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Natural aspects of wetlands restoration in Roztocze National Park

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A b s t r a c t. Drainage in the southern part of Roztocze National Park caused intensification of drying which markedly changed habitat conditions. Negative changes were observed in flora of the only peat bog vegetation complex in the Park. The area of raised bogs became smaller, part of them transformed into marshy coniferous forests, whereas some lost its non-forest character. In order to stop unfavourable tendencies in vegetation, complex restoration efforts were made to recreate natural conditions of water circulation and to limit the effects of previous drainage. The results of monitoring conducted from 2000 on permanent plots located in raised bog and marshy coniferous forest indicate the curbing of unfavourable changes in herb layer vegetation observed before. Peat bog vegetation grew stronger and some hygrophilous species expanded onto the area of marshy coniferous forest.

K e y w o r d s: hydrological conditions, restoration, raised bog, Roztocze National Park

INTRODUCTION

Restoration – understood as restoring transformed ecosystems to a state close to their natural one – is becoming a more and more widely used method of active nature conservation. Special attention is paid to the restoration of wetlands which in the nineteenth and twentieth century underwent either most intensive transformation or were completely destroyed. This interest draws its origin from the special role the wetlands play in water circulation and purification and in preserving biological diversity (Williams, 1990; Dugan, 1993; Mitsch, 1994; Ilnicki, 2002).

One of the most common methods of restoration of meadow and peat-bog ecosystems is rewetting (Pfadenhauer and Klötzli, 1996). There have been many successfully completed programmes during which outflow was blocked and the ground water level rose (Wheeler, 1995; Bakker *et al*., 1996; Jansen and Roelofs, 1996; Grootjans and van Diggelen, 1998). In Poland, undertakings of wetlands restoration were carried out, among others, on Łęczna-Włodawa Lakeland (Chmielewski *et al.*, 1996), Pomerania (Herbich *et al*., 1990; 1991; Buliński, 1996) and at the mouth of the Wieprz river in the valley of the Vistula river (Chmielewski and Sielewicz, 1996). Attempts at curbing the degradation of vegetation on wetlands were made also in the Roztocze National Park (Bartoszewski and Lorens, 1999).

The largest complex of raised and transitory bogs is situated in the southern part of the Roztocze National Park (RPN), near 'Międzyrzeki' bog. Plant communities there are characterized by a high degree of naturalness and are of great natural interest. In the course of the studies conducted there in 1980s there were 10 peat-bog and forest communities singled out (Lorens *et al.*, 1991). Vegetation of this area is characterized by the presence of a number of rare species, such as *Scheuchzeria palustris*, *Rhynchospora alba*, *Carex limosa*, *Drosera intermedia*, *D. rotundifolia* and protected species – *Lycopodium annotinum*, *Huperzia selago*, *Dactylorhiza majalis* and two from the above mentioned of the *Drosera* sp. genus.

As a result of long periods of water shortage in the ground, especially at the beginning of 1990s, there was to be observed a number of phenomena unfavourable as far as the conservation of peat-bog ecosystems is concerned. Some patches of raised bogs transformed into marshy coniferous

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forests, the blanked structure of raised bogs partly disappeared, whereas the density of tree layer increased markedly causing a greater shadowing of herb layer vegetation (at the same time a share of *Oxycoccus palustris* and *Andromeda polifolia* decreased there). Also the area of some transitional bogs became smaller; in all patches of *Vaccinio uliginosi-Pinetum* the coverage of *Ledum palustre* diminished. Additionally, there were observed unfavourable changes in the size of some populations of rare and protected species.

Land reclamation of the 'Międzyrzeki' swamp in the 60 and 70-ties of the 20th century seriously influenced water conditions of that area. As the result of training and mining of the existing river beds and formation of the network of drainage ditches cutting peat deposit to the mineral ground, lowering of the groundwater level and accelaration of the underground and surface runoff took place in the vast area. Peat deposit was partly mineralized and slowly subsided. Wet habitats with water occuring permanently on the surface of the terrain or very shallowly underground were getting changed into periodically waterlogged and then overdried.

In 1996 the realization of a programme of restoration of the natural water cycle in the area of 'Międzyrzeki' begun (Bartoszewski and Lorens, 1999; Bartoszewski *et al*., 2003). Its main aim was limitation of the results of the former drainage actions, and particularly restoration of the natural water circulation on the transitional and raised bogs. Designed and partly implemented actions limited river drainage and caused an increase in the groundwater table level.

Restoration activities are examined and estimated in the monitoring studies. Basic information considering the groundwater monitoring is coming from the observations of groundwater dynamics in 4 wells (piezometers) in the area of the nature preserve 'Międzyrzeki'. Measurements of the groundwater table level have been conducting since October, 1998, once a week, in the following wells: P1 piezometer localized on a sandy meadow terrace, P2 piezometer on a dune ridge, P3 and P4 piezometers on the peatland area of the nature preserve 'Międzyrzeki'. P1, P2 and P3 piezometers drain the first unconfined groundwater aquifer. P4 piezometer drains deeper groundwater aquifer which occurs in the Quaternary sands covered by silty sands in the roof. Their occurrence results in hydrostatic pressure of the groundwater table whose rise is about 1 m.

The undertaken procedures had a considerable impact on the vegetation. Positive tendencies in the dynamics of vegetation began to be observed from 1998. Periods of humidity deficit in the ground became shorter and the raised level of ground water caused the dying of some specimens of pine on raised bogs and the slowing down of their succession in the direction of *Vaccinio uliginosi-Pinetum*. Patches of transitional bogs with a dominance of *Carex lasiocarpa* and *Rhynchospora alba* partly regenerated. In some phytocenoses there also increased the cover of highly hygrophilous species – *Carex rostrata*, which may be a symptom of the improvement of local hydrological conditions. Moreover, in comparison with the previous periods, the number of populations of rare and protected species increased.

METHODS

In 1983 the Department of Ecology of Maria Curie-Skłodowska University conducted research on geobotanical cartography of peat-bogs and marshy coniferous forest complexes (Izdebski *et al*., 1992), completed later by detailed phytosociological analyses (Lorens *et al.*, 1991). In the years 1998-1999 the area mentioned above was thoroughly inspected with special attention paid to the character and directions of the processes in peat bog and forest phytocenoses on wet habitats. In addition, the changes in the areas covered by patches of individual associations were assessed.

The belt transect, consisting of 45 adjoining squares of 2x2 m, was established in 2000. Its forepart was within a typical path of *Ledo-Sphagnetum magellanici* association and the end in a representative path of *Vaccinio uliginosi-Pinetum*. In each of the plots of the transect the occurrence and percentage cover of herb layer plant species were recorded, after an 11-degree scale of quantity. Additionally, the cartograms of the distribution of selected diagnostic species were made. According to the method proposed by Matuszkiewicz (1972), species occurring in the herb layer were divided into three groups: locally differentiating *Ledo-Sphagnetum magellanici*, locally differentiating *Vaccinio uliginosi-Pinetum,* and not differentiating. The research on the plots established previously was repeated in 2003. Spatial distribution of plant species was compared with the situation in 2000. Their position and coverage in study plots were taken into account, and additionally changes in percentage share of the groups of locally differentiating species of two studied associations.

RESULTS

The course of the water levels in the described wells shows similarity of the rhythm of the groundwater table changes. Times of occurrence of the extreme water levels are almost identical. The only observed difference is in the dynamics of fluctuations. P1 and P2 piezometers localized on the outskirts of the peatland are characterized by similar groundwater levels that are visible in amplitude (Fig. 1). The lowest levels were recorded at the end of the extremely dry period of the summer of 2002 and 2003. The amplitude of the groundwater changes in the analyzed 6-year period was 66 and 60 cm, respectively, which was proof for identical hydrogeological conditions of the aquifer. The varied thickness of the unsaturated zone was the result of the

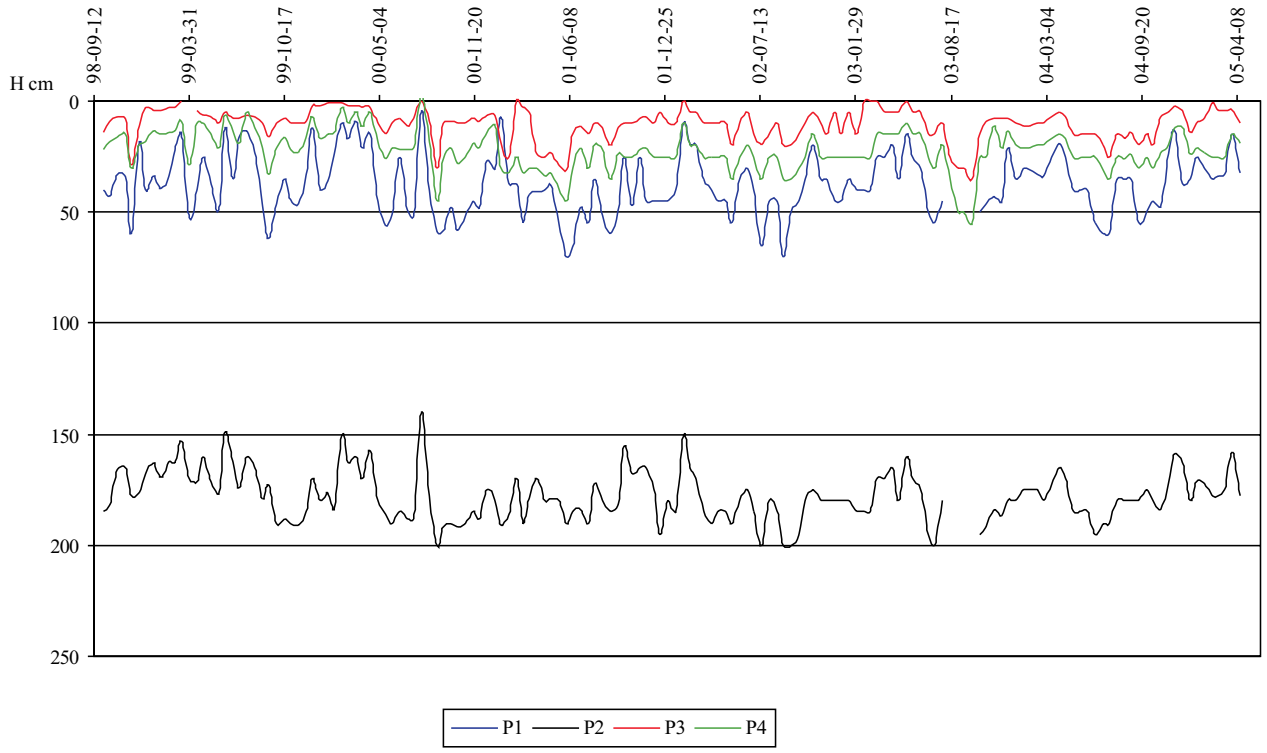

Fig. 1. The level of groundwater table in piezometers in the area of the nature preserve 'Międzyrzeki' between 1998 and 2005.

surface relief. The lowest observed amplitude of the groundwater levels was 35 cm; it was recorded in the P3 well draining the groundwater aquifer in the layer of peat of the thickness of several centimeters. Maximum groundwater level (0 cm) was observed when it reached the surface of the terrain.

The highest groundwater levels were observed during the cool and rainy summer period of 2000.

In the course of groundwater levels on the peatland 'Międzyrzeki' slight reaction of the groundwater level to limited atmospheric supply in the summer and autumn of 2003 was observed. Recorded value of precipitation in August and September, 2003, was 50.1 mm, that is much lower than average value. Decreased groundwater table was observed, but the unsaturated layer was in the capillary zone, which had a favorable influence on peat formation processes in the area of the nature preserve.

Larger fluctuations, 58 cm, were noted in the next well, P4, draining the deeper groundwater aquifer. In the summer of 2000, groundwater table was stabilized at about 3 cm above the terrain surface (in the piezometer pipe). The slightly decreasing trend observed till the summer season of 2003 was probably connected with temporary lowering of the hydrostatic pressure of the concerned groundwater aquifer. The course of the groundwater levels did not show any relationship with the course of values of air temperature and precipitation. Some relationships were shown only for extreme values – minimum and maximum.

On the basis of the results of the analysis of the percentage share of species locally differentiating the studied phytocenoses it is possible to select three sections within the transect (Fig. 2). In the first one, covering the squares from 1 to 9, there is a majority of raised bog species which consti- tute 69-100% of all species. In comparison with the year 2000, there was an increase in the share of species of the described phytocenose by 14-20%. Simultaneously, within these plots the percentage share of species typical for *Vaccinio uliginosi-Pinetum* was very low and varied from 0 to 9%. Within three years the quantity of *Eriophorum vaginatum*, *Sphagnum palustre*, *Carex nigra* and *Scheuchzeria palustris* increased, whereas the cover of *Oxycoccus pa- lustris* and *Eriophorum angustifolium* diminished. In the following squares (10-25) there is still a predominance of *Ledo-Sphagnetum magellanici* species, however the share of the elements of *Vaccinio uliginosi-Pinetum* is slightly higher than in the previous section. The raised bog species constitute from 43 to 86% of all species, whereas species characteristic for the second phytocenose account for from 10 to 30%. When compared to the year 2000, the cover of the majority of species locally characterising raised bog –

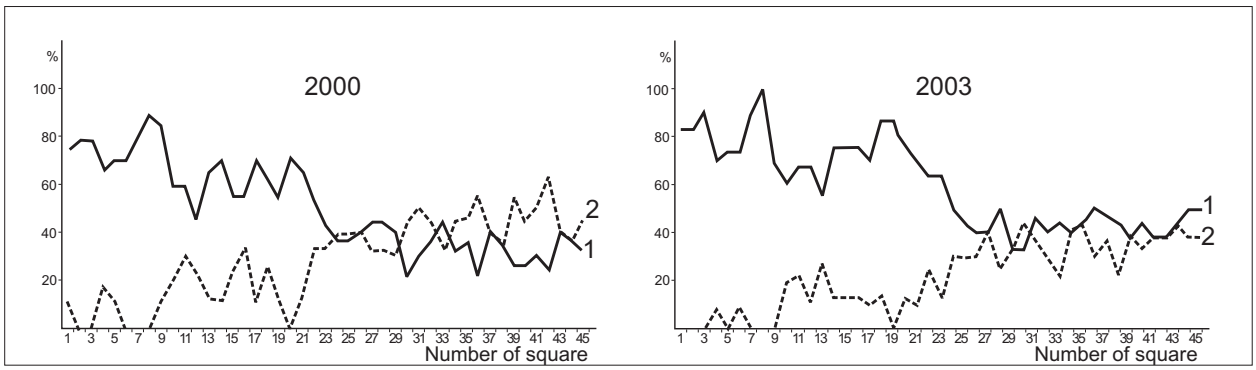

Fig. 2. Percentage distribution along the transect of species group in the years 2000 and 2003; differentiating *Ledo-Sphagnetum magellanici* (1), differentiating *Vaccinio uliginosi-Pinetum* (2), 1-45 – numbers of the square in the transect.

especially *Sphagnum palustre* and *Eriophorum vaginatum* was higher. At the same time in some squares the species typical for *Vaccinio uliginosi-Pinetum* disappeared. Further in the transect (squares from 26 to 45) a relative balance in the percentage of the elements of neighbouring phytocenoses can be observed. Locally characteristic species of *Ledo-Sphagnetum magellanici* constitute 33-50%, while *Vaccinio uliginosi-Pinetum* 22-44%. When we compare the results of the research from 2000 and 2003, in the squares from 26 to 45 there is a visible increase in the share of peat bog elements and a slight decrease (5-6%) in the share of *Vaccinio uliginosi-Pinetum* elements. During the analysed period peat bog species increased their range and quantity, whereas the quantity and distribution of majority of taxa distinctive for *Vaccinio uliginosi-Pinetum* remained unchanged.

CONCLUSIONS

1. Data taken during the hydrological monitoring show stability or improvement of conditions of water circulation. It is particularly important for air-soil conditions of peatland areas.

2. Vital changes in the quantitative structure of herb layer and distribution of some species were observed within the permanent research plots situated in the neighbouring patches of *Ledo-Sphagnetum magellanici* and *Vaccinio uliginosi-Pinetum* associations.

3. A number of species connected with raised bog increased its coverage, some of them reached the area of typical *Vaccinio uliginosi-Pinetum* patch. Simultaneously the coverage of some species of the last association diminished, especially in the plots of the transect situated on raised bog.

4. The above changes indicate a marked improvement in ground humidity, which hinders the previously intense process of transformation of raised bog into marshy coniferous forest.

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