

**DISTRIBUTION AND ABUNDANCE
OF *PULSATILLA PATENS* POPULATIONS IN NATURE
RESERVES IN NORTH-EASTERN POLAND**

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A b s t r a c t

In the past most *Pulsatilla patens* sites were found in north-eastern Poland particularly in North-Podlasie Lowland, where the populations were also numerous. The purpose of my investigation has been to trace the current distribution of *Pulsatilla patens* in 16 nature reserves in north-eastern Poland. The data concerning the presence of this species have been verified following a few steps. First, the source references, such as the protection plans containing information about the selected nature reserves, were analyzed. Next, in each nature reserve the following components were analyzed: distribution of the stands, abundance of the populations, type of a community in which *P. patens* grows and type of the soil. Later, these data were verified by referring them to the current data of 2010, supplied by the Regional Directorate of National Forests (RDLP) in Białystok. Analysis of the documentation from the years 1955–2010 shows the gradual disappearance of *Pulsatilla patens* sites. Currently the sites of *Pulsatilla patens* have been preserved only in the 5 nature reserves (Krasne, Kukle, Góra Pieszczana, Kuriańskie Bagno, Szelągówka). At all the examined sites, the populations are very small, consisting of a few individuals. This suggests that the actions undertaken to protect it have failed.

**WYSTĘPOWANIE I ZASOBY POPULACJI *PULSATILLA PATENS*
W REZERWATACH PRZYRODY PÓŁNOCNO-WSCHODNIEJ POLSKI**

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Abstrakt

Większość stanowisk *Pulsatilla patens* w przeszłości występowała w północno-wschodniej Polsce, szczególnie na terenie Niziny Północno-Podlaskiej, gdzie populacje były reprezentowane przez liczne osobniki. Celem badań było opracowanie aktualnego rozmieszczenia stanowisk sasanki otwartej na terenie 16 rezerwatów przyrody oraz ocena zasobów populacji. Weryfikację danych o występowaniu i liczebności badanego gatunku przeprowadzono w kilku etapach. Najpierw dokonano analizy planów ochrony rezerwatów przyrody. Na terenie każdego obiektu analizowano: rozmieszczenie stanowisk, liczebność populacji, typ zbiorowiska w jakim sasanka występuje oraz typ gleby. Następnie dane te zweryfikowano, bazując na materiałach z 2010 r. otrzymanych z Regionalnej Dyrekcji Lasów Państwowych w Białymstoku oraz przeprowadzono badania terenowe w wybranych obiektach. W celu uzyskania pełnego obrazu zmian w występowaniu i zasobach populacji sasanki wykorzystano w pracy publikacje naukowe dotyczące rezerwatów. Analiza danych z lat 1955–2010 wskazuje na stopniowy zanik stanowisk sasanki. Aktualnie gatunek ten występuje tylko w pięciu rezerwach przyrody (Krasne, Kukle, Góra Pieszczana, Kuriańskie Bagno, Szelałówka). Wszystkie populacje są bardzo nieliczne, obejmują po kilka osobników. Wskazuje to na nieskuteczność działań podjętych w celu ochrony tego gatunku.

Introduction

Pulsatilla patens (L.) Mill. (Eastern pasque flower) is a threatened plant species in Europe, listed in the Bern Convention and in Annex II of the European Habitats Directive. In Poland, this rare species has been legally protected since 1958. In Wielkopolska and Western Pomerania, *P. patens* is considered to be a threatened taxon (ŻUKOWSKI, JACKOWIAK 1995). It is included in the Polish Red Book of Plants, listed as a low risk (LR) taxon (WÓJTOWICZ 2001). In a recently published Red List of Vascular Plants in Poland (ZARZYCKI, SZELAĞ 2006), *P. patens* is considered to be critically endangered.

Considering the fact that the number of sites has diminished significantly in many parts of the country (MICHALAK 1976, CIOSEK 1999, NOWAK et al. 2000, CHMURA 2003, *Zagrożone gatunki*. 2003), a national plan for the conservation of this species has been elaborated. It points to sources of the threat and specifies aims of the actions undertaken, such as active conservation of edge and scarce populations, improvement of the conditions for non-renewable populations, broadening our knowledge on the distribution and status of the population of *P. patens* and education of the general population on the need to maintain biological diversity (ZYCH 2007).

Within its geographical range, *P. patens* appears in different types of plant communities, including calcareous grasslands in Germany (RÖDER, KIEHL 2006), pine-dominated forests in Finland, (UOTILA 1996, KALLIOVIRTA et al. 2006), in steppe communities in Russia (RYSINA 1981), in alvar forests and shrublands, boreal heath forests, also in dry boreal forests in Estonia (PILT, KUKK 2002).

In Poland, the largest number of sites is found in the north-east. These are relatively abundant sites, comprising tens to hundreds of plants (WÓJTOWICZ 2000). Eastern pasque flower grows mainly in pine forests with elements of thermophilic vegetation. The presence of this species has been determined in *Peucedano-Pinetum* communities in Kurpiowska Forest (FALIŃSKI 1965, CZERWIŃSKI 1970), Augustowska Forest (SOKOŁOWSKI 1966, 1969, CZERWIŃSKI 1970, MATUSZKIEWICZ 1965, SOKOŁOWSKI 1968), Białowieska Forest (SOKOŁOWSKI 1966, 1991) and Knyszyńska Forest (CZERWIŃSKI 1995) as well as on Dobrzyń Moraine Plateau (KĘPCZYŃSKI 1965). In north-eastern Poland, *P. patens* has been considered as a species locally characteristic of *Peucedano-Pinetum* association and *Dicrano-Pinion* allion (CZERWIŃSKI 1978, 1995). Easter pasque flower also occurs in *Serratulo-Pinetum* (CZERWIŃSKI 1995) and *Querco-Pinetum* associations (ENDLER 1979).

The above references, which document the presence of *P. patens*, are mainly of historical value and need to be verified. The purpose of my investigation has been to establish the current distribution of *Pulsatilla patens* in nature reserves in north-eastern Poland, to evaluate the abundance of these populations. The first step for such verification is the present analysis of the current occurrence of *P. patens* in nature reserves in north-eastern Poland, which deals with such issues as abundance of the populations and description of the characteristics of the ecological conditions. The author has chosen nature reserves for the research because she believes that areas under legally imposed conservation provide good environmental conditions for the existence and development of *P. patens* populations.

Material and Methods

Study area

Nature reserves where *P. patens* stands have been identified are in north-eastern Poland (Figure 1). According to the physical and geographical division of Poland into regions, these nature reserves lie in North Podlasie Lowland and Masurian Lake District. The area comprises part of the catchment basins of the rivers flowing to the Baltic Sea, i.e. the Vistula, Pregola and Neman Rivers. Another important component of the local hydrographic relations is the vast abundance of lakes and wetlands (KONDRACKI 2001). North-eastern Poland is in the Masurian and Podlasie climatic region, which stretches over the eastern part of the Masurian Lakes and Podlasie (WOŚ 1996). The weather is characterized by strong affinity to the continental climate with its typical length of seasons, such as a long and freezing winter (110 days), long summer

(90 days), but shorter spring and autumn than in the other parts of Poland. The snow cover remains here for a long time (85–96 days) and can be up to 10 cm thick. The average annual temperature is low (7°C) and the growing season is short, lasting about 200 days (GÓRNIAK 2000).



Fig. 1. Location of the sites (name of reserves – see Table 1)

Study species

Pulsatilla patens is a hemicryptophyte with an upright, branching rhizome, which makes older plants to form clumps. Two types of buds are produced annually: one replaces the terminal bud, which is transformed to a flowering apex and one becomes dormant, the resulting flower bud remains enclosed by the bud scales until the spring (mid-April until mid May) of the third season. The second type of bud produced annually is smaller and after producing protective bud scales enters what may be a prolonged dormancy. The reserve of viable dormant buds is augmented annually and enables the plant to regenerate new branches if terminal apices are damaged. The largest, most highly branched specimens which can form over 20 flowers and 50 leaves in one growing season are frequently found in locations that are grazed or burned (WILDEMAN, STEEVES 1982). The older individuals of *Pulsatilla patens* are very

sensitive to root damage (WÓJTOWICZ 2000). The seeds are dispersed by wind in June and July over short distances. In warm and moist weather germination occurs in late summer, but if the weather is cold and dry, it is delayed until the next spring or seeds may remain in the transient seed bank (PILT, KUKK 2002). Intensity of formation of leaf rosettes, flowering and fruit bearing depends on such weather conditions as winter temperatures, snow cover, autumn precipitations, temperature and sunlight in spring (WÓJTOWICZ 2000). *Pulsatilla patens* is a species that has a circumpolar distribution, with its western border running through Lusatia and Brandenburg (KRAWIEC 1932).

Methods

Based on an inventory of nature reserves in northern Poland (*Rezerwaty przyrody...* 2005), 16 objects have been selected, in which stands of *P. patens* are documented (Figure 1). The data concerning the presence and abundance of the examined species have been verified following a few steps. First, the source references, such as the protection plans containing information about the selected nature reserves, were analyzed. The protection plans of the nature reserves were made available by the Regional Directorate for Environmental Protection (RDOŚ) in Białystok. Next, in each nature reserve the following components were analyzed: distribution of the stands, abundance of the populations, type of a community in which *P. patens* grows and type of the soil. Later, these data were verified by referring them to the current data of 2010, supplied by the Regional Directorate of National Forests (RDLP) in Białystok. In order to obtain a more complete picture of the changes in the presence and abundance of Easter pasque flower, the author included the information from scientific publications concerning the nature reserves. A field investigation was also made in two nature reserves, such as Kulka and Piłackie Wzgórza. The observations are shown in Table 1, in which names for plant communities adhere to the terminology by MATUSZKIEWICZ (2007).

Results

In north-eastern Poland, the presence of Easter pasque flower has been determined in 16 nature reserves (Figure 1, Table 1). These wildlife refuges were established in 1970–1995 mainly to conserve woodland ecosystems, except Kulka Nature Reserve, which was set up in 1955 in order to conserve steppe flora. Almost all the nature reserves lie on North Podlasie Lowland, except Piłackie Wzgórza and Kulka, which are in the Masurian Lake District.

Table 1
Specification of data on *Pulsatilla patens* sites in nature reserves in north-eastern Poland

Nature reserve	Year of creation	Community	Data according to the reference – year, presence	Current state in 2010 year
1. Kulka	1955	Calcareous grassland	1955 (-)	(-)
2. Piłackie Wzgórza	1989	<i>Quercus-Pinetum</i>	1990 (+)	(-)
3. Łokieć	1989	<i>Peucedano-Pinetum</i>	1997 (-)	(-)
4. Rycerski Kierz	1989	<i>Quercus-Pinetum</i>	1996 (-)	(-)
5. Szelągówka	1995	<i>Peucedano-Pinetum</i>	2003 (-)	(+)
6. Góra Uszeście	1985	<i>Quercus-Pinetum</i>	1994 (+)	(-)
7. Kukle	1983	<i>Peucedano-Pinetum</i>	2006 (+)	(+)
8. Kuriańskie Bagno	1985	<i>Peucedano-Pinetum</i>	1994 (+)	(+)
9. Międzyrzecze	1990	<i>Serratulo-Pinetum</i>	1991 (+)	(-)
10. Woronicza	1989	<i>Serratulo-Pinetum</i>	2000 (+)	(-)
11. Stare Biele	1987	<i>Serratulo-Pinetum</i>	2004 (+)	(-)
12. Góra Pieszczana	1987	<i>Serratulo-Pinetum</i>	2003 (+)	(+)
13. Krasne	1990	<i>Peucedano-Pinetum</i>	2007 (+)	(+)
14. Krzemienne Góry	1987	<i>Serratulo-Pinetum</i>	2007 (+)	(-)
15. Gnilec	1995	<i>Peucedano-Pinetum</i>	2002 (-)	(-)
16. Sitki	1979	<i>Peucedano-Pinetum</i>	1991 (+)	(-)

While making an environmental inventory, which was essential for setting up a nature reserve, presence of *Pulsatilla patens* was determined in all these objects. However, the populations of this species were represented by a small number of individuals. Nonetheless, in the phytosociological tables prepared for these areas the contribution of this species was assigned (+).

In 7 nature reserves (Table 1), Easter pasque flower occurred in communities of the sub-continental pine forest *Peucedano-Pinetum*. The tree stands in such forests consist of pine trees, with single specimens of birch, oak and spruce trees. The undergrowth is created by *Convalaria majalis*, *Peucedanum oreoselinum*, *Polygonatum odoratum*, *Veronica officinalis*, *Anthericum ramosum*, *Solidago virgaurea*, *Carex ericetorum*, *Arctostaphylos uva-ursi*, *Antenaria dioica*, *Koeleria polonica* etc. These communities grow on rusty and brown-rusty soils. The subboreal multi-species forest *Serratulo-Pinetum* is a habitat of Easter pasque flower in four nature reserves (Table 1). The tree stand in this forest consists of spruce with a considerable share of pine and oak trees. The herbaceous plants contain, for example, *Vaccinium vitis-idaea*, *Melampyrum pratense*, *Chimaphila umbellata*, *Pirola chlorantha*, *Arctostaphylos uva-ursi*, *Goodyera repens*, *Polygonatum odoratum*, *Campanula persicifolia*, *Calamintha vulgaris*. These communities grow on rusty and brown-

-rusty soils. In three nature reserves (Rycerski Kierz, Góra Uszeście and Piłackie Wzgórza), *Pulsatilla patens* grew in a continental mixed forest *Quercus-Pinetum*, growing on mesotrophic loamy and sandy soils. The oldest known stand of Easter pasque flower (documented since 1898) in Kulka Nature Reserve grows on xerothermic grasslands of the class *Festuco-Brometea*. Unfortunately, since 1955 the species has not been observed at this site. Analysis of the documentation regarding these nature reserves suggests that in 1991–1997 no stands of Eastern pasque flower was determined in 2 nature reserves (Rycerski Kierz, Łokieć). Another inventory study, carried out in 1999–2007, demonstrated that three more stands had disappeared (in the nature reserves called Gilec, Szelałówka, Międzyrzecze). The data collected in May 2010 show that the stands of *Pulsatilla patens* have been preserved only in the following nature reserves: Krasne, Kukle, Góra Pieszczana, Kuriańskie Bagno and Szelałówka (in this site the species has reappeared after a few years). At all the examined sites, the populations were very small, consisting of a few individuals. They have survived mainly at the edges of forests, in open and well sunlit places.

Ever since Easter pasque flower became a legally protected species, the number of sites where it grew in the analyzed nature reserves has drastically diminished (about 60%).

Discussion

In the light of the Polish law, nature reserves are areas preserved in a natural or nearly unaltered natural state, which comprise ecosystems, wildlife havens and natural habitats, including stands of plants, fungi and forms of inanimate nature of outstanding natural, scientific, cultural and landscape-related values (*Ustawa o ochronie przyrody*, 2004). In Poland, the first nature reserve was established in 1827 to protect the common yew trees (*Taxus baccata*) in Wierzchlas. Before 1939, about 200 nature reserves had been created in Poland (*Rezerваты przyrody...* 2005). At present, according to the data from the *Centralny Rejestr Form Ochrony Przyrody* (2006) there are 1,546 reserves, among which forest reserves are the most numerous. For nature reserves to function properly, a conservation plan has to be prepared every twenty years, in which the following are determined: conditions for any economic activity in a nature reserve as well as identification and ways of eliminating potential threats. In general, nature reserves are a good and effective form of nature conservation which enable us to preserve valuable natural ecosystems and rare species of plants and animals. Unfortunately, this cannot be said about sites of *Pulsatilla patens*. The present study indicates that

nature reserves as a form of nature conservation are not effective in protecting this rare species, as documented by the disappearance of *P. patens* in 11 out of the 16 examined nature reserves, where the species has been previously observed. The fact that the steppe flora in Kulka Nature Reserve in the Masurian Lake District is threatened has been implied by POLAKOWSKI (1956) and ENDLER, ZIELIŃSKA (2003). Among the reasons for gradual disappearance of rare and protected plant species, including Easter pasque flower, these authors listed excessive growth of shrubs and increased forested area, which drastically change the access to light.

A negative influence of excessive shading of the bottom layer of a forest by an expansive species of the spruce *Picea abies* on xerothermic heliophytes has been described to occur in Sitki Nature Reserve in Białowieża Forest. When that reserve was being planned to be set up, it was suggested the forest undergrowth and some young spruce trees should be removed over a certain area and treated as the so-called 'unchangeable area' (SOKOŁOWSKI 1976). This would have been a treatment producing positive influence on natural stands of such species as *Neottianthe cucullata*, *Pulsatilla patens*, *Dianthus arenarius*, *Gypsophila fastigiata*, *Arctostaphylos uva-ursi*, *Potentilla arenaria*, all of which are rare in that region. Unfortunately, no such treatment has been carried out, and consequently the abundance of these plants has been decreasing, leading to gradual disappearance of their stands (SOKOŁOWSKI 1991). A similar situation occurs in other forest nature reserves, where any actions aimed at halting the natural succession of plants and maintaining good conditions for such plants as *P. patens* have been discontinued. In some nature reserves, all man's intervention has been stopped due to the protection zones of bird nests which exist in those reserves. It should be underlined that populations of *Pulsatilla patens* in the nature reserves described in this paper are very small – they were typically single specimens or groups of a few individuals. Considering the fact that at present Easter pasque flower appears in only 5 of the analyzed reserves, in very small numbers, it can be concluded that it is now a threatened taxon and the current conservation conditions are insufficient. This suggests that the actions undertaken to protect it have failed. It is possible that the causes for this gradual disappearance of *Pulsatilla patens* are excessive shrub cover and dense tree cover over large areas, which means that sunlight conditions are inferior and as a result Easter pasque flower, like other heliophilous xerothermic plants, recede. No treatments have been introduced to shape proper ecological conditions for the occurrence of *P. patens*. Should this situation continue, it is likely that in the nearest future other valuable plant species will disappear as well.

A decrease in the populations of *P. patens* has also been reported in Harchinger Heide Nature Reserve in Germany. In 1991–2003, the abundance

of the local populations fell from 27,000 to about 9,700 specimens (RÖDER, KIEHL 2006). Although this is a relatively large number compared to populations in other parts of Europe, e.g. in Estonia, where populations of *Pulsatilla patens* consist of 100–1,000 specimens and only in some sites they are as large as about 10,000 individuals (PILT, KUKK 2002). At present, we know the data generated by the system of monitoring involved in Natura 2000, for example a total of 21,000 specimens of *P. patens* have been counted in Estonia and between 1994–2000 some of the populations rose in abundance owing to an improvement in the light conditions, whereas some other populations continued to diminish, mainly due to increased moss layer density. Long-term observations in Finland imply a similar tendency – out of the 24 analyzed populations of *P. patens*, 8 tended to increase, 12 were stabilized and 4 seemed to be decreasing. A growing tendency was observed at the sites with semi-open grounds and fields as well as sufficiently scarce litter (KALLIOVITRA et al. 2003). Good conditions for the growth of Easter pasque flower are also found in a Natura 2000 wildlife refuge called the Grasslands in the Military Training Grounds in Orzysz, in the Masurian Lake District (NE Poland). One of the most numerous Polish populations of this plant species, consisting of 300 specimens, grows there (JUŚKIEWICZ-SWACZYNA 2010). A preliminary inventory carried out in 2007–2010 in north-eastern Poland by the Regional Management of National Forests in Białystok identified about 10 populations of *Pulsatilla patens*, containing between tens to hundreds of individual plants. The sites are localized in areas where regular forest economy is conducted. It should be therefore assumed that man's intervention is necessary for the existence of Easter pasque flower as it counteracts natural succession of plants, for example by extensive land use, removal of young trees and shrubs, grazing by animals. In order to establish successful conservation of *P. patens* in the Polish nature reserves described here, conservation plans should be elaborated that would take into consideration habitat requirements of this plant species; afterwards, the recommendations formulated in such plans should be strictly followed and the nature reserves should be monitored constantly. In nature reserves where *P. patens* has already disappeared, one might consider reintroduction of populations of this plant.

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