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# Changes in the natural environment and vegetation of the Białowieża Primeval Forest (N.E. Poland) between the 5th and 19th IPE (1928-1989)

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## 1. INTRODUCTION

The Bialowieza Primeval Forest is one of the best preserved forest complexes in the European Lowlands (Falinski 1986). The Polish part of the Bialowieza Forest covers 58'000 ha, and the Belorussian part is 67'000 ha. Sixty years ago, only an elementary part of the national park existed (protected area approx. 6'800 ha, i.e. 5.5% of the Bialowieza Forest area). At present, the Bialowieza Forest as a whole is subject to partial protection and within it, the Bialowieza National Park was included in the list of the World Natural Heritage in 1979. In spite of the fact that about 15'000 ha in Poland and Belorussia were taken under special protection (c. 12.5% of the Forest area) a series of environment changes have taken place in recent decades (Fig. 1) as well as advancing alterations of the flora and fauna (Okolow 1979, Dabrowski 1983, Borowski and Okolow 1988, Tomialoje 1991, and others). Detailed studies on the vegetation dynamics in Bialowieza have been carried out for many years now (Falinski 1986, Falinska 1991).

## 2. CHANGES IN NATURAL ENVIRONMENT

The most conspicuous changes in the natural environment are alterations in hydrological relations, triggered by drainage systems introduced in the E part of the Forest in 1957-1968. The drainage systems covered c. 10'000 ha. As a



result, groundwater level has decreased, and the characteristics of the peat bogs have changed. In effect, the occurrence of *Picea* in raised peat bogs has been noted. Changes in the species composition of bog pine woods (*Vaccinio uliginosi-Pinetum*) and the succession of *Picea* into alder woods (*Carici elongatae-Alnetum*) have been observed.

At the same time, several artificial water reservoirs, covering an area of 310 ha, were built in the W part for hunting purposes. The development of the town of Hajnowka on the W foreland of the forest and the increased demand for water for communal and technological purposes resulted in excessive exploitation of the ground water. As a result, the quantity of water in rivers and streams has increased along with the toxic wastes discharged into them. An example is the Narewka river whose water cannot be classified by any water purity standards. Curiously enough, only thirty years ago, its water was classified between the first and the second class on the water purity scale. The

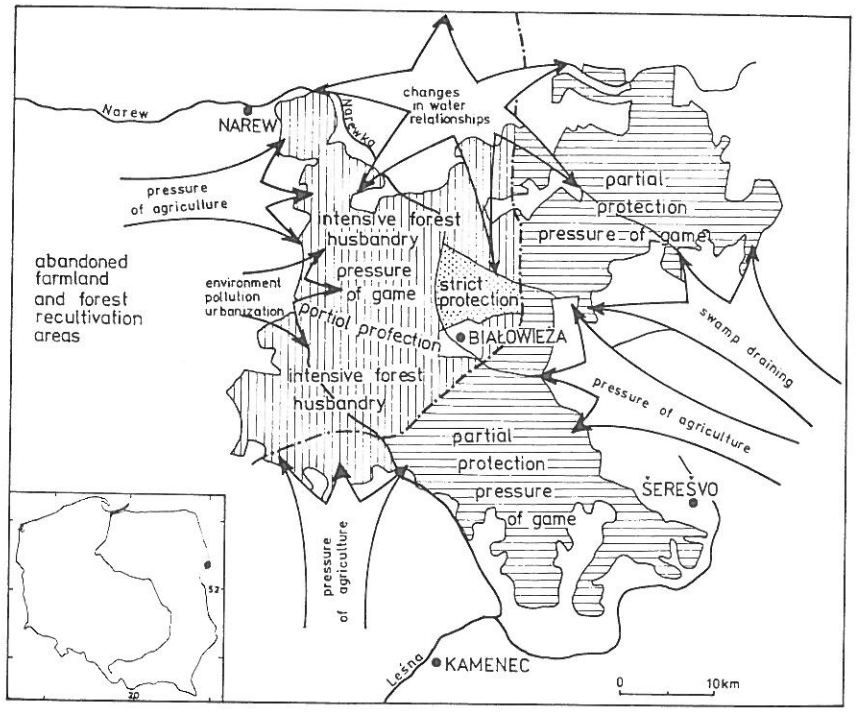


**Fig. 1.** Bialowieza Forest in the man-dominated landscape. (Falinski 1986, slightly modified).

water of the Lesna Prawa River has, until quite recently, been polluted with highly toxic substances from the wood distillation plant in Hajnowka causing the death of over 200 ha of the *Circaeo-Alnetum* in the river neighbourhood.
Likewise, air pollution has increased markedly, especially that coming from local sources. This is connected with the development of housing estates, especially that of the town of Hajnowka and the settlement of Bialowieza where heating with wood has been abandoned in favour of central heating systems fueled with coal containing considerable amounts of sulphur. At present, the mean pollution monitoring data (FORESTRY RESEARCH INSTITUTE 1989, 1990) are: 10.030-11.113 mg/m$^2$/24h for $SO_2$, 0.073-0.098 mg/m$^2$/24h for NOx and 0.010-0.015 mg/m$^2$/24h for F. In summer months pollution data are 1.932 mg/m$^2$/24h for $SO_2$, 0.008 mg/m$^2$/24h for NOx and 0.004-0.009 mg/m$^2$/24h for F. The Bialowieza National Park is relatively lightly polluted with heavy metals (GRODZINSKA 1978, 1990, GRODZINSKA et al. 1990). The greatest pollution has been recorded from road-adjacent areas, especially along the Hajnowka-Bialowieza road. After the Czernobyl fall-out, the Bialowieza Forest was the most highly radioactive contaminated area in all of Poland (REPORT 1990, ENVIRONMENT PROTECTION 1991, SMULEK and GRODZINSKA 1988). The studies carried out in Belorussia suggest that the strongly contaminated areas are located as close as 20 km from the SE part of the Forest (CHERNYSHEV 1989, JASINSKA et al. 1991).
Another type of environmental violation is the damage being done to the landscape. Refuge dumps are one type of damage. The dump located in Polana Bialowieza is merely 0.5 km from the Park limits. Considerable violation of natural landscapes was done by the exploitation of sand and gravel by the building industry. Another type of damage is the transition from traditional wood into brick architecture which is in disharmony with the landscape. Even worse is the random growth of the building industry, resulting in dwelling-houses being built as close as 800 m from the edge of the forest. Power lines are another distortion of the landscape. Wide asphalt roads through the forest complex are likewise harmful. Even greater harm was done by the deforestation of a wide stripe of land along the national border, dividing the forest into Polish and Belorussian parts. Both are being cultivated according to different criteria, and in addition, have been separated by a barbed-wire fence since 1981.



## 3. CHANGES IN TREE STAND COMPOSITION AND STRUCTURE

Serious changes in the composition and structure of the tree stands have been effected by the exploitation of timber resources for half a century now. These changes are presented in Tables 1 and 2 and refer to the managed parts of the forest, including the Polish and Belorussian parts and excepting the National Park. In the Park, pioneer species (*Betula, Populus, Salix, Pinus*) are retreating in favour of shade resistant species, such as *Picea, Carpinus* and *Tilia* (KOWALSKI 1982). The former meadows along the Narewka and Hwozna rivers are gradually becoming overgrown. Abandonment of cattle grazing in the forests of the Polish part of the forest has caused changes in their structure and the disappearance of the *Potentillo albae-Quercetum* association (KWIATKOWSKA 1986) among others. An excessive number of game animals, especially of the deer family, in the Belorussian part of the forest has caused an increase in *Picea*, while other species, mainly *Fraxinus*, have been irrevocably eliminated. This phenomenon has also been observed in the W part of the forest but on a smaller scale.

**Table 1.** Changes of the tree stands age category in the Bialowieza Forest in 1931 and 1978.

| Age category | Years | Percentage 1931 | Percentage 1978 |
|---|---|---|---|
| I | <20 | 19.74 | 16.79 |
| II | 20-40 | 2.80 | 8.35 |
| III | 40-60 | 4.68 | 15.62 |
| IV | 60-80 | 9.02 | 9.78 |
| V | 80-100 | 15.59 | 12.57 |
| VI | 100-120 | 19.54 | 15.57 |
| VII | >120 | 28.63 | 21.32 |

**Table 2.** Changes of the tree stands species composition in the Bialowieza Forest in 1931 and 1978.

| Species | Percentage 1931 | Percentage 1978 |
|---|---|---|
| *Pinus sylvestris* | 42.00 | 47.19 |
| *Picea abies* | 16.00 | 9.93 |
| *Quercus* sp. | 6.00 | 7.93 |
| other | 36.00 | 34.95 |

## 4. CHANGES IN FLORA

In the last fifty years, various changes in the composition of flora and fauna species of the Bialowieza Primeval Forest occurred, as well as changes in the quantity of certain species. Many lichen species disappeared irretrievably (CIESLINSKI et al. 1992). The population density and number of sites of *Orchidaceae* (e.g. *Cypripedium calceolus*) and *Drosera rotundifolia* has decreased. The following species completely disappeared: *Carlina acaulis, Rhynchospora alba* and *Lycopodium inundatum*, recorded on one single site (SOKOLOWSKI 1981). On the other hand, newcomers have appeared, among them are *Erigeron ramosus* and *Impatiens parviflora*. The latter reached Polana Bialowieza advancing along the Hajnowka-Bialowieza road within the last ten years. Along with the seedlings of *Larix europaea* planted in the Palace Park in Bialowieza in the fifties, a new fungus species, *Suillus grevellei*, appeared (PACHLEWSKI 1963).

Last of all, it should be stressed that in spite of any shortcomings, positive changes in the legal protection of portions of the Bialowieza Primeval Forest have taken place within the past 50 years.

### REFERENCES


BOROWSKI S. and OKOLOW C., 1988: The birds of the Bialowieza Forest. Acta Zool. Cracov. *31(2)*, 65-144.

CHERNYSHEV V. A., 1989: Macrofungi and radiation. 1:2000 map. Polymja, Minsk.

CIESLINSKI S., CZYZEWSKA K. and GLANC K., 1992: Resources of lichens at the Bialowieza National Park (NE Poland) and their changes. Veröff.Geobot.Inst.ETH, Stiftung Rübel, Zürich, *107*, 392-401.

DABROWSKI H.S., 1983: The notice of the state threat to the lepidopterofauna in national parks. Part IV. Bialowieza Primeval Forest and Bialowieza National Park. (In Polish with English summary). Parki Narodowe i Rezerwaty Przyrody *4(2)*, 5-28.

ENVIRONMENT PROTECTION, 1991. Materials and statistical analyses. Glowny Urzad Statystyczny, Warszawa. 311 p.

FALINSKA K., 1991: Plant demography in vegetation succession. Tasks for vegetation science 26. Kluver Acad.Publ., Dortrecht/Boston/London. 210 p.

FALINSKI J.B., 1986: Vegetation dynamics in temperate lowland primeval forests. Ecological studies in Bialowieza forest. Geobotany 8. Junk, Dortrecht/Boston/Lancaster. 537 p.

FORESTRY RESEARCH INSTITUTE, 1989: Investigation on air pollution in forests - technical monitoring. Report for winter period 1988/89. (In Polish). Inst.Bad.Lesnictwa, Warszawa. 101 p. (Polycopy).

FORESTRY RESEARCH INSTITUTE, 1990: Investigation on air pollution in forests - technical monitoring. Report for winter period 1989. (In Polish). Inst.Bad.Lesnictwa, Warszawa. 95 p. (Polycopy).

GRODZINSKA K., 1978: Mosses as bioindicators of heavy metal pollution in Polish National Parks. Air and Soil Pollution *9*, 83-97.





GRODZINSKA K., 1990: Long-term ecological monitoring in the National Parks. of Poland. In: GRODZINSKI W., COWLING E. B. and BREYMEYER A. I. (eds.), Ecological risks - perspectives from Poland and the United States. Acad. Press, Washington. 232-246.

GRODZINSKA K., SZAREK G. and GODZIK B., 1990: Heavy metal deposition in Polish National Parks - changes during ten years. Water, Air and Soil Pollution *49*, 409-419.

JASINSKA M., KOZAK K. and MIETELSKI J.W., 1991: Additional effective dose equivalent for adults and children in Poland as the result of mushrooms consumption. In: Proc.Intern.Symp., Post-Chernobyl Environmental Radioactivity Studies in East European Countries, Kazimierz, Poland, September 17-19, 1990. M. Curie-Sklodovska Univ., Lublin. 71-76.

KOWALSKI M., 1982: Development of natural tree stands on experimental plots in the Bialowieza National Park. (In Polish with English summary). Rozprawy SGGW-AR, Roz.Nauk.Monogr., Warszawa, *19*, 1-87.

KWIATKOWSKA A., 1986: Reconstruction of the old range and the present day boundary of a *Potentillo albae-Quercetum* (Libb.) 1933 phytocenosis in the Bialowieza Primeval Forest landscape. Ekol.Pol. *34(1)*, 31-45.

OKOLOW C., 1979: Anthropogenic changes of entomofauna in the Bialowieza Primeval Forest. (In Russian). In: VII Mezdunarodnyj Simpozjum po entomofaune srednej Evropy. Leningrad. 108-110.

PACHLEWSKI 1963: *Suillus grevellei* (Klotzsch) Sing. and *Suillus serugiescens* (Secr.) Snell. in the Bialowieza Botanical Garden and urbanized part of the Bialowieza Primeval Forest. (In Polish). Prace Inst.Bad.Lesn. *257-263*, 103-117.

REPORT, 1991: Report on the threat to and nature protection. Materials and statistical analyses. (In Polish). Glowny Urzad Statystyczny, Warszawa. 357 p.

SMULEK W. and GRODZINSKA K., 1988: Radionuclids content in mosses of Polish national parks. (In Polish). Sprawozdanie z programu CPBP 04.04. za rok 1988. W. Szafer Institute of Botany, Krakow. 6 p. (Polycopy).

SOKOLOWSKI A. W., 1981: Flora of the vascular plants of the Bialowieza National Park. (In Polish with English summary). Fragm.Flor.Geobot. *27(1-2)*, 51-131.

TOMIALOJE L., 1991: Characteristics of old growth in the Bialowieza Forest, Poland. Natural Areas J. *11(1)*, 7-18.



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