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# BIODIVERSITY OF WATER AND PEAT-BOGS ECOSYSTEMS IN POLAND – RESEARCH METHODS, ORGANIZATION LEVELS, ENRICHMENT AND PROTECTION

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**Summary**. Inland water ecosystems in Poland are characterized by high diversity, especially in lake landscape of the north part of the country. They consist of: lakes, rivers, springs, bog-springs, small natural water reservoirs and ponds. All types of water ecosystems cover the area of 4550 km$^2$, of which composes 1.5% of Poland's area. Different types of water reservoirs, peat bogs and rivers have great importance in maintaining habitat and landscape diversity. A special attention should be given to carbonate peat bogs in the vicinity of Chełm, *Lobelia* – type of lakes in Pomeranian Lakeland, small water reservoirs surrounded by peat bogs or field reservoirs which create a specific and unique type of rural landscape, being refuges for many rare species of plants and animals. They also preserve and enrich species diversity. The most dangerous for species diversity in water ecosystem proved to be the pollution of water, eutrophication, the so-called land improvement, invasive species such as brown bullhead, spiny-cheek crayfish and some species of amphipods. All of these factors lead to degradation or disappearance of specific habitats for many native species of fish and some invertebrates. The effective ways of enriching and protecting the diversity (at species, ecosystem and landscape level) are: species restitution, i.e. introducing some plant or animal species to habitats that were previously settled by them; renaturalization, i.e. reconstruction of natural state of the degraded ecosystem; restoration of biological activity in ecologically devastated areas.

**Key words**: biodiversity, water and peat-bogs ecosystems

## INTRODUCTION

### Levels of biodiversity

Biological diversity determines the variety of particular nature elements and frequency of their occurrence on each level. Its uniqueness was created during evolution processes for billion years. The evaluation of biological diversity and its role in nature functioning has become a research subject already in the 1960's of 20$^{th}$ century [Fisher 1960]. Nowadays a very rapid development of this subject is observed as one of the most important trends in present ecology.

From the ecological point of view biodiversity is created by two basic phenomena: variety and variability of organisms. It does allow an estimation of species and ecosystems variety. It is not a sum of species, breeds or races of animals and plants, both wild and domestic [Gaston 1996, Hawksworth 1996, Weiner 2000, Dyduch-Falniowska *et al.* 2001]. Biological diversity is determined on four basic levels:

1) genetic – variety of genetic combinations within populations, species, ecotypes, groups of sibling species, etc.;

2) species – species diversity, their occurrence and ecological demands;

3) habitat and ecosystem – diversity and changeability of habitats, warrant variety of settled plants and animals and whole biocenosis;

4) landscape – variety of habitats in particular nature space (Fig. 1).

Species, habitat, ecosystem and landscape diversity may be considered in global, continental, geographic, regional or even in domestic and local scales. It is determined by many factors, like geographical position (climate and physiogeographical differences), limited animal and plants development and interspecific relations.

The recognition of relations between species variety and ecosystem and landscape diversity became the main problem of worldwide ecology. A very wide influence of various factors determining species diversity can be examined in four effect groups: resources quality, quantity and availability of resources and interspecific relations [Diamond 1988].

## METHODS OF BIODIVERSITY ESTIMATION

Studies on biodiversity are usually long-term and they require many specialists. The results from different areas should be comparable. The comparison of zoocenosis in different habitats is commonly made by means of some indexes based on the number of species and density of individuals, e.g. Shannon-Wiener or Simpson index. The evaluation of ecosystem diversity is very difficult, because of complete lack of generally accepted typology for different continents or climate zones. It can be estimated based on satellite pictures (remote sensing information) [Hillbricht-Ilkowska 1998, Radwan and Sender 1996].

The evaluation of species and habitat diversity can comprise rivers, lakes or peatbogs and include a number of species, rare species, indicator species (mesotrophic, eutrophic, dystrophic), key species and the final punctual estimation and quality classes. Each criterion can be considered according to 5-points quality classes: 1 point – very low diversity, 2 points – low diversity, 3 points – intermediate diversity, 4 points – high diversity, 5 points – very high diversity [Radwan *et al.* 1999, Radwan and Sender 1999].

The estimation of peat-bog ecosystems diversity can be made with reference to territorial units including: surface, depth, littoral type, fishery type, trophy, type of mixis, purity class (lakes) or river longitude, hydrobiological region, fishery region, differentiation of river along its course, anthropogenic transformation (rivers) [Radwan *et al.* 1999].

Estimation and comparison of landscape diversity as well changes of its ecological structure require some leading criteria, such as: differentiation of land surface, habitat conditions, including water occurrence: number, size and shape of patches, scale of their compactness, diversity and density of contact zones [Chmielewski 2001]. Separate areas of maximal internal similarity (surface sculpture, water conditions, geochemical features,

etc.) can delimit basic territorial units approximately conforming landscape modifications. Density of their particular elements can be analyzed according to precisely described criteria of diversity estimation [Radwan *et al.* 1999].

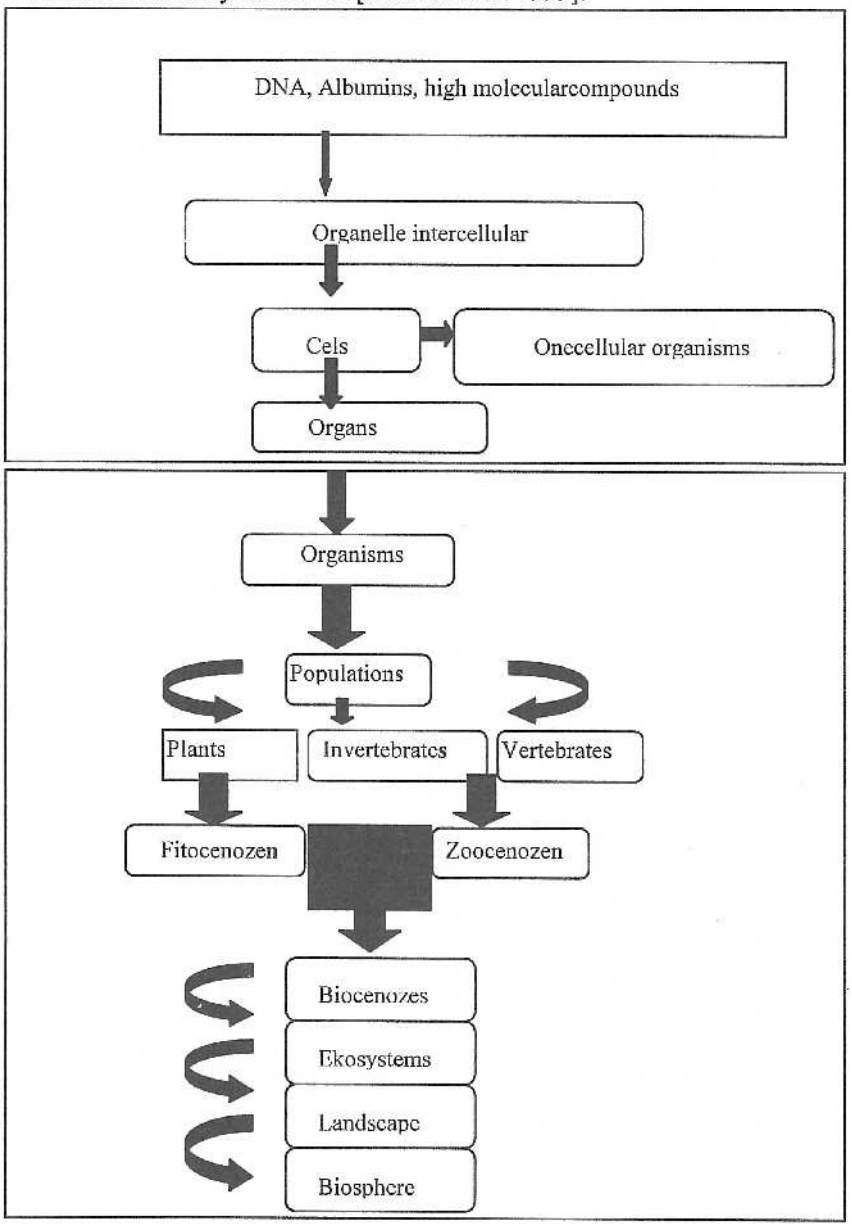


Fig. 1. Organization levels of living organisms (according Krebs 1996, Radwan 2003 – modificated)

Rys. 1. Poziomy organizacji świata organizmów żywych (wg Krebsa 1996, Radwan 2003 – zmodyfikowane)

## BIODIVERSITY OF HYDROGENIC AREAS IN POLAND

Biological diversity, both species and biocenosis, has been determined on the Earth for milliard years. During Earth history in different geological periods, species diversity of biosphere was changing very rapidly. Particular changes were caused by cosmic catastrophes (e.g. meteorites, comets, etc.) or current climate changes or geochemical changes of the environment [Weiner 2000].

Species richness of living organisms in Poland results from specific environmental conditions – very high naturalness level of environmental space and historical climate conditions which are very important for zoogeographic extents of flora and fauna occurrence [Andrzejewski and Weigle 2003].

Habitat and ecosystems diversity in Poland is still very high. A lot of specific water and peat-bog ecosystems, unique in the whole Europe, still exist. Very important are wet riparian forests and some types of carbonate peat bogs on Polesie Lubelskie Region and Chełm District. A very high ecological value is still represented by numerous lobelia lakes on Pomeranian Lakeland [Radwan 2003, Radwan *et al.* 2004].

### Species diversity

High naturalness and complexity of water-peat-bog ecosystems have allowed creating a very diverse group of living organisms. In Polish waters 1647 *Cyanophyta* species, *Algae* are represented by 10000 taxa, *Bryophyta* and *Pteridophyta*, living in hydrogenise

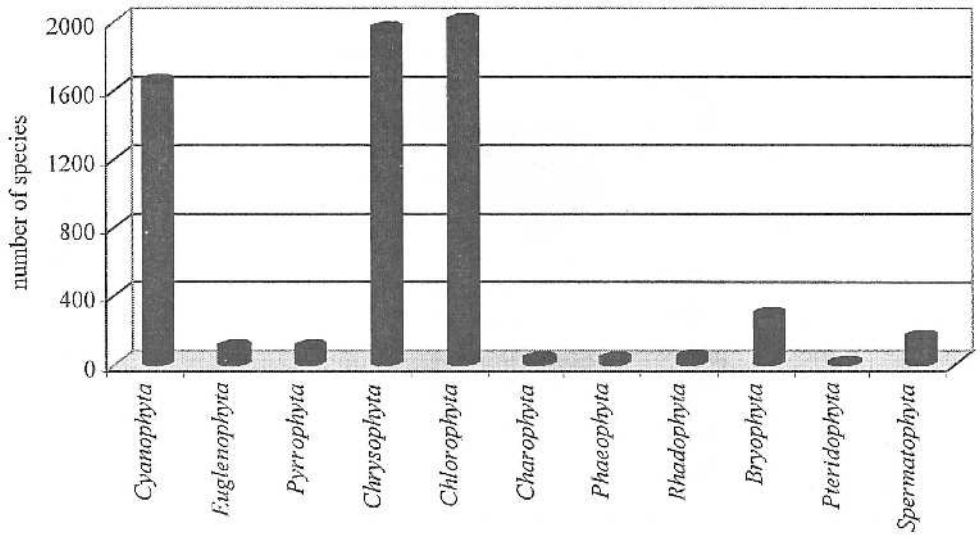


Fig. 2. Species diversity of cyanophyceae and plants of water and wet habitats in Poland
Rys. 2. Różnorodność gatunkowa sinic oraz roślin środowisk wodnych i podmokłych w Polsce

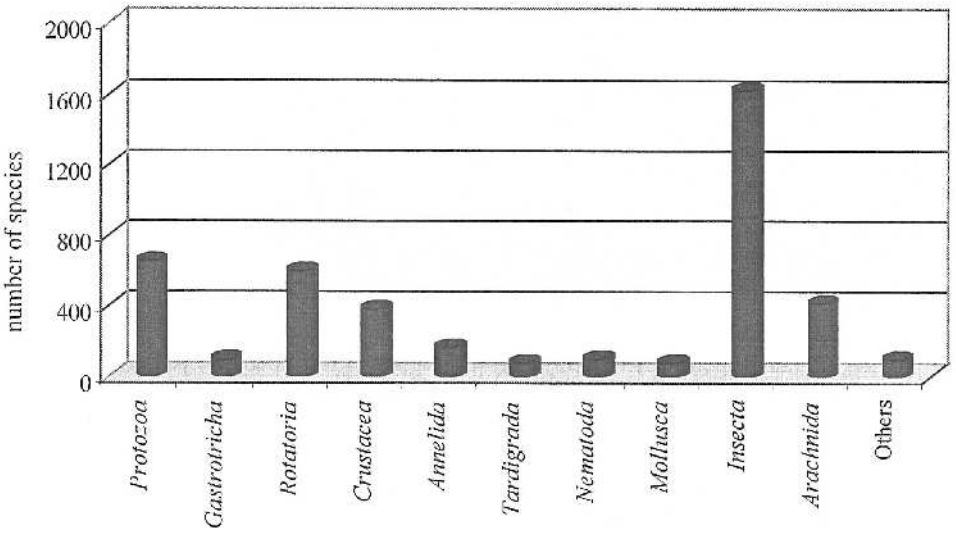


Fig. 3. Species diversity of protozoa and invertebrates of water and wet habitats in Poland
Rys. 3. Różnorodność gatunkowa pierwotniaków oraz zwierząt bezkręgowych środowisk wodnych i podmokłych w Polsce

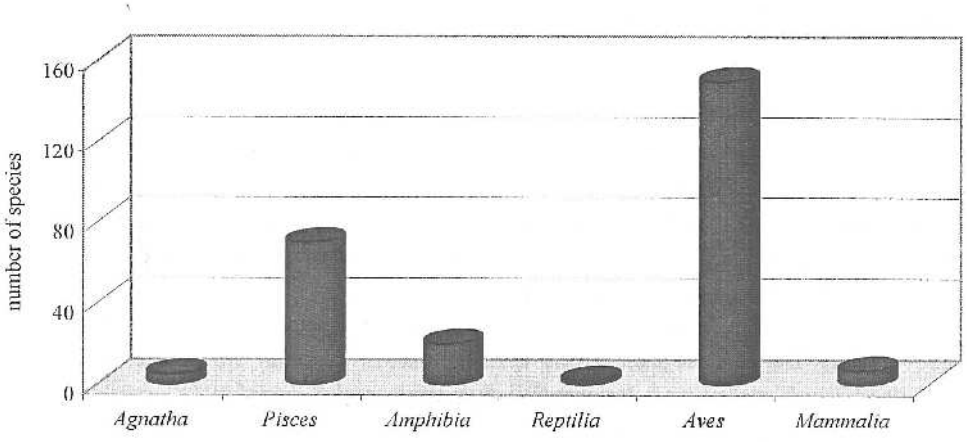


Fig. 4. Species diversity of vertebrates of water and wet habitats in Poland
Rys. 4. Różnorodność gatunkowa zwierząt kręgowych środowisk wodnych i podmokłych w Polsce

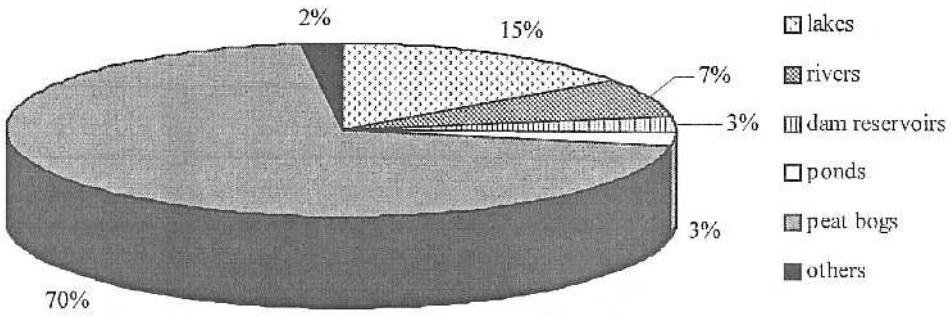


Fig. 5. Habitat and ecosystems diversity of freshwater hydrogenic biotops in Poland
Rys. 5. Różnorodność siedliskowo-ekosystemowa słodkowodnych siedlisk hydrogenicznych w Polsce

environments – 287 species, *Spermatophyta* – 150 species (Fig. 2). Unicellular *Protozoa* comprise 750 species, but *Metazoa*, as much as 3919 species. Most *Metazoa* species – 3667 – belong to invertebrates, only 252 to vertebrates. Among invertebrates the most numerous group are *Insecta* – 1631 species, then *Protozoa, Rotatoria, Arachnida* and *Crustacea* (Fig. 3). In Poland the most numerous vertebrate group, living in freshwater and marsh habitats are birds (*Aves*) – about 150 species and the less numerous – *Amphibia* – only 2 species. Quite high species diversity is observed among fish (*Pisces*) – they are represented by about 70 freshwater species (Fig. 4) [Hillbricht-Ilkowska 1998, Andrzejewski and Weigle 2003].

Nevertheless, the state of ecological recognition, mainly algae and vertebrates does not exceed 25-30% of described species [Hillbricht-Ilkowska 1998].

**Habitat and ecosystem diversity**

Water-peat-bog ecosystems in Poland are ecologically differentiated especially in Lakeland landscape. They include mainly lakes, rivers, springs, bog-springs, small water reservoirs, dam reservoirs and ponds. All water ecosystems occupy about 1.5% of Poland's territory. The majority is constituted by lakes – 0.7% and rivers – 0.4% (Fig. 5) [Andrzejewski and Weigle 1994].

**Lakes** are still quite natural. The number of lakes in Poland reach 7081 (surface area above 1 ha). The highest lake density is in the north (Masurian, Suwalskie, Pomorskie Lakelands) and central-west Poland (Wielkopolskie and Kujawskie Lakelands). Much lower lakes density is observed on the areas of Łęczna-Włodawa Lakeland and Gostyńskie and in the Tatra Mountains. Polish lakes are mostly postglacial: ribbon (e.g. Drawsko, Jeziorak, Drwęckie, Talty, Bełdany, Mikołajskie, Nidzkie) or marginal (e.g. Śniardwy, Mamry, Niegocin, Wielimie. A lot of lakes preserved its ecological identity expressed by the occurrence of different trophy types: eu-, mezo- and dystrophic. Each trophy type is inhabited by its own flora and fauna. Natural lake ecosystems are usually very diverse. Littoral zone is characterized by the development of strip-structure. It begins, depending on the water depth, from emergent vegetation belt; next appeared floating-leaved plants and submerged macrophytes. Littoral constitutes diversified and

mosaic habitats for many different species, both invertebrates and vertebrates [Dobrowolski and Lewandowski 1998].

**Ponds** – shallow, natural or artificial reservoirs. The highest ecological value is represented by: Milickie Ponds in the Barycza River Valley, Przemkowskie Ponds in Bory Dolnośląskie, Imielity Ług in Janowskie Forests, Siemień Pond in Polesie Lubelskie, etc. [Dobrowolski and Lewandowski 1998, Radwan *et al.* 1997]. Most ponds in Poland are artificial, carp type, with periodical drainage (during autumn-winter catching). They are usually eutrophic with dense vegetation. Such artificial ponds are a very important part of agricultural landscape, especially on the areas with very low freshwater reservoirs density. Apart from this, artificial ponds constitute breeding sites for many water and marsh bird species [Dobrowolski and Lewandowski 1998].

**Small water reservoirs** are natural (overgrowing lakes, field ponds, rural pools, astatic reservoirs) or artificial (peat-ponds, clay-pits, etc.). Ecological structure of natural water reservoirs, especially overgrowing lakes, is similar to lake littoral. That is why flora and fauna density are very high; such reservoirs are often refuges for many valuable species. Usually, water ecosystems surrounded by peat bogs and forests are characterized by the highest ecological value, creating a unique landscape type with a variety of relicts of peat flora and fauna. The remaining ecosystems represent a completely different ecological structure, especially on agricultural areas (field ponds). They are usually open, exposed to surface flow from the surrounding fields, which is why they are often eutrophic. Nevertheless, small water ecosystems can play an important role in the preservation of biological diversity on the agricultural areas, creating an ecological niche for species requiring higher temperature. Apart from this, small water ecosystems diversity the agricultural landscape, they constitute water resource, refuge for many plants and animals species, both water and marsh, especially many bird species [Dobrowolski and Lewandowski 1998].

**Depresion reservoirs** can originate from collapse reservoirs (ground depression after minerals extraction) or excavation reservoirs (peat-pits, clay-pits, gravel-pits, sand-pits, reservoirs in old stone-pits). In some areas excavation reservoirs constitute the only freshwater source. Usually characterized by low trophy, exploitation reservoirs may play a very important role as refuge for rare and vanishing species, breeding sites and habitats for water birds [Mioduszewski 1999].

**Rivers**, mostly lowland, still have their own natural, anastomosis beds, e.g. unique in whole Europe – the Narew River, called „small Amazon" and other valuable mountain, upland and seaside rivers. Almost the whole Poland area is situated in drainage basins of two big rivers: the Vistula and the Odra. The river system allows distinguishing some river types: mountain and piedmont (Dunajec, Raba, Wisłoka, San), upland rivers (Bug, Pilica), lowland rivers (Biebrza, Narew, Krzna, Wkra) and sea-coast rivers (Rega, Parsęta, Wieprza, Pasłęka). Rivers and their valleys are strictly connected. During a flooding river influences the inundation terraces. In turn, valleys influence the water regime of the river by valley retention, presence of old river-beds, lowmoors, alder carrs, springs and bog-springs. Plant communities well developed in wet habitats countertract surface flows and protect the quality of river waters. The structure of plant communities growing on wet and humid habitats is much differentiated, creating good conditions for inhabiting of numerous and diversified

fauna. Among them are the most valuable birds and many invertebrate species, amphibians, reptiles and mammals, especially rare, endangered and protected species. Up till now only in the Vistula Valley there are noted 320 birds species (constituting above 75% of Polish avifauna). Fito- and zooplankton communities well developed in river waters high densities reached bottom fauna (predominated by insects' larvae and oligochaetes) in high densities. Fish (mainly migratory) usually showed high density [Dobrowolski and Lewandowski 1998].

**Dam reservoirs** according to their localization and character were divided into mountainous and transitional (e.g. Rożnowski, Soliński and Goczałkowicki Reservoirs) and lowland, such as: Włocławski, Rybnicki, Zegrzyński and Sulejowski Reservoirs. The highest number of dam reservoirs are situated in north and south Poland. Dam reservoirs create very diverse physical, chemical and biological habitats as a result of the presence of three zones: river, transitional and lake. Spatial environmental heterogeneity enables the existence of many different water organisms. The negative influence on biodiversity of dam reservoirs is connected with the bad quality of feeding waters and high fluctuations of water level which preclude development of the littoral zone [Dobrowolski and Lewandowski 1998].

**Peat-bogs** in Poland envelop the area of 1.3 million ha, which constitutes 4.2% of the country's territory. The largest peat-bog complexes are situated in the north-east part of the country. The most valuable are: peat-bogs in the drainage basin of the Narew and Biebrza Rivers (e.g. Bagno Ławki), peat-bogs in Polesie Lubelskie region (e.g. Durne Bagno, Bagno Bubnów, Bagno Staw) and Imielty Ług in Janowskie Forests [Dobrowolski and Lewandowski 1998, Radwan *et al.* 1997]. Water, marsh and peat-bog areas are genetically and floristically differentiated and are characterized by very specific flora with individual plant communities (even rare species on the border of their natural geographical extent). The occurrence of specific flora and fauna creates a unique biocenosis of wet habitats. Peat-bogs play an important role in the preservation and protection of biodiversity, marking and causing retention of water resources [Dobrowolski and Lewandowski 1998].

## THREATS AND PROTECTION

### Threats

#### Global threats

Very rapid the unfavorable changes in the environment have led to fast decrease of both species and habitat diversity. It became clearly visible already at the beginning of 1980's of 20$^{th}$ century. Excessive exploitation of natural resources has brought about global environmental degradation [Weiner 2000]. Long-term climate changes caused disturbances of water resources in the local, regional and global scales. The forestage decrease intensified biogeochemical conversions of the natural environment. All these processes led to habitat homogeneity and biodiversity degradation, creating threats for flora and fauna development [Ryszkowski 2000, Radwan 2003].

Local threats

Biodiversity in the rural areas in Poland has been rapidly decreasing. During the past centuries 15 vertebrates species (3 mammals, 11 birds and 1 fish, which constitute about 2.5% of the total number of noted species) have become extinct. Apart from this, 31 species of vascular plants have disappeared. A very sudden decrease of species, habitats and ecosystem diversity was observed during the last three decades. It resulted in an increased number of extremely endangered species. Vanishing species populations showed current density decrease and a reduction of their territorial extent [Andrzejewskiand Weigle 1994, 2003]. Similar directions in biodiversity changes have been shown other taxonomic group of flora and fauna.

The most dangerous for hydrogenise habitats are unreasonable land reclamation in valleys and regulation of river-beds and pollutions leading to water eutrophication. All these processes have brought about destruction or vanishing of specific habitats for many domestic fish, other vertebrates and water invertebrates. Species usually prefer good oxygen conditions and those sensitive to shadow are absent in eutrophic waters. Rapid eutrophication processes eliminated the key species for biocenosis structure. Excessive drainage of wetlands and regulation of river-beds have led to the degradation of many peat-bog and marsh ecosystems and clearly decreased habitat variety and diminished their role as a protection barrier for waters [Hillbricht-Ilkowska 1999]. Disappearance of specific habitats and water pollution have brought about an increasing number of endangered species. Among the endangered fish species are: lake minnow (inhabiting peat-bogs small reservoirs), thunderfish, stone loach, golden loach, bitterling, salmon, lake trout, Danube salmon, white fin gudgeon, among invertebrates – mostly swamp crayfish.

The most important biodiversity threats of hydrogenise rural areas in Poland (on each organization levels) are:

– unreasonable land reclamations – excessive drainage of agricultural areas (the drop of ground water level, drainage and degradation of peat-bog and marsh areas, disappearance of small reservoirs);

– river-beds regulation – vanishing of many specific habitats, both in river-beds and surrounding habitats

– unreasonable sewage management – rapid water eutrophication, reduction of species diversity;

– agricultural activity – huge amounts of artificial fertilizers and crop protection chemicals get to the rivers during the surface flow precipitate eutrophication process and water pollution in local and regional scales;

– inappropriate urbanization, particularly in rural areas – landscape devastation, decrease of ecosystem and habitat diversity, homogeneity of natural environment, disappearance of small hydrogenise habitats;

– invasive species – extremely dangerous for water ecosystems – e.g. some amphipods and fish species and two crayfish species [Hillbricht-Ilkowska 1998, Jażdżewski *et al.* 2002];

– changes in land use structure in catchment areas (e.g. forests degradation lead to deforestation of large areas).

## Protection

Enrichment and protection of biological diversity

The most efficient ways of enriching and protecting biological diversity (species, ecosystem and landscape) in water-peat-bog ecosystems are: species restitution, renaturalization of whole ecosystems or their parts, reclamation of degraded and completely transformed areas.

**Species restitution** is an introduction of plant or animal species on the area inhabited by this species before. Restitution of the European beaver was realized in Parczewskie and Sobiborskie Forests during 1970's. Next, restitution activities were conducted in 1992 in the area of Poleski National Park. Beaver restitution finished successfully. Population density increased 10-times and expanded on the areas bordering with Poleski National Park.

Another restituted species is black grouse. This species densely occurred in the Polesie region. A rapid decrease of population density was probably caused by agricultural drainage and predators' pressure. Nowadays introduction of 4 birds on the flooded areas of Poleski National Park is planned.

Swamp turtle is the next species under environmental protection. Studies on turtle population in the area of Poleski National Park have led to localization of their breeding sites. Their eggs were sheltered and kept during winter time. As a result, the present population grew by 440 young turtles during the years 2000-2001 [Różycki 2002].

In the area of Poleski National Park some restitution trials of swamp crayfish and lake minnow have been undetaken [Radwan *et al.* 2004]. In other regions some restitution activities have taken place, e.g. restitution of migratory fish in the system of the Vistula and Odra Rivers, concerning common sturgeon, pacific salmon, brown trout and vimba [Sych 1998].

**Endangered breeds** – preservation breeding relies on the survival and reproduction of domestic populations of primeval species of plants and animals. Nowadays preservation breeding concerns white-barked cattle in the Polesie Lubelskie Region and the Polish Pony in Roztoczański National Park and „Lasy Janowskie" Landscape Park [Różycki 2002, Andrzejewski 2003, Radwan 2003].

**Ecosystems renaturalization** relies on regeneration of degraded water-peat-bog ecosystems. In Polesie Region renaturalization activity mainly focuses on slowing down water outflow and restoration of previous retention. Water-peat-bog ecosystems, the most valuable in this area, are the most sensitive to the drop of ground water level.

The first renaturalization activity took place in the area of Uściwierskie Lakes. At the beginning it relied on preparing the system, with furnace bridges, dikes and locks on drainage ditches and irrigation ditch on the peat-bog edge. The second stage concerned a removal of the Piwonia River from the deep bed to the new, shallow one anastomosing within lowmoor. The last stage consisted in regeneration of vegetation typical of wet meadows. As a result of hydrotechnic measures, water level in the new Piwonia bed and on drainage meadows increased about 10-35 cm, water level in surrounded lakes become stabilized and drying of Ciesacin Lake was stopped. In lakes included in renaturalization

processes biocenosis and species diversity are slowly restored [Chmielewski *et al.* 1996]. Apart from this, in the area of Poleski National Park i many dikes on drainage ditches were built, shrubs were removed from peat-bogs, meadows were mowed and regeneration of persistent flood waters, took place.

**Restoration of degraded and completely transformed areas** has led to restoring the biological activity of particular areas. Among water ecosystems, usually extremely eutrophic lakes were submitted to restoration processes. Their reclamation consists in artificial aeration of deoxidized hypolimnion waters (Lake Starodworskie, Miłki, etc.), selective draining of near bottom waters (Lake Kortowskie), inactivation of biogenic compounds (Lake Starodworskie) or removal of bottom sediments from the lake basin (Lake Mogileńskie). The most common method used in lake reclamation in Poland is artificial aeration. Reclamation measures often lead to visible improvement of lake trophy, but they are successful only under limited nutrients inflow [Lossow 1998].

In the Polesie Lubelskie Region mining deformations resulted in the appearance of exploitation reservoirs. The existing flood waters created as a result of ground sinking on the area of coal mine should not be drained. It can minimize the negative influence of coal mine for water conditions of this region (particularly in the complex of Uściwierskie Lakes). These flood waters can positively influence natural retention, local microclimate and landscape values. Flood waters create refugies for marsh and water birds and habitats for water flora and fauna, increasing biological diversity. Planned recreational Szczecin Reservoir may act as an ecological barrier for Poleski National Park. Such an ecological barrier would separate the protected and agricultural areas from the urbanized areas of „Bogdanka" Coal Mine.

## NATIONAL BIODIVERSITY PROTECTION SYSTEM

National protected Areas System has existed in Poland for many years. This system constitutes a hierarchical ecological scheme of submitted and complementary form of nature protection, representing different scientific, aesthetical and cultural values.

The most important form of nature protection is constituted by national parks, usually occupying large areas of above 1000 ha, with preserved valuable nature elements [Olaczek *et al.* 1996].

Nature reserves occupying valuable, but smaller, 1000 ha, areas, protected the ecosystems (peat-bog, water, sylvan, steppe, geological, floral, faunal, historical, etc.) and selected nature elements. In Poland the number of nature reserves reached 1260, constituting only 0.5% of the country's territory. Floral reserves usually dominated, the less numerous are geological and historical reserves. 441 reserves are situated on water and peat-bog areas, among them Brzeziczno Lake (Polesie Lubelskie), Imielty Ług (Janowskie Forests), Wielki Dział (Narew River Valley), etc. The highest number of reserves are located in the north-east of Poland. The most protected water-peat-bog reserves are: peat-bogs (164), lakes (148) and rivers (62) [Dobrowolski and Lewandowski 1998].

Landscape Parks in the number of 122 constitute 8% of the country's territory, protecting characteristic or unique elements of natural environment and cultural values. These areas have admitted sustainable administration (agriculture, tourism, etc.) according to environmental protection [Baran *et al.* 2000, Kozłowski 2002]. Totally in all landscape parks there are situated 750 lakes, the most valuable in Masurian Landscape Park, Pojezierze Łęczyńskie Landscape Park, Pojezierze Iławskie Landscape Park, Suwalski Landscape Park and Kaszubski Landscape Park. Mostly they are small and overgrown. Apart form lakes rivers are situated on the area of landscape parks, peat-bogs and other hydrogenise areas (Nadwieprzański Landscape Park, Janowski Forests Landscape Park, Nadbużański Landscape Park) [Dobrowolski and Lewandowski 1998, Rąkowski *et al.* 2002].

Landscape Protected Areas, just as landscape parks, occupy the largest areas. On Poland's territory there are located 231 Landscape Protected Areas. Generally, they protect elements or whole nature complexes with changes in ecological structure caused by human activity, such as forest complexes, peat-bogs, swamps.

The last area protection form is Sylvan Promotion Complex. At present there are 10 such complexes constituting 1.42% of the country's territory. Other form's of nature protection are single objects of animated and inanimate nature, distinguished by species uniqueness, structure or shape, recognized as nature monuments. These are single trees, old tree alleys, erratic boulders, etc. In Poland the number of nature monuments reached 23529. Comparatively new forms of nature protection are ecological grounds and record sites. The last ones protect objects of inanimate nature, places with numerous fossils, etc. They constitute geological heritage [Olaczek *et al.* 1996].

## OUTLINE OF BIODIVERSITY PROTECTION IN POLAND IN EUROPEAN SYSTEM NATURE 2000

In the face of potential threats of biological diversity in global and local scales activities were undertaken bringing about creation of efficient strategy of its protection. Three elements of international importance: Earth Summit in Rio (1992), Conference in Maastricht (1993) and the acceptance of „Pan-European strategy of biological and landscape diversity protection" in Sofia gave basis to a compact European system of nature protection. As a result, the document NATURE 2000 was created, a kind of nature protection program – biodiversity protection (genetic species and habitat) and tracing of ecological policy directions in the European Union countries. This document obliges to inform societies about local resources of biodiversity, its threats and protection trends.

Habitat Directive obliges member countries to mark, according to accepted criteria, areas of community importance, describe kinds of protection activities, work out protection plans, administrate areas under protection, and make reports.

Program NATURE 2000 contains of two directives (legal acts): Bird Directive and Habitat Directive giving basis for law protection of European flora and fauna.

Bird Directive concerns the protection of wild birds, natural habitats and wild animals and plants. According to the remaining directives, all member countries are obliged to quality all protection activities and if it is necessary to elaborate protection plans for selected nature elements, evaluate the consequences of influence on particular components of NATURE 2000 net, administrate the protected areas, etc. Poland participates in realization of NATURE 2000 Programme. According to the rules 400 refugees were selected, including the most valuable areas. All of them have been described as protected areas of international importance. These areas, mostly wet and marsh habitats, covere about 15% of the country's territory [Makomaska-Juchiewicz *et al.* 2001, Radwan 2003].

## CONCLUSIONS

1. Habitat and ecosystem diversity in Poland is still very high. Many specific, unique in the whole Europe, water and peat-bog ecosystems were preserved. Unfortunately during the last decades many visible changes have been observed – habitat fragmentation or transformation of landscape structure.

2. Saprogenic processes, excessive drainage of marsh areas and invasive species are considered to be the most important threats for species diversity, leading to degradation or vanishing of specific habitats for domestic species of fish, other vertebrates and some water invertebrates' taxa.

3. The most effective ways of enrichment and protection of biological diversity (species, ecosystem and landscape) of areas under ecological degradation seem to be species restitution, preservation breeding, renaturalization and land restoration.

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## RÓŻNORODNOŚĆ BIOLOGICZNA OBSZARÓW WODNO-TORFOWISKOWYCH POLSKI – METODY BADAŃ, POZIOMY ORGANIZACJI, WZBOGACANIE I OCHRONA

**Streszczenie**. Ekosystemy wodne Polski cechuje duże zróżnicowanie, zwłaszcza w jej północnej części w krajobrazie pojeziernym. W ich skład wchodzą: jeziora, rzeki, źródła, młaki, naturalne drobne zbiorniki wodne oraz zbudowane przez człowieka zbiorniki zaporowe i stawy. Wszystkie te typy ekosystemów wodnych zajmują powierzchnię 4550 km$^2$, co stanowi 1,5% obszaru Polski. Mają one duże znaczenie w utrzymaniu różnorodności siedliskowo-krajobrazowej. Na szczególną uwagę zasługują torfowiska węglanowe w okolicach Chełma, jeziora lobeliowe na Pojezierzu Pomorskim, drobne zbiorniki wodne otoczone torfowiskami, a także zbiorniki śródpolne. Tworzą one specyficzny, często unikalny typ krajobrazu, w którym znajduje ostoję wiele rzadkich gatunków roślin i zwierząt; dzięki temu zachowują i wzbogacają różnorodność gatunkową tych siedlisk. Największe zagrożenie dla różnorodności gatunkowej w ekosystemach stwarzają: zanieczyszczenie wód, ich eutrofizacja, osuszanie terenu oraz gatunki inwazyjne, np.: sumik karłowaty, rak pręgowaty i niektóre gatunki obunogów. Prowadzą one do niszczenia lub zaniku specyficznych siedlisk wielu rodzimych gatunków ryb, innych kręgowców oraz niektórych gatunków bezkręgowców wodnych.

Skutecznymi sposobami wzbogacania i ochrony różnorodności biologicznej (gatunkowej, ekosystemowej i krajobrazowej) są: restytucja gatunków, czyli wprowadzanie danego gatunku roślin lub zwierząt do siedlisk uprzednio przez niego zasiedlanych; renaturalizacja, czyli odtwarzanie naturalnego stanu w zdegradowanych ekosystemach; rekultywacja, czyli przywracanie aktywności biologicznej na terenach całkowicie zdegradowanych.

**Słowa kluczowe**: różnorodność biologiczna, ekosystemy wodne