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Reconstruction of vegetation dynamics in "Linje" peat-bog (N Poland) using remote sensing method

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Abstract: The study reports vegetation changes in the "Linje" nature reserve in the Chełmińskie Lakeland (N Poland), a locality of a glacial relict dwarf birch *Betula nana* L. Former condition of the peat-bog vegetation was determined by the use of the remote sensing method, based on a set of aerial photographs from 1951-1996. In the second half of 20th century, in the area occupied by *B. nana*, a *Pinus sylvestris* forest extincted. In 1978-1996, the area of scrubs and forests dominated by *Betula pubescens* increased by ca. 100%, and open bog communities decreased of 22%. Expansion of *B. pubescens* negatively influenced the abundance of *B. nana*, whereas the extinction of the pine stand and the development of *Ledum palustre* dominated communities instead, probably improved conditions for existence of the dwarf birch.

Key words: *Betula nana* L., glacial relict, remote sensing, wetlands, peat-bog, vegetation succession

1. Introduction

The peat-bog in the "Linje" nature reserve in the Chełmińskie Lakeland (Kondracki 1998), situated 15 km NE from Bydgoszcz, is one of only three localities of the dwarf birch in Poland. *Betula nana* is glacial relict, which occur in our country outside the compact range. It is endangered and strictly protected species in Poland (Kruszelnicki & Fabiszewski 2001). The peat-bog was drained in the second half of the 19th century (Conventz 1902), probably to make a peat extraction possible. After overgrowth of ditches the peat-bog is well saturated with water. The area is covered mainly by ombrotrophic and mesotrophic plant communities. Population of *B. nana* occupies its central part, forming dense thickets.

Dwarf birch is a clonal shrub belonging to the family Betulaceae, usually up to 1 m in height, with prostrate to ascending shoots. Leaves are 0.5-2.0 cm long, orbicular or obovate-orbicular, deeply and regularly crenate all around, rounded at the both apex (de Groot *et al*. 1997). To conserve the locality of the glacial relict it is necessary to define the dangers threatening its existence. Hence, the aim of this study is to estimate the vegetation changes in the last half-century in the "Linje" nature reserve.

2. Material and methods

The remote sensing methods was used in the study. The panchromatic aerial photos from 1951, 1972, 1978, 1985 and color aerial image from 1996 were compared. The analysis of the vegetation structure changes visible on the aerial images was done in the Geographical Information System (GIS) – Bentley/MicroStation software. Calibrated aerial photos were interpreted. At this stage, identical areas were separated on the screen by visual methods. The main interpretation features which differentiate those areas were photo-structure and photo-pattern. They involve the dimension and arrangement of picture elements and in some cases the color. The photo-interpretation key of selected elements covering the studied area was created. On this base separate areas were characterized, named and measured. A value of 10% was assumed as a significance level of the vegetation changes in the analyzed periods.

Plant communities in the separated areas of aerial photographs were recognized on the basis of plant cover descriptions of Stecki & Kulesza (1928), Miłkowska (1962) and Ceynowa-Giełdon (1971) and a present-day vegetation study. Contemporary plant cover was a reference to the projection of the vegetation in the past.

The fieldwork research were carried out in 2002-2003. Syntaxonomic nomenclature follows Brzeg & Wojterska (2001).

3. Results

The estimated area of the "Linje" bog is 4.4 ha. In 1951, its central part (0.9 ha) was occupied by *Pinus sylvestris* forest identified as *Vaccinio uliginosi-Pinetum* community with the cover of tree crowns of about 50%. In the period of 1951-1972 *P. sylvestris* retreated from the mire and *Ledo-Sphagnetum magellanici* community developed instead in the area of 0.6 ha (Fig. 1). The rest part of plant cover in 1951 and 1972 is undistinguished.

In 1972-1996, the area covered by *Ledo-Sphagnetum magellanici* with *Ledum palustre*, *Vaccinium uliginosum* and *Betula nana* as dominants in a shrub layer increased by about 85% (from 0.6 to 1.1 ha), although transitionally decreased to 0.5 ha in 1978. The area occupied by *Betula pubescens* communities, including *Vaccinio uliginosi-Betuletum*, *Sphagno recurvi-Eriophoretum vaginati* variant with *B. pubescens* and *Sphagno-Alnetum*, increased considerably from 0.2 to 0.4 ha in the period 1978-1996, although decreased in 1985-1996 by 20% (from 0.5 to 0.4 ha), especially in the eastern part of the bog. As a consequence of scrubs and forests expansion, the area occupied by the open bog communities, mainly *Sphagno recurvi-Eriophoretum vaginati* and *Sphagno recurvi-Eriophoretum angustifolii*, decreased in 1978-1985 by 22% (from 3.7 to 2.9 ha).

4. Discussion and conclusions

The vegetation changes are currently the most important factor affecting the species extinction in the bogs. Increase in trees vegetation cover after the widespread drainages in the bogs in Poland is well noticeable in the 20th century (Jasnowski 1972). Especially small, isolated populations of glacial relicts are endangered due to the vegetation succession.

Betula nana is the most abundant in *Ledo-Sphagnetum magellanici* association, less numerous on more wet habitats of *Sphagno recurvi-Eriophoretum vaginati*. It rarely grows in *Betula pubescens* scrub. The

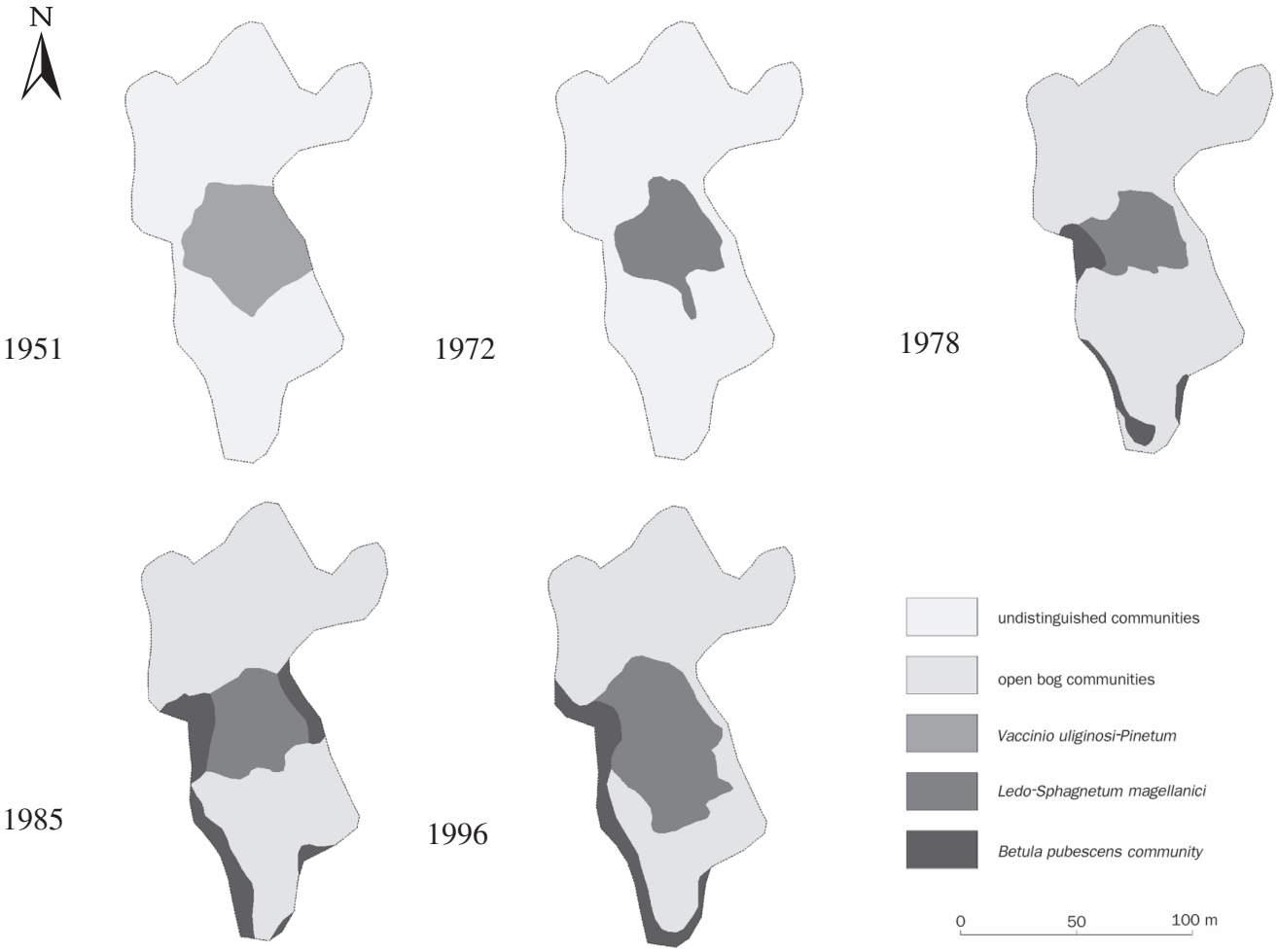

Fig. 1. Vegetation changes in "Linje" nature reserve in 1951-1996

development of *B. pubescens* communities, especially the forests, influences negatively *B. nana* abundance (Ejankowski, in press). Hence, it can modify distribution of dwarf birch in the bog and can lead to an extinction of the local population. The aerial photographs indicate the increase of *B. pubescens* communities since 1978. The decrease in the area occupied by them in 1996 in comparison to 1985 has been caused by anthropogenic deforesting of pubescent birch trees in 90's, carried out to protect *B. nana* population (Kruszelnicki & Fabiszewski 2001). However, the manipulation had only a short-term result, because current habitat conditions still make regeneration of the communities dominated by *B. pubescens* possible (pers. obser.).

The retreat of *Pinus* stand from the central part of the bog has probably improved the living conditions of the dwarf birch (Laine *et al.* 1995) showed that the development of *P. sylvestris* in the peat-bogs limits the abundance of *B. nana* due to the growth competition.

Small abundance can be the cause of population extinction (Gaston 1995). Pubescent birch expansion in the "Linje" peat-bog is a danger for the protected species. Rutkowski (1997) includes *Betula nana* in the Kujavian-Pomeranian region in the rare species (R) category, but the study suggests that the plant cover transformations in the "Linje" nature reserve can influence a fate of *Betula nana* in future. An example of plant cover changes indicates that *Betula nana* in the "Linje" peat-bog is endangered (En category) and the valuation of a current danger status (Rutkowski 1997) is underestimated.

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