw materials including iron, manganese, potassium, coal, oil and natural gas. The main agricultural products include cereals, potatoes, sugar beet, meat, milk and eggs. Principal exports are steel, ships, aircraft, timber, military equipment and agricultural products. Three main physiographical zones are recognised in the lowland part of Ukraine: mixed forests (Ukrainian Polissia), forest-steppe, and steppe. The highland regions include the Ukrainian Carpathians in the west and the Crimean Mountains in the south. The whole territory of Ukraine lies within the temperate climatic zone, except for the Crimean South Coast which has some subtropical climatic features and belongs to the sub-Mediterranean zone. Of considerable importance to Ukraine is the influence that peatlands have on microclimate and water regime.

* peat deposits more than 0.7 m deep (industrial resources).

Biodiversity values of peatlands

Three biogeographical regions are recognised for Ukraine (Figure 27). In the *Alpine region* (the Carpathians) small bogs, transitional mires and fens all occur. In the Carpathians, mires are less numerous but deep and old; rare mountain pine-*Sphagnum* and larch-*Sphagnum* bog types occur here. The *Continental region* (Forest and Forest-Steppe zones) is rich in peatlands, which are predominantly fens but also include transitional mires and bogs. In the *Steppe region* (Steppe zone including the

Plate 23. Salix lapponum *(foreground) in a mesotrophic sedge-Sphagnum mire.*

Grigoriy Parchuk

Grigoriy Parchuk

Plate 24. *Paludifying former river bed.*

Crimean Mountains), peatlands are rare but do occur near large rivers.

The Ukrainian Red List includes 50 species of peatland animals, including the birds aquatic warbler *Acrocephalus paludicola*, corncrake *Crex crex*, capercaillie *Tetrao urogallus*, golden eagle *Aquila chrysaetos*, greater spotted eagle *Aquila clanga*, lesser spotted eagle *Aquila pomarina*, eastern imperial eagle *Aquila heliaca*, purple heron *Ardea purpurea* and peregrine falcon *Falco peregrinus*; the mammals lynx *Felix lynx* and otter *Lutra lutra*; and the insects *Aeshna viridis*, *Leucorhinia caudalis*, *Coenonympha oedippus*, *Lycaena dispar*, *Maculinea arion*, *M. nausithous* and *M. teleius.* The flora includes a number of rare and relict peatland species, in particular the Rannoch rush *Scheuchzeria palustris*, the willows *Salix lapponum* and *S. myrtilloides*, the few-flowered sedge *Carex pauciflora*, the small-leaved cranberry *Vaccinium microcarpum* and some *Sphagnum* mosses.

Extent and trends

Ukraine now has approximately 2,400 peatland sites which cover around 1 million ha. An estimated 100,000 ha have been significantly extracted, more than 150,000 ha have been drained, 170,000 ha are currently being mined for peat and about 150,000 ha are under protection. The remaining 430,000 ha are unprotected natural peatlands. Peat is extracted commercially, mainly for fuel but also for peat products such as "peat pots". Peat is also used locally for heating and as a soil conditioner fertiliser, but the quantities involved are not registered making it difficult to estimate total use.

The current extent of mire habitats is shown in relation to the original area in Figure 28. The pie chart shows the estimated original extent of peatland, and the fraction of this that remains as some form of mire habitat today. The bar chart alongside indicates the relative proportions of the three major mire types – bog, fen and transition mire – represented within the surviving mire area.

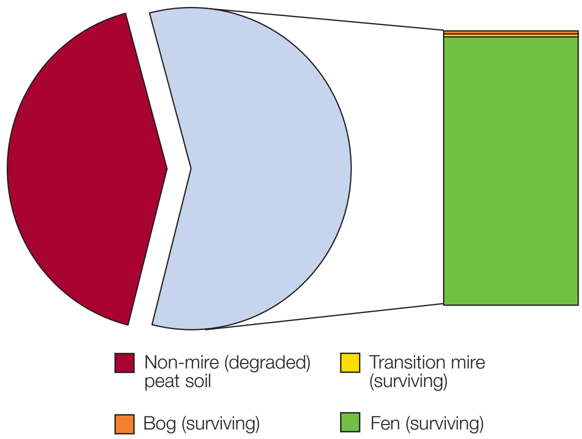
Policies

Water-covered land (seas, rivers, lakes, ponds and mires), water protected zones and offshore belts are administered according to the *Law of Ukraine On Water Resources Fund* (1995). Mires and other land areas are included because they are important for water regulation. Users of land allocated to the Water Resources Fund are required to apply measures to protect it from erosion, pollution, etc., and to minimise the effects of drainage and peat extraction.

Drained peatlands with at least medium-depth peat are classed as particularly valuable productive land within the Land Code and therefore cannot be privatised. The *Land Resources Code* determines the conditions under which areas are allocated for peat extraction.

The *Law of Ukraine On Protection of the Environment* (1991) sets the ecological requirements for use of all natural resources, including peat (Article 40).

Figure 28. **Ukraine: extent of peatland and mire habitats.**



Main Directions of Policy for Environmental Protection (1998) is a parliamentary resolution on the use of natural resources, environmental protection and ecological safety. It lists the following peatland-related priorities:

- Improvement of the ecological status of river basins. It is necessary to restore natural conditions within river basin systems. Peatlands are important catchment elements and they play a major role in regulation of the water level.
- Conservation of biological and landscape diversity by expansion of protected areas. All the most valuable ecosystems, including peatlands, must be taken under protection and added to the Protected Areas Network of Ukraine. Ukraine's National Econet Development Programme (State programme, 2000) aims to enlarge the Protected Areas Network by 5.5%, to 10% of the area of the country.
- Introduction of sustainable use principles. There are plans to reduce the ploughed area by 5% to 50%.
- Development of a programme of ecological education and public awareness.

A Government Resolution of 1997 (No. 439) adopted the *Strategy of Biodiversity Conservation in Ukraine*, which highlights conservation of biological and landscape diversity together with restoration of wetlands.

When land is drained, irrigation-drainage systems with automatic water regulation must be installed. It is intended that the area of perennial grasses on drained peatlands will be increased to 60–70%. The law *On Amelioration of Lands* (2000) obliges developers to agree amelioration projects with nature protection authorities.

The change in pattern of land ownership anticipated as a result of changes in agricultural management is not yet complete, and the associated new legislation is still being developed.

In general, peatland ecosystems are poorly understood and there are few initiatives for improving their conservation in Ukraine. There are some peatland conservation programmes, but the country's economic crisis currently precludes adequate funding and, in the immediate future, land privatisation will considerably hamper their progress. Consequently there is an urgent need to identify valuable peatlands and to adopt best international practice for their management, rational use, assessment and monitoring.

Peatland protection and its effectiveness

Protection of valuable natural complexes and sites, including mires, is achieved by granting protected area status. The *Programme for Development of Principles for Reserve Affairs in Ukraine* (1994) focuses on optimisation of a system to protect biological diversity and landscapes; and to promote ecological stability, environmental monitoring, scientific research, and ecological and patriotic education of the public.

The system of protected areas includes: 17 Nature Reserves (IUCN category I a,b), 12 National Nature Parks (IUCN category II), 132 Natural Monuments (IUCN category III), 292 Wildlife Reserves (IUCN category IV), 44 Regional Landscape Parks (IUCN category V) and four Biosphere Reserves, as well as several protected areas of local importance. The protected areas cover around 2.7 million ha, which is 4.5% of the area of the country. The most widespread protection measure for peatlands is their designation as Wildlife Reserves (Zakaznyks). Forest, steppe, mire and other landscapes can be granted Wildlife Reserve status if they possess the requisite scientific, nature protection and aesthetic attributes. Special regulations which impose restrictions on users apply for all protected areas. Nature Reserves, National Nature Parks and Biosphere Reserves, together with 21 of the 44 Regional Landscape Parks and five of the 22 Ramsar Sites, have administrations with guards and research divisions. For other designations, including Wildlife Reserves, the responsibility for protection lies with the users, but although the activities of landowners are restricted they receive no compensation.

Two National Nature Parks, four Nature Reserves and six Regional Landscape Parks together contain 90,000 ha of peatland. 13,500 ha of peatland in the Polissian Region (Volynska Oblast) were added to the Ramsar List in 1995, through designation of the Shatsk Lakes, the Prypiat River Floodplains and the Stokhid River Floodplains sites. When small protected areas are taken into account, the total area of protected peatland amounts to approximately 150,000 ha, leaving 430,000 ha unprotected.

Within the planned programme for establishing Ukraine's National Econet, 34 new protected areas will be designated and 11 existing Nature Reserves and National Nature Parks will be enlarged, by 2015. These measures will extend protection to 12 additional peatland ecosystems, the most important of which are the Snov River floodplains (4,500 ha), the Vorskla River valley (1,000 ha) and the swamp massif "Zamglai" (3,000 ha). In addition, more peatlands will be designated as Ramsar Sites.

Small peatlands on mountain slopes in the Carpathians are not protected strictly enough, but otherwise all types are protected equally well.

Threats and impediments

- *Peat extraction for fuel and mineral soil conditioners/ fertilisers*. The "National Energy Programme of Ukraine to 2010" prescribes annual extraction of around 1.6 million tonnes of peat and production of 0.7 million tonnes of peat briquettes under licence over the next 15 years. There are 170,000 ha of peat fields but the rate of extraction is currently low due to lack of money. In 1999, extraction of 1,233,000 tonnes of peat including 889,000 tonnes for fuel, was planned. Peat extraction is extremely damaging to ecology. The extractors select sites without regard for nature conservation and exhausted peat fields are not restored. Practically all extraction is preceded by large-scale drainage which significantly alters the natural hydrological regime and renders worked-out areas susceptible to wastage and fire, releasing considerable amounts of carbon dioxide. The fire hazard could be reduced by closing drains before abandonment of the peat fields.
- *Land reclamation*. Around 80% of peatlands are "improved" in one way or another and this often

triggers degenerative processes such as wind and water erosion, desertification and increased salinity, leading to loss of climate-regulating functions and contamination of water by organic matter. Over the last 30 years, 120–150 million tonnes of peat have been lost as a consequence of such activities on about 60,000 ha of peatland.

- *Re-cultivation after peat extraction*. Extracted areas are normally used for agriculture (arable land, pasture, hay mowing), forestry or creation of fishponds. Re-naturalisation is not valued as an after-use, but it often occurs in practice due to lack of money.
- *Drainage and intensive agriculture.* Since the Second World War more than 300,000 ha of peatland have been drained and converted into pastures, hay meadows, ploughed fields, forestry plantations and fishponds.
- *Flooding* caused by construction of dams for hydro-power and flood protection. Such schemes are often located far upstream of human habitation and can be achieved without appropriate ecological input; many peatland ecosystems have been harmed.
- *Pollution* by organic or inorganic substances may cause decline in biological diversity and rapid succession.
- *Radioactive pollution*. Chernobyl accident.
- *Development of infrastructure*, including construction of national and transboundary roads, has affected many peatlands.
- *Land privatisation* is now proceeding rapidly, and it is anticipated that this will exert a strong negative influence on shallow and drained peatlands.
- The *legislation regulating peat extraction* is inadequate and no guidance is available on the application of wise use principles in development, working and after-use of exploited peatlands.

Opportunities

Development of Ukraine's Econet by 2015 (see above).

Priorities and recommendations

National priorities have been selected on the basis of discussion with the environmental authorities.

1. *Improved legislation for peatland conservation*. Review and development of legislation governing the use of land and mineral resources is necessary to take into account economic transition and recent changes in the structure of executive bodies. The existing law is particularly outdated with regard to extraction, re-cultivation and wise use of peatlands, and conservation of peatlands should be given priority in the review process.
2. *Peatland inventory and creation of new protected areas*. An updated peatland inventory, including assessment of biodiversity/conservation values, is essential to legislative reform and selection of new protected areas.
3. *Strengthening of management capacity*. Ukraine's protected peatlands need management plans which should include restoration measures. Special arrangements will be needed to improve management of protected areas that do not have resident administrations.
4. *Raise awareness* of the values and functions of peatlands amongst decision-makers, landowners and other stakeholders. Strengthen co-operation between authorities, users, owners and local communities. Introduce the principle of compensation of owners for land-use restrictions. Develop wise use guidelines for decision makers, landowners and other stakeholders.

Additional recommendations

- Reduce existing threats to peatlands
- Develop wise use guidelines for peatlands including recommendations for good practice in peat extraction
- Monitoring of valuable peatland areas
- Increase co-operation between environmental authorities, local authorities, land-users, NGOs and local people
- Encourage traditional management of fens.

International requests

- International support for inventory is requested
- In order to improve conservation of biological and landscape values, input of international expertise is requested; particularly in relation to management, monitoring, capacity building and public awareness.

5. Peatland conservation in Central Europe

This Section reviews the conservation status of the remaining natural peatlands (mires) within the focal region, summarises threats to their continued survival that have been identified by the focal countries, and identifies principal needs to improve the future prospects of the resource.

5.1 The protection status of Central European peatlands

Figure 29 shows the fraction of the reported "near-natural" peatland area in each of the focal countries that has some form of statutory designation for nature conservation. The designated area exceeds the near-natural area in Lithuania, Poland, Slovakia and the Czech Republic.

However, in four countries (including Belarus and Ukraine which together contain 54% of the region's total peatland resource), at least two-thirds of the remaining natural peatland has no statutory protection.

Figure 30 shows how the designated fraction of near-natural peatland varies with the current near-natural area. Whilst there are inconsistencies between countries in the degree of disturbance to sites that are included in the "near-natural" area (Section 3.2), it does not seem plausible that these can account for the whole of the difference in intensity of statutory peatland protection between countries where the area of near-natural peatland is 300,000 ha (30 km^2) or more, and those where it has fallen below this threshold. For countries at or above the threshold, only 12–33% of near-natural peatland is designated; whilst below the threshold, the designated fraction is 104–173% (i.e. the designated area exceeds the near-natural area). There are a number of possible explanations, for example:

- Focus of nature conservation on rare and threatened habitats/species.
- Extensive disturbance to peatlands is one symptom of relative economic prosperity, which creates a situation where some national income can more readily be directed towards the "luxury" of nature conservation.
- Disturbance of peatlands creates additional habitat types, which may acquire conservation value for their unnaturally diverse assemblages of species (Section 2.5); thus the extent of designation necessary to include examples of all peatland types may well increase with disturbance.

Regardless of the contributing mechanisms, this analysis indicates a clear (albeit inadvertent) bias in regional peatland conservation policy towards the conservation of rarity and possibly also of local species diversity. Within this approach, the conservation of natural and typical habitats (Section 2.5), and of the vital environmental and landscape functions of peatlands (e.g. Section 2.3), are likely to be neglected.

The successful operation of any nature conservation policy depends upon its effective implementation in practice. Several of the accounts included in Section 4 indicate that this is not always achieved simply through the designation of sites. Indeed it is clear that some of the designations used for peatlands in the target countries actually allow sites to be damaged. For example, all of the most important Slovakian peatlands are protected by law, but this does not prevent disturbance of their water regimes by human activities, while in both Slovakia and Poland, lack of active management means that protection is ineffective for semi-natural systems, in particular fens and fen meadows. Since responsibility for peatland conservation lies principally at national level, a wide variety of legislation governs its operation across the region. Table 10 summarises the designations that are used for peatlands within each country, and gives an indication of the intensity of management for each category of protected area. Even where the same nominal designation is used in more than one country, national

Figure 29. **The fraction of the remaining natural peatland area that has some form of statutory conservation designation, for each of the focal countries.**

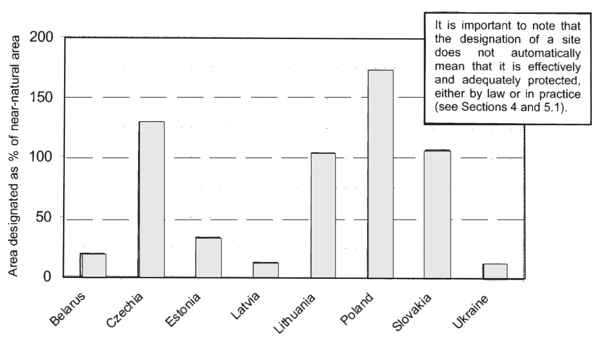
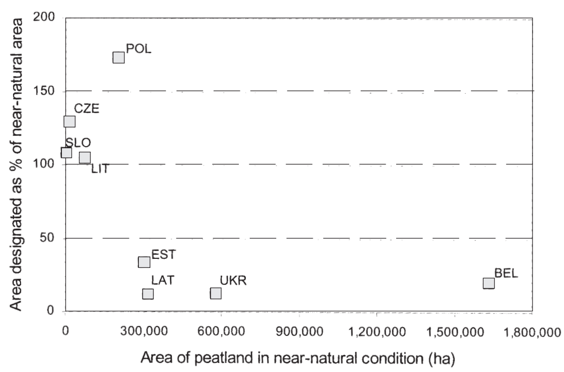


Figure 30. **The relationship between the area of designated peatland[15] and the total area of near-natural peatland within each of the focal countries.** ***The data point representing each of the focal countries is labelled with the first three letters of the country's name.***



15 Expressed as a fraction of the area of near-natural peatland reported for each country.

Table 10. Summary of the statutory conservation designations that are currently used for peatlands in the focal countries, with an indication of the intensity of management.

	Bel	Cze	Est	Lat	Lit	Pol	Slo	Ukr
Berry Zakaznik	P							
Biosphere Monitoring Area					A			
Biosphere Reserve	A	a		P	A			A
Botanical Zakaznik	P				A			
Buffer Zone	A							
Hydrological Zakaznik	P	P						
Important Landscape Element		P			A			
Key Ornithological Territory	P	a			P			
Landscape Park/Reserve	A		P			P		
National Nature Monument		A						
National Nature Reserve	A						A	
National Park/National Nature Park	A	A	A	A	A	P	A	A
Natural peatland not allocated to a Fund	P							
Nature/Natural Monument		A		A				P
Nature Park		a		P				
Nature Reserve		A	a	A	A	P	A	
Other protected area			P					
Protected Landscape Area		A		P		P	a	
Protection Area/Protected Site					A			
Ramsar Site	A	a	a	n/a	A	n/a	P	a
Regional Park/Regional Landscape Park					A			a
Reserve Stow								P
Restoration (recuperation) area		P			P			
Strict Nature Reserve		A		A	P			A
Wildlife Reserve (Zakaznyk)	P							P

Key: A: active management; a: active management on some sites only; P: passive management; n/a: category exists, but no details are available on the country's approach to management. Further information is given in each national account (Section 4).

approaches to management differ; for example, National Parks and Ramsar Sites are actively managed in some countries and not in others.

In view of the variation between countries in the effectiveness of national protection measures, it is of interest to know how much of the resource is protected according to internationally prescribed standards. The only designation that is consistent across all of the focal countries is that of Ramsar Site (Wetland of International Importance) (Section 2.10). Table 11 shows the fraction of designated peatland included in Ramsar Sites within each country. The countries are arranged in descending order of the percentage of their protected peatlands that are included within Ramsar Sites. There is no clear pattern, but it seems that those countries that have lost 70% or more of their natural peatlands (Table 7) have generally obtained Ramsar designation for larger fractions (26–65%) of the remainder. Those that retain more than 47% of their natural peatlands have designated only 6–32% of what is left.

Table 11. The fraction of protected mires lying within Ramsar Sites (the only common conservation designation) for each of the focal countries.

Country	Area of protected peatland (ha)	Number of Ramsar Sites	Area of peatland in Ramsar Sites (ha)	% of protected peatland area with Ramsar designation
Lithuania	78,357	5	24,596	65
Slovakia*	2,773	4	~1,500	54
Estonia	163,000	6	58,900	36
Poland	350,000	8	90,455	26
Czech Republic	19,000**	10	8,605	32
Ukraine	70,305	3	13,500	14
Belarus	317,200	1	18,869	6
Latvia	38,000	6	n/a	n/a

* data are not precise; they refer to habitats that are mainly peatlands but also include complexes of peatland with non-peat wetlands such as tall sedge and reed bed communities.
** all peatlands in Czechia are protected; this figure indicates the area with more than the minimum level of protection.
n/a: no information available.

5.2 The principal threats to the peatlands of Central Europe

The above review, albeit based upon limited quantitative data combined with expert opinion from the participating countries, delivers a clear message. There have been significant losses of peatland throughout the region. There are uncertainties about the true extent of the resource that remains, and there has been insufficient research about the degree to which important functions and services provided by natural peatlands are retained in association with different human uses. And yet, activities that damage these vital functions and services irreversibly are allowed to continue and are even promoted – albeit unintentionally – through a combination of government policy, practical administrative difficulties, and public ignorance.

A wide range of peatland uses that are non-sustainable – in that they are incompatible with continuation of the peat forming process – have been reported from the participant countries (Section 4), and must be regarded as threats to the region's peatland resource. These are summarised in Table 12. From this analysis, it emerges that peat extraction, drainage, inappropriate agricultural practice and pollution are universal influences, although their exact nature often varies between countries. For example, acid

Table 12. Summary of main threats to peatlands reported from the focal countries.

Threats		Est	Lat	Lit	Pol	Cze	Slo	Ukr	Bel
		Country							
Peat extraction	Horticulture	■	■	■	■	■		■	
	Agriculture (humus/fertiliser)		■			■		■	
	Balneology					■			
	Fuel	■	■	■				■	■
Change in hydrology	Drainage	■	■	■	■	■	■	■	■
	Excessive use of water				■		■		
	Drainage in catchment	■			■	■	■		
	Drainage of reclaimed areas				■	■			
	Drainage of margins (forestry)	■				■	■		
	Forest die-back					■			
Management regime (semi-natural sites)	Intensification*				■			■	■
	Extensivation / abandonment	■		■	■	■	■		
	Mineralisation	■		■	■	■		■	■
	Peat degradation	■		■	■	■		■	■
	Salinisation/desertification				■			■	
	Erosion				■	■		■	
	Fire	■	■			■		■	■
Pollution	Acid rain				■	■			
	Liming					■			
	Eutrophication	■	■		■	■	■		■
	Pesticides					■			
	Flue gas	■							
	Oil spills								■
	Organic/inorganic pollution							■	
	Radioactive pollution							■	■
	Climate change	■				■	■		■
Construction	Hydropower dams (flooding)					■		■	
	Urban development / roads	■			■		■	■	■
	Fishponds				■			■	
	Protection of settlements							■	
	Straightening of rivers					■	■		
Agriculture					■	■		■	■
Mining for mineral resources	Oil shales	■							
	Sapropel			■	■				
Forestry		■			■	■			■
Fragmentation					■	■			
Inadequate legislation	Privatisation				■	■		■	
	Lack of priority				■	■		■	
After-use					■	■		■	
Garbage disposal					■				
Tourism		■				■			■
Hunting/Poaching						■		■	
Gathering of plants	Berry pickers#			■					■
	Orchid collection					■			
	Medicine								■

* Intensification includes ploughing, fertilising, pesticides, burning, over-grazing, early mowing etc.
# Problems arising from the annual influx of berry pickers include littering, fire and invasion of non-indigenous species.

rain presents problems in Poland and the Czech Republic whilst Ukrainian peatlands suffer mostly from chemical and radioactive pollution. Other threats are more localised, occurring in single or small groups of countries. These include mining, forestry and garbage disposal. Even plant gathering, which has traditionally been practised in a fully sustainable manner, has become problematic in some localities due to sheer pressure of numbers of increasingly mobile people searching out a dwindling resource. Apart from such direct influences, two infrastructural threats emerge. Inadequate legislation is implicated for three countries, whilst most nations complain of lack of funding.

5.3 Summary of needs for peatland conservation in the focal countries

In Section 4, priorities and needs for peatland conservation in each country are outlined. These are summarised in Table 13. Review of these reveals substantial consistency across the region, presumably at least in part as a result of the global and continental forces that now drive conservation policy (Section 2). Needs have been identified in the fields of policy, legislation, inventory, management and monitoring, communication and public awareness, and are discussed below under these headings.

5.3.1 Policy

There is a general need to reduce threats to peatlands and to increase their conservation priority and protection status (Slovakia, Ukraine, Lithuania, Poland), as well as to improve restoration and management planning policy (Slovakia). More specifically, it would be desirable to increase the number of protected fen systems, including those whose biodiversity value is maintained by traditional management, in order to ensure that the whole resource is equitably represented in the suite of protected sites (Ukraine, Poland, Estonia, Latvia). International assistance is deemed necessary to approach the target of doubling the protected peatland area in Belarus.

Development of national strategies for peatland/wetland conservation is a current priority in two countries (Estonia, Czechia). There is widespread emphasis on inventory and database development, but conservation management, supporting legislation and infrastructure also need to be considered.

The adoption of wise use principles is proposed by most countries. In Belarus it is envisaged that this would dictate cessation of agriculture and forestry on some valuable peatlands, whilst in Ukraine and Estonia the principles would be most helpful in relation to peat extraction. In Estonia, wise use objectives are already being pursued through dialogue between the peat industry and other interest groups. This involves addressing issues such as estimation of peat resources, planning, restoration of reclaimed and extracted areas, objective assessment of peat formation and regeneration rates, and certification of peat products. Introduction of the principle of compensating owners for land-use restrictions is regarded as potentially helpful in Ukraine. Two countries (Estonia and Belarus) indicate needs for international assistance in this context, whilst in Estonia this assistance could be specifically extended to the issue of including peat in the carbon-trading mechanisms of the Kyoto Protocol.

5.3.2 Legislation

Legislation for peatland conservation is inadequate and/or outdated in several countries, especially in view of international obligations set by EU and Emerald Network requirements. Specific problems are reported with Estonian Regulation No. 213 and the Lithuanian Law on Energy. Since these are driven by international requirements, updating of legislation tends to be an established national priority in most cases, although international input is felt to be appropriate for Lithuania. Improving the implementation of legislation specifically relating to mire protection is highlighted as a need in Poland.

Table 13. Summary of main needs and wishes for peatland conservation in the focal countries.

	Est	Lat	Lit	Pol	Cze	Slo	Ukr	Bel
Legislation								
National legislation for peatlands	X		X	X	X		X	X
More efficient protection of peatlands	X		X	X	X	X		X
Incorporation of international commitments				X	X		X	X
Compensation measures				X		X	X	X
Awareness								
Public awareness campaign	X	X	X	X	X		X	X
Policy decision-makers	X		X		X		X	X
Managers	X		X	X	X	X	X	
Farmers							X	
Education – schools	X	X		X	X	X	X	X
Local communities	X			X			X	
Conservation								
Management plans	X		X	X	X	X		X
Monitoring guidelines	X			X	X	X		
Restoration	X		X		X	X		X
Assign more peatlands to International Conventions	X			X	X			X
Protect more peatland/types	X		X	X	X			
Training								
Conservation	X		X	X	X		X	X
Restoration	X		X		X	X	X	X
Management	X		X	X	X	X	X	X
Monitoring	X			X	X	X	X	X
Values and functions	X		X		X		X	X
Discussion forum for knowledge transfer	X				X		X	
Specialists	X			X	X		X	
Policy decision-makers	X		X	X	X		X	
Managers	X		X				X	
Inventory								
National peatland database (GIS)	X		X	X	X		X	X
Update of existing peatland inventory	X			X	X			X
Assessment of biodiversity	X			X	X		X	X
Red lists				X	X		X	X
Wise use / sustainable use								
Guidelines	X		X	X	X	X	X	X
Research								
Wise use	X				X		X	X
Ability of peatlands to store radioactivity					X		X	X

5.3.3 Inventory

Completion and/or updating of peatland inventory is a priority for all the focal countries except Lithuania. Inventory is seen as the key to understanding the nature of the peatland resource (biodiversity, depth of peat, threats, hydrological function, management needs etc.), and as the primary tool for determining conservation value and in supporting decision-making on all important issues concerning peatlands, including national policy, legislative reform and establishment of the Natura 2000 Network. A need for development of guidelines for assessment of the biodiversity and conservation values of peatlands is also identified. International support for these activities is requested by most countries.

5.3.4 Management and monitoring

Peatland management and monitoring are, in general, recognised national priorities established through obligations to Natura 2000, EMERALD network, Ramsar and World Heritage Sites. In particular, management guidelines and active restoration of disturbed peatland systems are both needed. It is pointed out for Ukraine that special arrangements will be needed to improve the management of protected areas that do not have resident administrations.

Three countries identify needs for international input to the preparation of management plans (Belarus, Estonia, Slovakia). An interesting proposal from Czechia is the development of an expert system for peatland evaluation designed to be used for use by mire managers and non-government organisations, and produced through international collaboration. Its preparation is especially urgent for the management of peatlands designated as Ramsar Sites. Supporting research, focusing on the hydrology and optimisation of management of fens is also proposed, and a need for international input to such activities is identified (Latvia).

The issue of active conservation of fen meadows where traditional management is no longer practised is raised by Poland, Estonia and Slovakia. Opportunities for support through the EU agri-environmental schemes (Common Agricultural Policy, Regulation No 2080/92) are of particular interest in this context.

5.3.5 Transboundary issues

For historical reasons, a number of peatlands that straddle national boundaries escaped substantial disturbance until fairly recently, but are now subject to new pressures. Particular needs for attention to such problems are mentioned by Lithuania and Slovakia (specifically for the Orava region which straddles the border between Poland and Slovakia) through international co-operation and funding.

5.3.6 Communication

Exchange of opinions and information is seen to be desirable at a number of levels; for example to strengthen co-operation between mire conservation stakeholders in Poland and Ukraine. In the Czech Republic, regular sharing of experience amongst mire scientists, managers, conservationists, NGO representatives, regional administration and local decision makers from all important peatland regions within the country at two to three-year intervals is suggested. There is also a need for international exchange of knowledge between mire experts (Poland), specifically in the fields of management, monitoring, capacity building and public awareness (Ukraine) and in developing an expert system for the evaluation of peatlands for conservation (Czech Republic).

5.3.7 Awareness raising

This is an urgent priority of six countries and is regarded as desirable for the remaining two (Czech Republic and Lithuania). The primary objectives are to promote a greater awareness and understanding of mires, and thereby to promote the adoption of wise use principles (Belarus, Estonia). Target audiences include schoolchildren, teachers, general public, farmers, decision makers, land-owners and other peatland stakeholders. Methods include publication of a book (Latvia), and the ongoing education programme for Slovakian teachers (see Section 6.2.7). International input is requested by five countries (Estonia, Latvia, Lithuania, Poland and Slovakia).

6. Towards Central European action on peatlands

This Section summarises priority topics for action on peatland conservation that have been identified through CEPP activities; it gives information on CEPP-initiated national projects that will begin to address some of these topics and outlines some larger action initiatives that have already arisen from the project. It also formulates recommendations for the pursuit of priorities that can be effectively tackled only at regional (international) level.

6.1 Wise use of peatlands

A detailed global framework for wise use of peatlands has now been developed by Joosten and Clarke (2002). The CEPP has been conducted in parallel with the development of this framework, and so has to some extent formulated its own approach to the topic with a specific geographical focus. The resulting indicative guidelines for wise use of the remaining resource of Central European peatlands emerge as follows:

- No further drainage of undrained mires.
- Establish a system of effectively managed peatland/ mire conservation areas that is large enough to ensure survival of all peatland biodiversity values in perpetuity.
- Concentrate any necessary peat extraction on sites that have already been drained for forestry or agriculture and that have poor prospects for successful re-wetting and restoration.
- Reduce emissions of greenhouse gases from sites used for forestry, agriculture and peat extraction, e.g. by optimising water management and the use of fertilisers.
- Restore peat accumulating conditions in drained and abandoned peatlands for biodiversity conservation, recovery of their regulation functions, and for production purposes.
- Where drained and abandoned peatlands are abundant, develop and improve techniques that enable exploitation of these peatlands to occur under peat accumulating conditions (e.g. cultivation of reed, sedge, alder and pine woodland, and *Sphagnum*).
- Review and standardise systems for peatland terminology and classification, at least across Europe, in order to ensure appropriate representation of this habitat type within the Natura 2000 network.

Useful instruments for the pursuit of these goals would be:
- development of biogeographical peatland zones
- certification of peat
- regional land-use planning
- the EU Common Agricultural Policy; and
- the EU Framework 6 funding.

6.2 National action priorities

During the life of the CEPP, specific priorities for national action within each of the focal countries were identified, and are listed below. A few of these have already been carried forward through the award of new international funding, as described in the accompanying boxes. In addition, a small CEPP project ("CEPP-initiated action") will now be conducted within each country.

6.2.1 Belarus

- A reliable and up-to-date inventory of peat distribution is lacking, making it difficult to identify the most valuable sites and to design a sound national strategy for the protection and wise use of peatlands. Currently, there are no accurate data on natural peatlands.
- Belarus possesses about 1,000,000 ha of drained peatlands which lose approximately 7,000,000 tonnes of peat per year though oxidation and erosion (7 tonnes loss of organic matter/ha/y). Furthermore, enormous quantities of CO_2 are being released to the atmosphere. Cessation of these processes is of primary importance for the protection of biodiversity and the climate change issue. Financial support and expert assistance are needed.
- The rehabilitation of peatlands after agricultural activities have ceased, or after peat extraction, needs to be addressed through a targeted programme.

Conservation and sustainable management of Polesie through integration of globally important biodiversity concerns into main areas of economic activity at key sites

The overall objective of this project is to secure the conservation of globally important biodiversity and the sustainable use of wetlands in the Pripyat river floodplain and adjacent areas, through integrated wetland management and environmentally sound nature use. It has successfully entered the GEF pipeline.

The main project goal will be pursued through the development and implementation of integrated management plans for the Pripyat river floodplain and key adjacent sites. The project will serve as a model for the Republic of Belarus to secure the preservation of its other globally important wetlands, with future work building on its strategic approach, technique development and training activities.

At selected key sites within the Pripyat river floodplain, the water management regime and flood defences will also be restructured with the objective of making them compatible with conservation objectives. Measures will be introduced to ensure that the burning of vegetation, cattle grazing, logging, illegal hunting and illegal fishing do not threaten biodiversity. This approach will be complemented by strengthening of the current system of protected areas and cross-border co-operation. Finally, the project will support the strengthening of constituencies for biodiversity conservation, both at the grass-roots and decision-making levels, especially through technical capacity-building in integrated ecosystem management.

- In many peatlands (particularly those in agricultural use) water quality is compromised, causing algal blooms in lakes and in the sea.
- The contamination of peat soils with radioactivity is another problem that needs specific attention. Ducks and geese feeding in the contaminated areas concentrate the radioactivity in their tissues and spread radioactivity to other areas afterwards.

CEPP-initiated action

Development of measures for the conservation and sustainable use of peatlands in the Belarussian Polesie. This project will clarify the extent and status of the Polessian peatlands. It will identify the sites which are most important for biodiversity protection, and it will produce management recommendations for both natural and disturbed areas. Activities will include:

- Collection and analysis of existing data, (e.g. geology, vegetation cover, drainage projects, peat extraction, forest management).
- Description of the natural peatlands that are most important for biodiversity protection, especially for Red Data Book species and globally threatened birds.
- Collection of data for natural peatlands located in different radioactive contamination zones.
- Collection of data for disturbance and classification of sites according to their degree of alteration.
- Development of scientifically based protocols for improving the use of natural, drained, extracted and abandoned agricultural peatlands in order to protect biodiversity and the environment.

It is envisaged that this project will run in parallel with a similar initiative in the Ukrainian Polissia, which

Environmental rehabilitation of anthropogenically disturbed peatlands in Belarus

The Government of Belarus recognises the need to comprehensively study and restore damaged peatlands. Being a state priority, about $400,000 is allocated annually to various programmes and activities, including the rehabilitation of drained peatlands to improve the environment and people's lives, conservation of biodiversity, and reduction of CO_2 emissions. So far, 10 peatlands have been withdrawn from agriculture (23,456 ha) and transferred to the so-called Reserve Fund. However, the state allocations are not sufficient to underpin a comprehensive approach to ecological rehabilitation of degraded peatlands due to the following barriers:

- Under-valuation of biodiversity and CO_2 sink resources leading to mis-pricing of natural capital in making decisions on rehabilitation programmes and activities. More information is needed as a basis for accurate estimates of these resources.
- Lack of managerial capacity within the government to co-ordinate the involvement of appropriate experts in the rehabilitation of peatlands.
- Poor access to modern techniques for rehabilitation of disturbed peatlands and insufficient inflow of international knowledge on best practices and technologies.
- Absence of capacity and expertise to deal with each degraded site individually.

The programme will strive to use a comprehensive strategy for rehabilitation of disturbed peatlands that would help to eliminate the above barriers. The proposed project's overall goals are to:

1. stabilise and improve globally threatened wetland biodiversity;
2. substantially reduce CO_2 emissions; and
3. arrest ongoing and prevent potential land degradation on anthropogenically degraded peatlands in Belarus through the application of an integrated planning approach and by increasing the awareness and capacity of the relevant governmental agencies.

The programme's specific objectives are:

- to conduct a comprehensive (in terms of geographic and thematic scope) inventory of anthropogenically disturbed peatlands;
- to restore 10–15 selected disturbed peatlands in order to expand the area of globally important fen habitats;
- to stop land degradation;
- to reduce CO_2 emissions by at least 100,000 tonnes annually; and
- to establish nature-protected areas on selected restored sites.

The following guiding principles will be applied in pursuing the above objectives:

- Make available information and techniques for accurate pricing of the nation's natural capital.
- Increase the capacity of the government to deal with rehabilitation of disturbed peatlands in a comprehensive manner, but individually for each site.
- Provide access for the relevant authorities to international expertise, best practices and modern techniques in peatland rehabilitation.
- Establish a model for the transfer of jurisdiction and subsequent state management and funding of the restored areas (during rehabilitation, responsibility for the sites will be transferred from the Ministry of Agriculture and Beltopgaz Concern to the Ministry of Natural Resources and Environmental Protection through establishment of nature protected areas). Management and funding of the newly established protected areas will subsequently be the sole responsibility of the state. This model will then be replicated both within Belarus and elsewhere.

By the end of the programme, a complete inventory of anthropogenically disturbed peatlands will be available and 10–15 peatlands with an estimated total area of 11,000 ha will have been rehabilitated, expanding the area of globally valuable fen habitats, and reducing CO_2 emissions by at least 100,000 tonnes annually.

constitutes the remainder of this transboundary wetland system.

6.2.2 Czech Republic

- The establishment of an expert system for mires including a metadatabase containing information about peatlands that is relevant to promoting the protection and wise use of Czech mires
- Raising public awareness about the biodiversity and ecological functioning of peatlands
- Ecological and hydrological assessment of mountain peatlands with regard to their protection
- Protection and maintenance of peat forming processes in regions with airborne acidification
- Protection of the biodiversity of fens that are affected by agriculture and forestry
- Protection of bog pines in raised bog ecosystems
- Inclusion of peatlands in the EU-Natura 2000 network and appropriate management, especially of fens that are used for agriculture and/or forestry.

CEPP-initiated action
Publication of a 200-page book entitled *Peatland Biodiversity Conservation in Czechia*, which will be the first Czech textbook on peatlands since the Dohnal *et al*. volume of 1965. The new book will contribute to raising public awareness about the importance of Czechia's peatlands. It will provide a scientific background and an overview of principles for the evaluation of peatland biodiversity, conservation and restoration. It will aim to serve the needs of decision-makers, managers, conservationists and scientists working at international, national, regional and local levels.

6.2.3 Estonia

- Development of a dataset on peatlands (location, surface characteristics, ecological data, etc.) using existing peat-related datasets from various stakeholders
- Strengthening the capacity of the "Estonian Wetland Society", one of whose functions is to enable representatives of various sectors to discuss peatland-related issues, thus influencing policy-making and raising awareness about peatland protection
- In relation to the exploitation and conservation of peatlands, a sustainable development approach should be promoted. There are currently problems in calculating the peat-accumulating mire area
- Development of a procedure for standardisation and certification of peat
- Finalisation of the National Wetland Inventory, with particular attention to peatlands
- Inclusion of appropriate peatlands in the national list of Natura 2000 sites (which should be ready by the accession date in 2004).

CEPP-initiated action
Establishment of the Estonian Mires Website. This will be a long-lived and easily updatable internet site focusing on the importance of mires and their wise use in Estonia. It will give objective information about the values of mires, the status of peat resources, planning, restoration of reclaimed and extracted areas, assessment of peat formation and regeneration rates, and certification of peat products. It will also incorporate a discussion forum. Thus it will provide a long-term source of information on the status of Estonian mires that will be readily accessible to national and international audiences. It will also provide a vehicle for communication between stakeholders.

6.2.4 Latvia

- Implementation of the Mire Habitat Management Plan developed in 2003
- Designation of new specially protected nature areas (potential Natura 2000 sites)
- Development of management plans for specially protected nature areas including mires
- Development of recultivation plans for worked-out peatlands
- Publication of a book to raise public awareness about the biodiversity values of Latvian mires.

CEPP-initiated action
Inventory and mapping of selected raised bogs that will form the focus of a proposal for EU LIFE funding. This project will involve hydrological and engineering investigations, development of management plans and functional zonation, restoration of natural raised bog hydrology and monitoring its effects. It will also result in publication of a book about mire habitats of EU importance.

6.2.5 Lithuania

- Renaturalisation of drained (and extracted) peatlands
- Establishment of a special commission to review the present boundaries of peatland sites, and to adjust these to ensure hydrological viability
- Prevention of (summer) fires in peatlands
- Development of a strategy to work with foreign peat mining companies towards improving the procedure for issue of peat extraction permits, in the context of wise use.

CEPP-initiated action
Preparation and publication of a handbook on peatland management and restoration. This will give a comprehensive international review of theory and practice that is suitable for use by site managers, environmental planners, decision makers, consultants, scientists, students and nature volunteers. Its principal objectives will be to encourage nature conservation bodies and others to undertake peatland management and restoration projects, and to provide practical information to assist with planning and implementation. It will fill the present gap in availability of information that is specifically relevant to the protection and management of Lithuanian mires, and will thus be a fundamental tool for meeting Natura 2000 requirements.

6.2.6 Poland

- The protection and maintenance of fen areas in extensive agricultural use, in particular through effective implementation of EU agri-environmental schemes on peatlands
- Updating of the national mire inventory
- Incorporation of major valuable peatland areas into the Natura 2000 network
- Awareness-raising campaign on mires and wetlands, including tourist guidebooks, internet and media involvement

- Awareness-raising campaign for the protection of the mires in the Nowotarski basin, especially with regard to the export of peat from this area to e.g. Germany and The Netherlands.

CEPP-initiated action
Establishment and first-year maintenance of a Polish internet service focusing on the wise use and conservation of peatlands. This will aim to enable information transfer between the different groups involved in mire conservation – in particular to fill the gap between practitioners and scientists – as well as to enhance general awareness of peatland values in Poland. Available data, including those produced within the CEPP, will be used to present the country's peatland resources and their problems. There will be links to numerous peatland conservation projects implemented by Polish and foreign NGOs. In addition, an electronic newsletter about peatland conservation will be produced.

6.2.7 Slovakia

- National peatland inventory
- Management plans and their implementation for important mire areas
- Awareness raising on the values and functions of peatlands.

CEPP-initiated action
Printing a further 1,000 copies of *World of Peatlands*, a 211-page teaching manual for primary schools that was developed as part of the DANCEE project *Conservation and Sustainable Use of Peatlands in Slovakia* (2001–2003). The recent Ministry of Education certification of this volume for use in primary schools has created new demand that cannot be satisfied by existing supplies.

6.2.8 Ukraine

- Detailed peatland inventory
- Restoration and re-establishment of sustainable management on drained and mined peatlands
- A national strategy for the protection and wise use of peatlands should be incorporated in the national Wetland Strategy, which is currently being developed
- Development of a Ramsar Shadow List.

CEPP-initiated action
Development of measures for the conservation and sustainable use of peatlands in Polissia. This project will run in parallel with the CEPP action in Belarus, focusing on the Ukrainian portion of the Polissian/Polessian peatlands. Thus a concerted transboundary action will be undertaken to clarify the extent and status of mires, to identify the most important sites for biodiversity, and to

Inventory results in 50% increase in recorded peatland area for Slovakia

The DANCEE project *Conservation and Sustainable Use of Peatlands in Slovakia* (2001–03) had three main themes:

Inventory and development of a peatland database
At the beginning of the project the registered area of peatlands in Slovakia was 2,526 ha, of which 64% (1,617 ha) had been mapped. 2,350 ha have now been mapped, and it seems likely that a total of around 3,670 ha (almost 50% more than the previous estimate) will have been recorded by the time the inventory is complete. Bryophytes that were previously un-recorded in Slovakia were found, and new saline fen types were described in the Spiš Region. After two field seasons, the database contained 41,593 species records. From these, six plant species (33 records) and five habitat types (861 records) in 555 localities were identified for input to the Natura 2000 selection process.

Management plans
Management plans were developed for six pilot sites, taking into account ownership, former use etc. These plans included baseline monitoring, which revealed new sites for very rare species and a new species of spider for Slovakia.

Awareness raising
A 211-page manual for primary school teachers entitled *World of Peatlands* was prepared and printed. This aims to:

- provide inspiration, motivation and useful information about peatlands for teachers
- encourage teachers to use interactive and creative elements in their teaching
- support active participation of children in the process of learning, through working in groups, having fun, problem solving, participating in discussions, and focusing on relationships rather than on facts.

A peatland kit box or Enviro-box containing teaching aids for environmental education in schools was developed to accompany the manual, and training sessions for teachers have been held. The Ministry of Education has now officially approved the manual for use in primary schools, and the resulting demand has taken up all 1,000 copies from the first print run. A book about biodiversity in Abrod National Nature Reserve (developed within a PHARE project) was also updated and printed.

Note on project sustainability
This was initially intended to be the first phase (two years) of a larger 4/5-year project, but it eventually proved impossible for DANCEE to fund the second phase due to a change in their priorities. However, the support already given by DANCEE has now been accepted as co-funding for the GEF PDF B-size project Conservation, Restoration and Sustainable Use of Calcareous Fens in Slovakia, which was approved in May 2003. The GEF funding will support finalisation of the peatland inventory and implementation of the management plans for the two largest pilot sites. Some management of the other four pilot sites will be funded by reimbursed VAT from the DANCEE project, and printing of 1,000 further copies of World of Peatlands will be financed by the CEPP (Section 6.2.7).

produce management recommendations. This action aims to reverse the current trend towards conversion of this area into a vast zone of degraded mires in the centre of Europe.

6.3 International recommendations

A number of recommendations for peatland conservation actions at regional or global level have also emerged from the CEPP, and these will require co-ordinated follow-up at international level.

6.3.1 Common terminology and classification

All of the focal countries have peatland inventories, but these are of different ages and some are based on vegetation composition whilst others are based on soil features. Where the latter are used, definitions for peat soils differ between countries. The classification of mires and peat soils into categories (e.g. fen, bog, transitional and mixed) also varies between countries. While the inconsistencies between national approaches to peatland inventory have posed significant challenges when attempting to compile a regional peatland database, an additional contributory factor has been the lack of an agreed internationally coherent set of terms and definitions for peatlands.

There is, therefore, an urgent need now to develop internationally agreed peatland terminology and classification systems which could be used:

- to put national peatland inventories into an international context
- to assist in the translation of existing and future scientific publications, thereby ensuring that new knowledge and understanding is disseminated as widely and effectively as possible
- to assist EU Member States and accession countries in meeting effectively the requirements of the EU Habitats Directive
- in using Natura 2000 data to fulfil the requirements of the GGAP (Knowledge of Global Peatland Resources and Peatland Inventory); and
- in implementation of a trading mechanism under the Kyoto Protocol.

Funding might be sought from the EU-LIFE fund where management of Natura 2000 priority habitats is involved, or through the EU Common Agricultural Policy (agri-environment measures).

6.3.2 Update peatland inventories; compile national data on the biodiversity values of peatlands

The GGAP calls for the production of an up-to-date overview of peatlands in order to assess their current distribution and to describe and monitor losses. Most of the data that are currently available were collected in the 1970s, and the focal countries generally lack up-to-date inventories of peatland distribution and condition. This means that it is difficult to identify the most valuable areas (e.g. for Natura 2000), or to implement sound national strategies for the protection and wise use of peatlands.

Up-to-date information about the biodiversity values of peatlands is essential to the design of targeted actions for their protection. Since six of the eight focal countries are about to accede to EU membership, they are required to propose sites for listing under the Habitats and Birds Directives (Natura 2000). However, few resources are available for additional inventories, so there is a clear danger that areas meeting Natura 2000 criteria will be omitted unless reliable inventory data can be made available.

Updating of national peatland inventories is also a prerequisite for developing the regional GIS database into a useful conservation tool. If it could be updated and standardised, the GIS would be of immense utility in identifying priority areas and topics for peatland conservation at regional level, and in the compilation of a Red List of the most endangered mires, particularly undisturbed bogs.

6.3.3 Standardise peatland evaluation criteria across Europe

There is a need to develop a more standardised set of criteria for assessing the biodiversity values of peatlands, together with operational recommendations to support peatland protection and monitoring. These should be suitable for application in all of the focal countries. This topic has recently been the subject of a review by the STRP of the Ramsar Convention, and also forms part of a longer-term review being undertaken by the IMCG; but it is important that the basic framework for assessment set out in Appendix 1 is populated with features and criteria that have specific relevance to peatlands in Europe. To some extent, this will not be possible for the CEPP focal countries until a more harmonised form of data collection and collation has been adopted throughout the region. This is a key theme that runs throughout the present Report and its roots lie in the problems that arise from using several systems for inventory, collation and evaluation, that are not yet sufficiently unified and harmonised. Criteria such as those set out by Ratcliffe (1977) give a general framework for assessment, but until it is possible to say what is ‘natural’ or ‘typical’ in terms of peatland microtopography, or species composition, for the CEPP region (or bioregion), it is not possible to evaluate the *degree* of naturalness or typicalness within this context for any particular site.

Thus there is an urgent need for harmonisation of data collection and collation across the focal countries – and indeed across Europe as a whole. Existing best-practice methods could be applied, but would require further development work to focus them specifically towards peatlands. This work could be undertaken by a single body, but must be overseen by a multi-national, multi-agency steering group.

6.3.4 Regional Red List; Ramsar/Natura 2000 Shadow List

It is inevitable that some anthropogenic development will continue to occur on peatlands. It would thus be beneficial to compile a ‘Red List’ of peatland sites for Central Europe. Such a list would highlight important areas that, on the basis of their natural heritage character, are ‘non-negotiable’ in relation to development proposals. The second function of this list is that it avoids the inevitable parochialism that results from consideration of sites country-by-country. The list would instead highlight the characteristic range of peatland diversity that is displayed at regional level. Such a supra-national approach is in accord with the principles of the Ramsar Convention and of Natura 2000, both of which explicitly seek to ensure that regional overviews inform the selection of site-protection networks. For example, the very first of the criteria used by the Ramsar Convention to identify Wetlands of International Importance states that:

> *A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.*

Ramsar's Strategic Framework for identification of Wetlands of International Importance (Section 9.1.1, Objective 1) then indicates that the intention is:

> *To have included in the Ramsar List at least one suitable (i.e. internationally important) representative of every natural or near-natural wetland type … present in each biogeographic region. These biogeographical regions are as defined globally, supra-nationally/ regionally or nationally, and applied by the Contracting Party in a form appropriate to that Party.*

The definitions regarding biogeographic regions and the sometimes synonymous 'bioregions' make it clear that individual regions will often include territory that belongs to more than one country, and that different bioregions may be appropriate for different wetland types.

Article 1 of the EU Habitats Directive defines 'natural habitat types of Community interest' as those which:

> *(iii) present outstanding examples of typical characteristics of one or more of the five following biogeographic regions: Alpine, Atlantic, Continental, Macaronesian and Mediterranean.*

Therefore, first and foremost, the Central European Red List must reflect regional biogeography. This means that it cannot be constructed simply as an amalgam of values determined solely at national level by the individual focal countries. Furthermore, experience from EU Habitats Directive implementation indicates that, in drawing up the Red List, it may be necessary to highlight that individual countries have special responsibility for particular peatland types and/or biogeographic regions whose ranges are centred on, concentrated within, or even restricted to, these countries' territories.

It is thus recommended that the Red List should be produced in the form of a Ramsar shadow list. When complete, this shadow list could be used in the biogeographic zone seminars that inform discussions and decisions concerning the future composition of the Natura 2000 network.

The Red List should be drawn together by first reviewing the set of sites that are considered to be nationally or internationally important on the basis of individual country lists, in terms of peatland quality (according to criteria set out by, for example, Ratcliffe 1977), peatland character (according to criteria set out in, for example, Appendix 1 of the present report), biogeographical region (as set out in, for example, Appendix 2 of the present report), and overall spatial distribution within the Central European region. On this basis, the highest-quality examples of site types that most effectively represents the character of peatlands belonging to each biogeographical region would be selected to form the core of the List. These would be supplemented by examples of site types that are azonal (i.e. occur largely without reference to biogeographical constraints) or important in expressing the full natural biogeographical range of a site type or species, together with sites that support viable populations of rare or locally/ regionally endemic species. The composition of the List might also be moderated and supplemented through consultation with those responsible for identifying potential Natura 2000 sites, Special Protection Areas, and Important Plant Areas.

6.3.5 Development of biogeographical regions

It is clearly vital for the effective production of the CEPP Red List that a robust and relevant set of biogeographic regions is established to cover the combined area of the focal countries. Several systems of biogeographic regions have already been developed, but as the definition of 'biogeographic region' provided by the Ramsar Convention rightly points out, bioregions defined for one habitat type may not be appropriate for another. The European Union recognises very broad bioregions in assigning the remits of its biogeographical seminars for Natura 2000, but the mire bioregions recognised by Succow and Joosten (2001) for Western and Central Europe are of more immediate relevance to the CEPP region. These mire bioregions give a good, if somewhat generalised, sense of how the different hydromorphological mire types (e.g. raised mire, aapa mire) are distributed within Europe, but the broad scale of the work inevitably means that the more localised, finer-scale pattern of peatland biodiversity found at the lower levels of the descriptive hierarchy (see Appendix 1) tends to be obscured.

The biogeographic, geobotanical and 'mire' regions described in Section 4 of the present volume provide a much more detailed indication of environmental variation within each of the focal countries. However, these have been drawn up for individual countries without (overt) reference to conditions that exist outside their national boundaries and, perhaps more importantly, without reference to similar bioregional classification work in adjoining countries. Consequently it is difficult to combine the various national systems into a single harmonious and internally consistent set of bioregions for the Central European region as a whole.

Appendix 2 presents tentative proposals for an approach to defining a set of biogeographic regions for the entire Baltic-Black Sea Corridor. It considers first the result of simply amalgamating the individual national systems, then investigates possibilities for combining the national systems with biogeobotanical information derived from the *Physico-Geographical Atlas of the World* published by the USSR Academy of Sciences (1964). What emerges from this exploratory synthesis is that certain bioregions appear to be relatively easy to define, whereas others are less distinct so that their delineation requires a much more detailed analysis.

Further development of this approach should involve the preparation of site characterisations following the descriptive hierarchy described in Appendix 1, and their consideration in combination with broader environmental factors (for example geology, landform and climate as used in the biogeographic analysis described in Appendix 2). The descriptive information collected for each level of the hierarchy could be relatively simple. The strength of the subsequent analysis would lie less in the compilation of detailed information than in the repetitive application of a consistent data collection standard over a relatively large number of sites, in much the same way that large volumes of simple presence-absence data can provide an extremely detailed picture of vegetation types within an area.

6.3.6 Develop wise use guidelines appropriate to practical peatland protection and management practices

In recent years, a considerable amount of activity and debate has been devoted to the question of how the 'wise use' concept might be applied to peatland ecosystems. As already described in Section 2.10.1, the 6th Conference of Parties to the Ramsar Convention (1996) undertook a commitment to develop a global action plan for peatlands, within which 'wise use' would be a core theme. This initiative led directly to a meeting between two of the principal international organisations concerned with peatland use – the International Peat Society (IPS) and the International Mire Conservation Group (IMCG) – at which the possibility of establishing an agreed set of wise use guidelines was discussed. This led, in turn, to establishment of the task force which developed the publication *Wise Use of Mires and Peatlands – Background and Principles including a Framework for Decision-making* (Joosten and Clarke 2002), also known as the *Wise Use Handbook*. This publication was adopted by the 8th Ramsar Conference, in 2002, as a primary source of guidance for Contracting Parties in adopting Ramsar's Guidelines for Global Action on Peatlands (GGAP).

Publication of the *Wise Use Handbook* represents an important practical step towards widespread adoption of wise use principles for peatland habitats, but several key issues remain to be addressed. For example, practical application of the principles set out in the *Handbook* involves reconciling the needs and values of conservation with those of development. Conflicts arise where values meet. Hence it is necessary to develop robust principles for the selection of peatland sites where development can be permitted. For example, peat extraction might be restricted exclusively to areas that have already been severely damaged by preparation for peat extraction or by previous extraction, as in Latvia; similar conditions have been used in Estonia by the World Bank to identify peatlands that could be used to support the conversion of oil-fired power plants to peat fuel (Section 3.2). Peat extraction practice for such areas also requires guidelines to indicate how development should proceed in order to maximise restoration potential, and especially how to create the best possible conditions for the re-growth of peat. Moreover, land-use planning and environmental impact assessment procedures should pay due attention to the values and functions of peatlands, and to the concepts of 'integrated catchment management' and 'buffer zones' as essential building blocks for peatland management, use and restoration potential.

Peat certification is linked to the application of wise use principles, and introduces a need for the development of standards for peatland use that must be met in order to qualify for certification of operators and/or end products. In this context, separate guidelines will be required to govern the certifiable use of peatlands for e.g. forestry, agriculture and peat extraction.

The best guidelines in the world are of no use if they are written in English but the end-user speaks only Czech. In other words, in order to promote the widespread adoption of wise use principles, such principles must be made accessible to non-English speakers. There is thus an urgent need to translate the key peatland works, or to otherwise communicate their contents, into appropriate national and/or local languages.

In order to balance adequately the needs of conservation and development, it will also be important to ensure that effective national and international legislation is in place. At the national level, legislation should at least be sufficient to meet the principles and obligations (where appropriate) of the relevant international conventions and directives, while at the same time ensuring that conservation and wise use principles are applied effectively at local level. Indeed, since Local Agenda 21 covers biodiversity obligations within the local perspective, there is clear international re-inforcement of, and support for, conservation action at all levels of decision-making. The critical issue is whether international commitments are being supported in practice by national and local actions. Where this is not the case, it is important that practical steps are taken, and measures put in place, to ensure that peatland conservation forms a clearly-recognised part of national and local decision-making.

6.3.7 Develop peatland management guidelines for the CAP

Peatlands with traditional management such as grazing and hay mowing are threatened by abandonment, since their high biodiversity will disappear in the absence of extensive agricultural management. The EU CAP agri-environment programmes contain provisions that appear to be relevant. Thus when the present review of the CAP mechanism (Section 2.10) is complete, it will be essential to re-evaluate the opportunities that it then offers for peatland management.

6.3.8 Peatland restoration, management and monitoring

A wide range of peatland management and monitoring practices are detailed in UK publications (in English) such as Stoneman and Brooks (1997), Hurford, Jones and Brown (2000), Brown (2000) and Lindsay *et al.* (2003); while Dupieux (1998) and Lugon, Matthey, Pearson and Grosvernier (1998) provide handbooks of peatland management information in French (for France and Switzerland respectively), and Akkermann (1982) gives an extensive overview of bog regeneration issues for German speakers. For the CEPP focal countries, Šeffer and

Stanová (1999) present an excellent management review for a river floodplain in Slovakia (in Slovakian and English); while Kotowski (2002) presents a range of valuable ecological and management information relating to Polish fenland ecosystems; and several of the workshop reports arising from the Darwin Initiative Peatland Biodiversity Programme focus on specific peatland management issues for these countries (see Bragg 2003). Whilst these publications and reports include a range of 'best practice' techniques and 'best-knowledge' accounts of the latest scientific understanding, the information is not currently available in a conveniently accessible format. Therefore, it would be valuable to draw together and summarise the restoration, management and monitoring methods that are directly relevant to the peatlands of the CEPP focal countries. These could then be presented as a set of best-practice options in the form of several published editions covering the full range of focal country languages. At the very least, it is vital that as much 'best-knowledge' and 'best-practice' information as possible is made available in local CEPP country languages.

The various relevant information sources should also be used within or developed into 'expert systems' for integrated management planning with stakeholder involvement[16]. Expert systems empower non-specialist decision-makers by giving them ready access to specialist knowledge, whilst stakeholder involvement is important because conflict often occurs where this is lacking. Information flow is vital to ensure that activities are optimally directed and decision-making is based on the best knowledge available. The expertise harnessed through such expert systems could be usefully supplemented and reinforced by establishing a range of demonstration 'best-practice' management and restoration projects. These would also provide real-life examples to assist in engaging the interest and support of local stakeholder groups. Further essential supporting activities include the establishment of training programmes for personnel involved in the management and restoration of peatlands, which should cover not only practical techniques, but also monitoring and data management procedures.

The non-specialist (and sometimes even the specialist) may make the mistake of assuming that site margins are, by definition, marginal in terms of their significance for the site as a whole. This is a wholly incorrect assumption. Not only does ecological science highlight the tendency for transition zones to be particularly rich in species, but the hydrological mechanisms that maintain peatland systems mean that marginal zones can also be crucial to the functioning and stability of the whole site. It is thus extremely important that site boundaries are determined and managed with these considerations in mind, and that appropriate buffer zones are established.

The association between the historically important defensive role of mires and their abundance and preservation in the vicinity of national boundaries was mentioned in Section 2.8. A unique aspect of the more recent history of the CEPP countries is that people were actively discouraged – if not prevented – from living in or visiting border areas for most of the second half of the 20th Century, with the result that the mires in these areas continued to suffer relatively little disturbance. Thus, many of Central Europe's important mire areas straddle national boundaries. Whilst the political changes since 1989 have introduced new threats of disturbance for these areas, there are also new opportunities for trans-boundary co-operation in their management for conservation. Areas where such efforts are already being focused, or which are worthy of attention in the near future include North Livonia (Estonia/Latvia, see Section 4.3), the *Augustovskaya Pushcha* (Belarus/Lithuania/Poland), Polesie/Polissia (Belarus/Poland/Ukraine, see Sections 4.1 and 6.2.1), the *Desniansko-Starogutski* – *Bryanski Les* area (Ukraine/Russia), the Orava Basin (Poland/Slovakia, see Section 4.7), Krkonoše/Karkonosze (Czechia/Poland, see Plate 4) and the Ore Mountains/Krušné hory (Czechia/Germany)[17]. In promoting and establishing transboundary initiatives, there is obviously a requirement for co-operative and co-ordinated action, in which different administrations and working teams may need to pay special attention to harmonising policy approaches and working practices.

6.3.9 Radioactively contaminated peatlands

The impacts of radioactive contamination in peatlands after the phase of acute toxicity are poorly understood. Thus research on local and international transportation of radioactivity by migrating birds and animals, in food, and in smoke from peat fires is urgently required, not least in relation to the potential effects on human health throughout Europe and beyond. Natural peatlands also have capacity to sequester and store harmful materials (Section 3.2), and it is possible that restoration of the natural functions of the contaminated areas will be beneficial in this context. Peat extraction from radioactive peatlands should be prohibited.

6.3.10 Incorporate peatlands into the Kyoto protocol

The importance of peat soils as carbon stores has been discussed in previous Sections, and specifically in the context of Central European peatlands in Section 3.3. (though it should be emphasised that even the figures derived there are likely to be on the conservative side). Given this importance, the absence of action for long-term carbon stores (and particularly peat deposits) from the provisions of the Kyoto Protocol (Section 2.10.1) is a source of considerable concern. Bergkamp and Orlando (1999: Ramsar web-site) provide an overview of the ways in which the Ramsar Convention and the UNFCCC can find common ground and move forward in relation to wetlands as a whole, while Resolutions VIII.3 and VIII.17 of the 8th Ramsar Conference highlight the need for action from all parties to seek mechanisms that can protect carbon stores in peat. The Global Environment Facility (GEF) is meanwhile co-funding (almost $2 million) a project on *Peatlands and Climate Change* to assess peatland management practices and impacts on biodiversity in relation to climate change issues – in particular the issue of carbon storage. Other funding partners in this project include the Canadian Climate Change Development Fund, The Netherlands Government and the Global Peat Initiative. These actions

16 Examples of the application of this approach in Latvia and Slovakia are described in Bragg (2003).
17 Transboundary activities in several of these areas are summarised in Bragg (2003).

should help to inform decision-making by Contracting Parties during ongoing review of the Kyoto Protocol, with a view to incorporating more explicit recognition of the important contribution that peatlands make to the process of long-term carbon storage.

In addition to these global initiatives, actions with more specific regional or national focus are in progress, and these could form models for similar actions within the CEPP focal countries. The $400,000 project currently being undertaken by the government of Belarus has already been described in Section 6.2.1. Given the potential carbon-release figures calculated for the various focal countries in Section 3.3, there would seem to be a strong case for more widespread adoption of the principles embraced within this project. In particular, it is important that one of the primary issues identified by the Belarus Government should be widely recognised and acted upon, namely:

> *Under-valuation of biodiversity and CO_2 sink resources leading to mis-pricing of natural capital in making decisions… [on rehabilitation programmes and activities]*; in fact the problem of under-valuation applies to all decision-making about peatland usage.

6.3.11 Clarify the relevance of the EU Water Framework Directive to peatlands

At present, no official guidance on interpretation of the Water Framework Directive (WFD) in relation to peatlands is available (Section 2.10.2). Nevertheless, the aim of the Directive

> "*to prevent further deterioration and protect and enhance the status (with regard to their water needs) of terrestrial ecosystems and wetlands directly depending on the aquatic systems*"

clearly has relevance to mire systems. However, since peatlands and mires tend to occupy intermediate positions with respect to categories defined by the Directive[18], its detailed interpretation in this context is unlikely to be straightforward. Although the Directive (adopted by the European Parliament in 2000 and transposed subsequently into the legislative systems of Member States) is still very new, relevant international, national and regional agencies within the EU are already heavily engaged in formulating guidance for its interpretation, in conducting implementation trials, and in developing the substantial programmes for collection of basic data that will be needed to meet its requirements. The focus of these activities has so far avoided addressing the issues that arise in relation to peatlands and mires, perhaps because these are considered to be more difficult than those associated with rivers, lakes, estuaries etc., but possibly also because they are potentially far-reaching in terms of the actions that will eventually be required by Member States.

These issues are likely to be even more fundamental for the peat-rich accession countries of Central Europe than for the established EU Member States of the west. For countries with substantial resources of bogs (whose biotic communities are supported by groundwater contained within the peat), the requirement of the Directive to achieve "good quantitative status" for groundwater, at which "the level of groundwater in the groundwater body is not subject to anthropogenic alterations such that would result in any significant damage to terrestrial ecosystems which depend directly on the groundwater body" would seem to be clearly relevant to activities involving drainage. Furthermore, Member States are required to prevent anthropogenic alteration of groundwater systems that would result in impairment of hydrology and water quality in associated surface water bodies (rivers and lakes). This obligation appears especially applicable to peatland systems that lie at the centre of the land mass that contains the sources of large European rivers.

In order to assist acceding Central European countries to define the role of the EU Water Framework Directive in directing their national peatland management programmes, the development of guidance for WFD implementation with respect to peatland ecosystems is recommended as an urgent priority.

6.3.12 Awareness raising

Awareness raising has also been identified as a priority issue for the target countries. In Slovakia, this theme has already been developed during the life of the CEPP through instigation of an education programme for teachers (Section 6.2.7). In Estonia, peatland teaching materials for use in schools were produced under the auspices of the Darwin Initiative PBP (Bragg 2003). Possible further options include:

- Establishment of a web site devoted to Central European peatlands, perhaps hosted by Wetlands International or the GPI. This would facilitate sharing of information (e.g. Red Lists for peatland species or peatland related species) and co-ordination of international actions
- Organisation of a conference on peatlands (status, threats and opportunities)
- Use of existing newsletters (e.g. those produced by IPS and IMCG).

6.3.13 Establish a regional Peatland Conservation Working Group

The function of the Working Group would be to co-ordinate the development of peatland conservation and actions for Central Europe, and thus to progress the work begun within the CEPP towards its logical conclusion. Some of its initial activities might include:

- *Supporting policy:* for example through preparation of a brief overview of the benefits of undisturbed peatlands for the management of water quantity and water quality. Another task might be to help align peatland protection and management with international initiatives such as the development of wise use principles, the GGAP and the Climate Change issue.
- Organisation of *stakeholder workshops* to clarify objectives, to obtain support for follow-up projects, and to provide a sound basis for their implementation

18 For example, they are neither truly terrestrial nor fully aquatic ecosystems; and different hydrological mire types are associated with different combinations of ground- and surface water influence.

- *Supporting projects:* especially in developing transboundary and regional initiatives; producing project proposals with clear and measurable outcomes; budgeting and clarification of national and international funding requirements (incremental cost assessment procedure); and identifying potential sources of funding (e.g. UNDP/GEF, GPI).

The Working Group might be modelled on the interdisciplinary working group that has been operating at the Belarussian National Academy of Sciences since 2000 with responsibility for co-ordination of the activities of peatland experts, instigation and planning of projects, information exchange, and international co-operation.

Appendix 1. Diversity of peatland systems

Water source – ombrotrophy and minerotrophy

The most fundamental division, or source of difference, for all peatland ecosystems is based on the source of water that causes waterlogging and consequent peat formation. The two words "bog" and "fen" in the English language together embrace the entire concept of mire/peatland. The words also highlight the fact that there are two fundamentally different types of peatland.

In the case of fen, waterlogging occurs because the landform tends to retain or collect surface water, or the groundwater may inundate the ground surface either because the surface lies below the level of the groundwater-table, or because the underlying geology forces groundwater to the surface.

This sort of peatland, which is waterlogged because the normal ground-water table provides the water, tends to have a water chemistry that reflects the surrounding geology and soils of the region, and is thus known as ***minerotrophic peatland*** (*minero* – derived from mineral; *trophic* – derived from *trophos* – food [Gk.]).

The other main source of peatland water is the atmosphere. In conditions of regular rainfall, the soil itself can become sufficiently saturated to encourage wetland plants to grow, particularly the bog-moss *Sphagnum*. Although a small plant growing at only 2 mm a year, *Sphagnum* is particularly resistant to decay. As its dead remains accumulate slowly over thousands of years, mounds of peat more than 10 metres deep can develop. The plants growing on the surfaces of these huge mounds cannot reach the sub-soil, so must obtain their water and nutrients directly from rain, snow or fog.

The essential characteristic of this type of peatland is that it relies largely on direct rainfall for its waterlogged condition. It is thus called ***ombrotrophic peatland*** (*ombros* = shower of rain [Gk.]; *trophos* = food [Gk.]). In general, rainfall is poor in solutes and thus ombrotrophic peatlands also tend to be systems characterised by extremely low nutrient availability. This explains why so many carnivorous plant species are found here – they obtain their nitrogen and phosphorus by digesting insects rather than by absorption from the soil.

The more widely used term for such a low fertility, rain-fed peatland system is "bog". This is a strange, highly specialised environment, yet it is widespread throughout the boreal and sub-arctic zones, and is also common in oceanic areas. Those readers wishing to have a more detailed explanation of this type of peatland should see Lindsay (1995).

Within the two broad peatland types – bog and fen – an enormous variety of ecosystem types can be found, though arguably fens display more variety in this respect than bogs. The wide variety arises, in part, because many different conditions can give rise to fen formation. To a lesser extent, the same is true for bogs. These differences, based on many of the factors described below, when combined with concepts such as 'naturalness' and fundamental species diversity, help to express the full biodiversity of the world's peatland systems.

Micro-relief

Water-table fluctuations in fens are much greater than those found in bogs. All things are relative, however, and fens themselves often show resistance to such fluctuations when compared with the surrounding mineral soils. Nevertheless, the extreme stability of water table shown by bog systems is almost a defining feature. Typically the water table fluctuates by no more than 40–50 cm even during extreme droughts, and under more normal conditions the fluctuations may be as little as 5 cm.

Such water-table stability combines with the fact that the main architect of a bog – namely *Sphagnum* moss – displays differing growth characteristics depending on the species involved, with some species growing as low hummocks while other species tend to occur in shallow hollows. This results in an undulating surface, rarely rising more than 75 cm above the water table, within which there is intense competition for living space. The stability of the water table means that very narrow vertical zones can be established within this undulating surface, in which conditions with respect to waterlogging are very stable.

The resulting pattern of floral and faunal distribution can be defined in terms of these vertical zones and undulations. These have been variously described by different authors over the years, but are broadly described as "hummocks", "hollows" and "pools". Again, those wishing to have a more detailed account of these features, and to obtain a fuller sense of the large number of structural elements found on bogs, should consult Lindsay (1995); extensive additional literature on the subject can be found.

Elements of micro-relief, many of which occupy zones having no more than a 10 cm or 20 cm vertical span, are an extremely characteristic feature of bogs and of certain fen types. These elements provide much of the potential for structural and species diversity within both the bog and fen environment. Some sites naturally have only a few elements, while others display an almost bewildering variety of these elements of micro-relief. The variety displayed both within and between sites is an important factor in determining the characteristic range of variation to be considered for comparing and evaluating sites within a region.

Within fen systems, in addition to any undulations produced by bryophyte growth, a somewhat more pronounced vertical zonation can be found associated with large tussocks, created generally by sedges (e.g. *Carex* spp.).

Surface pattern

In putting the various elements of micro-relief together into a repeated sequence, many peatland sites display a more or less distinct surface pattern. The science of pattern description is not yet sufficiently well-advanced to provide adequate terms for the range of patterns that can be observed. Nevertheless it is clear that the juxtaposition of features in a variety of ways gives peatland systems a significant additional source of biodiversity. In much the same way as a relatively few musical notes can give rise to an almost infinite variety of musical richness, so a relatively few elements of micro-relief can give rise to a natural richness that goes beyond current attempts to catalogue it. For a further exploration of this concept, see "*Music of the Mires*" on the IMCG web-site: www.imcg.net.

The range of surface patterns on peatland systems is not, in fact, infinite and therefore it is possible to make certain broad generalisations about the range of pattern diversity within any region. This diversity of pattern, and the need to express the range typical of the region, should be taken into account when comparing and evaluating sites.

Hydromorphology

At the next level of organisation or scale above that of surface pattern, it can be seen that peatlands occur as more than simply bogs or fens. Both broad types express a variety of faces depending on the hydromorphological position that the individual site occupies within the landscape. Thus a basin fen differs quite considerably from a fen formed within the floodplain of a river, and this in turn differs markedly from a spring fen formed on a hillside. Similarly, a bog occupying a flat watershed ridge in a mountainous region is different in character from a bog formed over a basin within a lowland plain.

The distinctions made at this level of description and function are probably the longest-established of any means of classifying peatlands. It is possible to recognise particular peatland types from descriptions dating back to the 14th Century – arguably even earlier. The hydro-morphological type still forms the basis of most national peatland classifications today, separating sites into "raised bogs", "flood-plain fens", "aapa mires", "percolation fens" and a range of other terms that identify what has been widely accepted as the working unit for the purposes of site evaluation (e.g. Tansley 1939, Ruuhjärvi 1983, Steiner 1992).

Hydromorphology provides the basic units by which site evaluation is carried out. They may themselves form more extensive complexes, but in any comparison it is important to compare like with like. There is a well-documented hierarchy of interconnected features that can be used to describe the characteristics of any peatland system. This hierarchy was initially set out by Hugo Sjörs in 1948 and has been expanded and built upon by others to create a simple but flexible hierarchy that is integrated throughout the various hierarchical levels by hydro-ecological features. The full hierarchy, as set out by Lindsay (1995) and Couwenberg and Joosten (1999), can be seen in Figure 31. In the case of a particular site, the individual hydromorphological units should be compared, one with another, within each hydromorphological type. After such comparison, it is then important to make judgements about the necessary additional ground that must be included if the selected units are to maintain their hydrological function.

Hydro-geochemistry

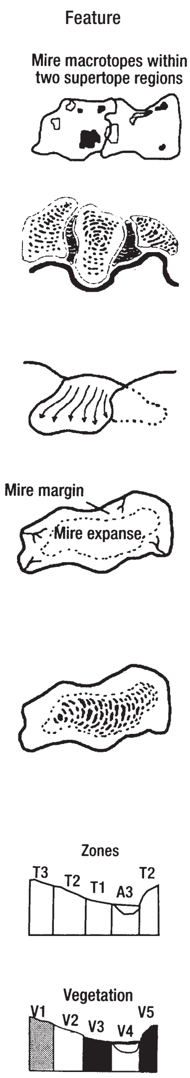
Having defined sites in terms of their overall hydromorphology, it is useful then to make an assessment of their characteristic hydrochemistry. Terms such as "rich fen" and "poor fen" have existed in the literature since earliest times, and are still used today, albeit in somewhat modified form, to describe the essential solute status of a peatland. Some peatlands will be found to have relatively high levels of nitrogen and phosphorus (macro-nutrients, or simply "nutrients"), or have high levels of other solutes such as calcium or magnesium (micro-nutrients or "bases").

The water chemistry of a peatland is important because it determines both its productivity and its vegetation character. Thus nutrient-rich, base-rich sites tend to be characterised by dense growths of tall reed, sedge, herbs and often trees, whereas nutrient-poor, base-rich sites tend to have much less luxuriant growth and are generally characterised by sedges and bryophytes. Nutrient-poor, base-poor sites are typical of the bog environment where *Sphagnum* and a limited number of the Cyperaceae predominate.

Site evaluation should also take into account variation arising from hydro-morphological and hydrochemical character. To some extent this will occur anyway when the vegetation and faunal characteristics of sites are assessed, but it is important to recognise that sometimes rather similar vegetation stands can result from markedly differing hydrological and hydrochemical processes; for example, bogs may develop through ecological succession from a range of fen types. In such circumstances the two apparently similar bog sites both merit consideration because their underlying processes (and requirements for conservation management) are likely to differ significantly.

The hydrochemistry of peatland waters is also important for other reasons. In Scotland the quality of water coming from the peat-dominated hills forms the basis of the whisky industry. In many flat-lying coastal areas in (sub)-tropical

Figure 31. The hierarchy of peatland ecosystems, based on hydro-ecological characteristics.



Hierarchical level	Description *and alternate names*	Source of description *and method of evaluation*	Utility for classification and evaluation
Supertope	Position of linked mire units within the regional landscape	IMCG 1998 *landscape analysis*	Regional overview
Macrotope	Assemblage of hydrologically linked mire units (*complex*: Sjörs, 1948, Moen 1985)	Ivanov 1981 *aerial photography, hydro-topography*	Identification of boundary for minimum, hydrologically sound, conservation unit
Mesotope	Distinct, recognisable hydro-topographic unit (*synsite*: Moen 1985, *Level 2, Form*: Zoltai and Pollett 1983)	Ivanov 1981; Lindsay *et al* 1988; *air photos, mire morphology*	Identification of individual, recognisable units for comparison
Mesotope	Distinction between mire-margin and mire expanse (*mire sites*: Moen 1985)	Sjörs 1948 *air photos, vegetation morphology*	Recognition of two or more distinct parts; in Europe, the margin often partly removed
Microtope	Repeated surface pattern – e.g. pool system (*mire features*: Moen 1985, *surface physiognomy*: Zoltai and Pollett 1983, *hummock-hollow mosaic*: Tansley 1949)	Ivanov 1981 *air photos, fractal geometry, image recognition*	Identification of hydrological character and naturalness; source of comparative diversity
Nanotope	Individual surface features (e.g. hummock, pool)	IMCG 1998 Lindsay 1995 *et al.* 1985, 1988 Ivanov 1981 *field survey*	Source of niches for individual species; comparison of diversity and damage
Vegetation	Distribution of vegetation within surface structures	A large literature exists, but see Sjörs 1948, Moen 1985, Eurola, Hicks and Kaakinen 1983, Lindsay 1995	Source of comparative diversity; indicator of "naturalness"

regions, peatlands lying inland from mangroves may well provide the iron-rich water which is a key factor in maintaining the productivity of mangroves as fish nursery areas. Remove the peatlands from the hinterland, and the productivity of the mangroves declines.

Consequently, the hydrochemical relationship of the peatland system with its surroundings is also an important consideration. Where the outputs from a peatland site contribute directly or indirectly to the overall biodiversity of the surrounding landscape, or alternatively the biodiversity of a peatland is enhanced because of particular inputs from its surroundings, the site should be given special consideration.

Vegetation

A very great deal has been written about peatland vegetation. Many systems for describing and classifying such vegetation now exist. Despite this, it will never be possible to provide a comprehensive classification by which all peatland sites can be judged. New areas of peatland and new types of vegetation are constantly being discovered.

Such a situation presents no real difficulties. Just as a range of broadly recognisable hydro-morphological types can be drawn out from the variety of classifications used around the world, so a number of reasonably standard broad vegetation types for peatlands can be recognised from within the existing literature. The detailed pattern of observed variation, reflecting small-scale microtopography or particular geochemical conditions, provides the appropriate degree of variation from which individual site-selection can be made.

The important point about the use of vegetation as a criterion when comparing and evaluating sites is that vegetation reflects various levels of regionality. Thus it is essential to ensure that the range of vegetation types considered in the assessment process reflects the natural biogeographical variation found within a region, considered at various scales from the local to the global. Some vegetation types also reflect a long cultural symbiosis between human activity and the wetland system. It is important also to include such sites and vegetation stands within the assessment process.

Fauna (including birds and fish)

Certain fenland systems are amongst the most productive ecosystems in the world. The productivity of their faunal assemblages has in the past provided immense quantities of produce for human consumption, and there are still some sites which continue to do so today. Even bog systems, though more famous for their lack of productivity, are undoubtedly capable of producing vast quantities of insects, and provide refuge and breeding grounds for important assemblages of wading birds, waterfowl, owls, cranes, eagles etc. as well as fish. Thus it is important to recognise that peatland systems may sometimes play only a small part, but a vital one, in many animal life-cycles.

Peat matrix

An extremely important aspect of the peat matrix, and one that is only just coming to be recognised as having global implications, lies in the fact that peatlands accumulate and store dead plant material over tens, or even hundreds of thousands of years. The deposits can be more than 50 metres thick. The carbon stored in these peat deposits has been sequestered from the atmosphere and put into long-term storage. While carbon storage timescales for forest ecosystems may be typically 700–1,000 years in ancient forests (though less than one-tenth of that in commercially managed woodlands), timescales for peatlands are typically 5,000–10,000 years, and some tropical peats may be closer to 100,000 years.

In terms of total carbon stored, it has been estimated (Immirzi *et al.* 1992) that peatlands contain more than one-fifth of the world's soil carbon, and hold more than three times the amount of carbon that is stored in the world's tropical rainforests.

On this basis, maintenance of the peatland carbon store clearly has important implications for issues of global warming and the overall objective of the UN Framework Convention on Climate Change (UN FCCC). Maintenance of such stores through the actions stimulated by the CEPP should thus be a priority.

Peat archive

One of the particularly unusual features displayed by peatland systems is that they store within their soil structure a record of ecosystem development and history from its earliest stages to the present day. With most ecosystems it is only possible to speculate about events in the past by looking at the present structure and composition of the ecosystem. In the case of peatlands it is possible to *see* the past by examining the material stored within the peat.

This peat archive consists not only of the plant material that created the peatland. Stored within the peat matrix are other fragments of the past, in the form of pollen grains blown from both local and more distant areas, insects and other invertebrates that may give vital information about ambient temperatures of the time, and even vertebrates – most spectacular of which are human remains such as Tollund Man, sacrificed in a Danish bog almost 2,000 years ago.

Much of what we now know about climates and vegetation patterns over the past 10,000 years – and in some places much longer than that – has been derived from the careful analysis of archives stored in peat deposits. Clearly, an undisturbed peat deposit will contain a much more useful record for interpretation in these terms than a peat deposit where parts of the archive are missing, or have been overturned and mixed with other layers.

All peat deposits are of value for their peat archive, even when they no longer support peat-forming vegetation. Peatlands that contain archives of more than 10,000 years are particularly valuable because much of the world's extensive peat resource lies in boreal regions, and these did not become free from ice cover until some 10,000 years ago. Even when less than 10,000 years old, relatively intact archives are still of considerable value. The need to understand local variations in landscape history means that a wide geographical spread of sites is also important, even if not all such sites have retained intact archives.

Appendix 2. Biogeographical regions of Central Europe

It is possible to identify, across the whole CEPP territory, a series of landscape units that display individual biogeographical character and reveal that the Baltic-Black Sea Corridor is perhaps not as broadly uniform as it might at first appear.

Each of the focal countries provided a national regionality map for inclusion in Section 4 of this document. However, these regionality maps are not consistent in their approaches; in that some display "mire regions", whilst others show "geo-botanical regions" or give general vegetation maps, so that it is not always possible to match units across national boundaries (Figures 32 and 34). A more consistent possible indicative map of biogeographical areas for the region was created by combining the national regionality maps with information derived from published maps of topography, geology and potential vegetation given in the *Physico-Geographical Atlas of the World* [19]. It subsequently proved possible to match many of the country units to the larger-scale mapping units of the *Atlas* in order to generate a more unified set of biogeographical units (Figures 33 and 35) than was provided by combining the individual country maps alone. The character of each biogeographical unit is summarised in Table 14.

These units are important for the regional peatland conservation strategy and action plan because they provide the context of environmental variation that influences the diversity of mire systems throughout the focal area. They thus form the context for a rational selection process to identify Red List peatland systems that are of importance at regional and international levels.

It must be emphasised that this map is indicative only. Given that the Ramsar Convention and the GGAP explicitly acknowledge the need for identification of appropriate biogeographical units for peatland systems in general, and for the use of such units as the basis for designation of important sites in particular, it would seem timely now to conduct a more detailed investigation of the biogeography of the region, using this initial review as a starting point.

19 Academy of Sciences of the USSR and Chief Directorate of Geodesy and Cartography, State Geological Committee of the USSR (1964).

Table 14. Indicative biogeographical areas for the CEPP region (mapped in Figure 33).

No.	Name	Vegetation type	Geology
1	Baltic Coastal Plain (plus islands)	Mixed sub-taiga/southern taiga forest	Silurian-Devonian
2	North Estonian Plain	Mixed sub-taiga/southern taiga forest	Cambrian
3	North Estonian Uplands	Broadleaved coniferous sub-taiga forest	largely Silurian
4	Lake Peipsi Depression	Southern taiga pine forest (*Picea excelsa*)	
5	North Vidzeme Plain	Mixed sub-taiga/southern taiga forest	middle Devonian
6	Vidzeme Uplands	Southern taiga pine forest	upper Devonian
7	West Latvia/Lithuania	Sub-taiga forest	igneous intrusion and associated Jurassic
8	Central Latvia/Lithuania	Sub-taiga forest	upper Devonian
9	East Latvian/Lithuanian Lowlands	Southern taiga pine forest	Devonian
10	North Belarussian Hill Country	Mixed sub-taiga/southern taiga forest	middle Devonian
11	Polish Coastal Plains and Uplands	Western pre-Atlantic oak beech forest with Central European pine-oak forest	Miocene
12	Northeast Polish Hill Landscape	Sub-taiga forest	Cretaceous
13	Southeast Lithuania	Southern taiga pine forest	Cretaceous
14	Belarus End-Moraine Landscape	Sub-taiga forest	Cretaceous
15	Loess Plain	Mixed sub-taiga/southern taiga forest	Cretaceous
16	Large Polish River Valleys	Central European mixed oak-pine forest	Pliocene
17	Western Polissia	Alder forest	Cretaceous and Oligocene
18	Central Polissia	East European mixed forest	Igneous and Miocene
19	Southeastern Polissia	East European oak forest	Mixed
20	Pre-Carpathian Depression	Central European mixed broadleaved oak forest	Miocene
21	Polish Highlands	Central European mixed oak-pine forest	Jurassic and igneous massif
22	Southwest Polissia	Mixed oak-lime forest	Cretaceous
23	Southwest-Central Polissia	East European oak forest/meadow steppe	Cretaceous and Eocene
24	Southeast-Central Polissia	East European oak forest	Igneous
25	Giant Mountains	Montane mixed beech forest	Igneous
26	Eastern Sudetes	Herb-rich montane beech forest	Lower Carboniferous
27	Bohemian Basin	Oak-hornbeam-lime woodland	Cretaceous
28	Bohemian Forest	Acidophilous oak-beech-hornbeam woodlands	Igneous
29	Brno Hills	Acidophilous montane beech forest	Igneous
30	North Danube Basin	Mixed oak-lime forest	Miocene and Lower Carboniferous
31	Western Slopes of West Carpathians	Acidophilous montane beech forest	Eocene
32	Danube Basin	Thermophilous oak woodland	Miocene
33	Tatras Mountains	Montane beech-conifer forest and high montane vegetation	Eocene and igneous
34	Southwestern Slopes of West Carpathians	Mixed oak-lime forest	Miocene
35	Western Slopes of East Carpathians	Mountain mixed conifer-beech forest	Eocene and Quaternary
36	East Slovakian Plain	Mixed oak-lime forest	Quaternary
37	East Carpathians	High montane vegetation	Eocene
38	South-facing Slopes north of Dnesmr River	Mixed oak-lime forest (easternmost extremity)	Complex geology within Miocene matrix
39	Western Forest-Steppe Region of Ukraine	East European oak forest	Complex igneous geology within Miocene matrix
40	Eastern Forest-Steppe Region of Ukraine	Meadow steppe	Oligocene
41	Steppe	Sub-Black Sea herb-rich steppe	Mixed
42	North Black Sea Coast	*Festuca-Stipa* steppe grassland	Pliocene
43	South Crimean Mountains	Sub-mediterranean formations with evergreen elements (forest and steppe)	Jurassic

Figure 32. Peatland zones derived from national regionality maps.

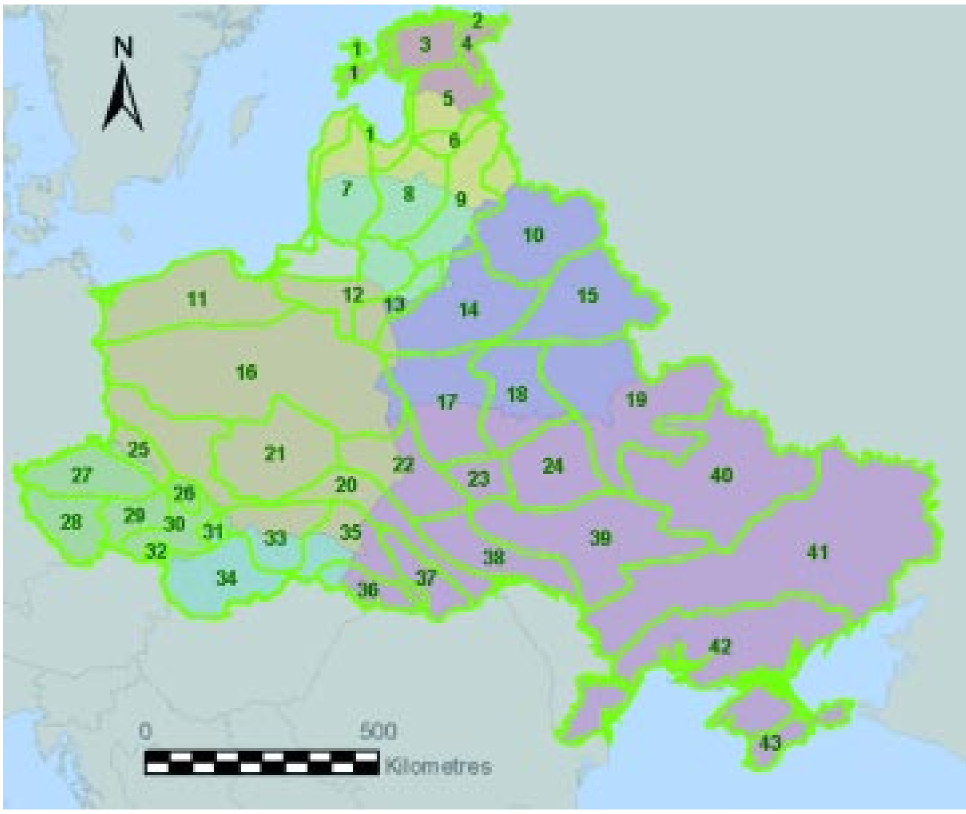


Figure 33. Possible indicative biogeographical zones for the peatlands of Central Europe derived from a combination of national biogeozones shown in Figure 32 and from biogeographical information taken from the Acadamy of Sciences of the USSR and Chief Directorate of Geodesy and Cartography, State Geological Committee of the USSR (1964) (see Table 14 for key).

Figure 34. The distribution of peatlands in relation to the zones indicated by national regionality maps.

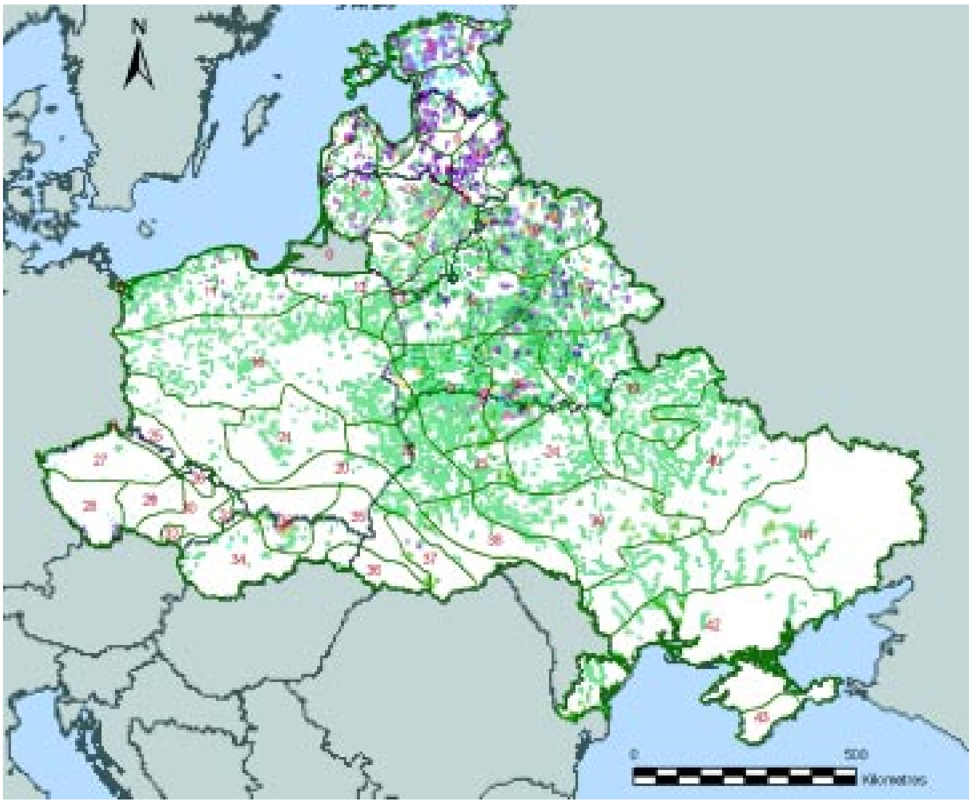


Figure 35. The distribution of peatlands in relation to the indicative peatland biogeographical zones for Central Europe.

Appendix 3. The quality of currently available spatial data on Central European peatlands

One of the objectives of the CEPP was to combine spatial data on the distribution of peatlands within the participating countries into a geodatabase of the region's peatland resource. This exercise was highly informative in that it revealed just how widely peatland inventory objectives – and therefore the types of information collected – have varied from country to country, but it also means that the results must be interpreted with caution.

Table 15 summarises the information available for the origin, collection criteria and accuracy of the data provided by each country. For five countries, the data are derived from (drift) geological/soil surveys focusing on the peat resource. These surveys have set minimum site area and peat thickness thresholds (which differ between countries), so that small peatlands (e.g. those whose areas are less than 100 ha in Belarus) and thin peat are not included. In some cases, however, the extent of small sites not included in the main inventory data has been assessed on the basis of expert opinion (e.g. for Lithuania) or presented in terms of size classes (e.g. Belarus). In all these cases, the result must be regarded as a probable under-estimate of each country's mire area, and whilst the combined dataset will indicate the locations of the principal peatlands, it is impossible to assess the accuracy of any quantitative calculations of total peatland area or peat volume. For the remaining three countries (Czechia, Slovakia and Latvia), the inventories catalogue the extent of mire vegetation. In these cases, the mire area may be slightly over-estimated since mire communities without accumulated peat are included, but on the other hand the extent of peatland (without mire communities) will be an under-estimate of the peat resource.

Ancillary information, for example on mire types[20], also varies with the purpose of the survey and with different national classification systems. Furthermore, some surveys were conducted many years ago and it is recognised that a proportion of the information will thus now be out of date.

The GIS data were used as the basis for construction of the indicative maps of the regional distribution of peatlands and the principal mire types (bog, transitional mire and fen) that appear in Figures 9 and 10. They were also used to arrive at estimates of the fractions of bog, transitional mire and fen represented within the present mire resource of each country (Table 6).

Before compiling the summary statistics on peatland losses for the whole region (Table 7, Fig. 12 and Section 5.1), the interpretation of the data was re-checked with national sources and a "best-estimate" summary dataset prepared (Appendix 4). These data were the most accurate available when they were compiled in 2001, but ongoing inventory meant that amendments (noted in Appendix 4) were already appropriate for Czechia and Slovakia by July 2003.

20 Countries were fairly consistent in classing most mires as "bog" or "fen". However, "intermediate" and "mixed" classes were also used quite frequently. In some cases the large lakes that occur within extensive peatlands had been coded as a separate category. In some other datasets certain sites were assigned to an "unknown" type class.

Table 15. Content and quality of the available spatial data for peatlands in the focal countries.

	Belarus
Data type:	map of peat deposits and updated information from the cadaster
Peatland definition:	geological
Characteristics:	peat types (raised bogs, transitional mires, fens and mixed category) land-use (ongoing excavation, excavated) current state (nearly natural) information about: agriculture, forestry, protection, drainage conditions (available only for selected peatlands)
Size threshold:	peatlands <1,000 ha presented as diagrams (three classes: 0–100 ha, 100–300 ha, 300–1,000 ha) peatlands >1,000 ha presented in real shapes
Depth threshold:	max. 4 m
Temporal accuracy:	based on maps from 1960s and updated information from 1990s
Positional accuracy:	1:1,000,000
Thematic accuracy:	based on peat deposits rather than mire vegetation
Completeness:	not complete (detailed characteristics omittted for small peatlands)

	Czech Republic
Data type:	un-referenced map
Peatland definition:	based on vegetation
Characteristics:	no information provided
Size threshold:	no information provided
Depth threshold:	no information provided
Temporal accuracy:	no information provided
Positional accuracy:	no information provided
Thematic accuracy:	mires with peat forming vegetation
Completeness:	not complete

	Estonia
Data type:	map of peat deposits
Peatland definition:	geological
Characteristics:	peat types (raised bogs, fens and mixed category) land-use (ongoing excavation, protection)
Size threshold:	no information provided
Depth threshold:	two classes: <0,9 m and >0,9 m
Temporal accuracy:	no information provided
Positional accuracy:	scale of the source material not recorded
Thematic accuracy:	based on peat deposits rather than mire vegetation
Completeness:	not complete

	Latvia
Data type:	database and map prepared in ArcView
Peatland definition:	geological and based on vegetation
Characteristics:	peat types (raised bogs, transitional mires, fens and mixed category) land-use (protection)
Size threshold:	peatlands <100 ha, presented as diagrams
Depth threshold:	no information provided
Temporal accuracy:	no information provided
Positional accuracy:	scale of the base map not known
Thematic accuracy:	mires with peat forming vegetation
Completeness:	not complete

Table 15 ***continued*****. Content and quality of the available spatial data for peatlands in the focal countries.**

	Lithuania
Data type:	map of peat deposits and updated information from the cadaster
Peatland definition:	geological
Characteristics:	peat types (raised bogs, transitional mires, fens, mixed), land-use (ongoing excavation, agriculture), current state (nearly natural, flooded), information about: forestry, protection, drainage conditions – available only for peatlands >50 ha
Size threshold:	minimum area: 20 ha
Depth threshold:	max. 6 m
Temporal accuracy:	based on maps from 1960s and updated information from 1990s
Positional accuracy:	1:300,000
Thematic accuracy:	no information provided
Completeness:	not complete

	Poland
Data type:	map of peat deposits and additional current information about selected peatlands
Peatland definition:	geological
Characteristics:	peat types (raised bogs, fens and mixed category),
Size threshold:	peatlands >100 ha
Depth threshold:	no information provided
Temporal accuracy:	based on peatland inventory in 1960s
Positional accuracy:	1:100,000
Thematic accuracy:	based on peat deposits rather than peat forming vegetation
Completeness:	not complete

	Slovakia
Data type:	database and map prepared in ArcView
Peatland definition:	based on vegetation
Characteristics:	peat types (raised bogs, transitional mires, fens, mixed) land-use (forestry, agriculture, excavation, protection) current state (nearly natural, drained)
Size threshold:	peatlands presented as diagrams
Depth threshold:	no information provided
Temporal accuracy:	no information provided
Positional accuracy:	not known
Thematic accuracy:	mires with peat forming vegetation
Completeness:	not complete

	Ukraine
Data type:	map of peat deposits;
Peatland definition:	geological
Characteristics:	peat types (raised bogs, transitional mires, fens, mixed) land-use (ongoing excavation, excavated) current state (nearly natural)
Size threshold:	peatlands <100 ha presented as diagrams peatlands >100 ha presented in real shapes
Depth threshold:	no information provided
Temporal accuracy:	based on maps from 1960s
Positional accuracy:	1: 750,000,000
Thematic accuracy:	based on peat deposits rather than mire vegetation
Completeness:	not complete

Appendix 4. Summary peatland conservation statistics for the focal countries

Table 16. Peatland area, condition and protection data for each of the focal countries.

column Country	*a* Total area of peatland (peat soil) (ha)	*b* Area of peatland now in near-natural condition (mire) (ha)	*c* Area of peatland with a conservation designation** (ha)	*d* Area of natural peatland (mire) lost (*a* – *b*) (ha)
Belarus	2,939,000	1,634,800	317,200	1,304,200
Czechia	27,000	14,742#	19,000	12,258
Estonia	1,009,100	300,000	100,000	709,100
Latvia	672,204	316,712	38,000	355,492
Lithuania	352,000	75,000	78,357	277,000
Poland	1,254,800	201,938	350,000	1,052,862
Slovakia	26,000	2,575##	2,773	23,425
Ukraine	1,000,000	580,000	70,305	420,000
Total	**7,280,104**	**3,125,767**	**975,635**	**4,154,337**

* The total area of peatland is derived from national soil/peat survey data (note that there are differences between countries in lower thresholds for site size, peat thickness and organic matter content) for seven countries, and by modelling for Slovakia.

** It is important to note that, in many cases, the designation of a site does not automatically mean that it is effectively and adequately protected either by law or in practice (Section 4).

Updated in July 2003 to ~11,025 ha;

Updated in July 2003 to >4,000 ha.

Table 17. Peatland statistics for the focal countries, calculated from the data in Table 16.

*calculation** Country	*b/a* Fraction of peatland** now in near-natural condition (%)	*d/a* Fraction of original natural peatland (mire) lost (%)	*c/a* Fraction of peatland with a conservation designation (%)	*c/b* Area of peatland with a conservation designation as a fraction of the current near-natural peatland (mire) area (%)
Belarus	56	44	11	19
Czechia	55	45	70	129
Estonia	30	70	10	33
Latvia	47	53	6	12
Lithuania	21	79	22	104
Poland	16	84	28	173
Slovakia	10	90	11	108
Ukraine	58	42	7	12
Total	**43**	**57**	**13**	**31**

* The formulae shown in the top row of the table refer to column labels from Table 16.

** The total area of peat soil (i.e. peatland in any condition) is assumed to be equal to the original area of natural peatland; thus estimates of losses are likely to be conservative.

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