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IS *POTAMOGETON POLYGONIFOLIUS* REALLY CRITICALLY ENDANGERED IN POLAND?

THE CASE OF STABLE POPULATIONS OF THE RARE SPECIES

ON ITS GEOGRAPHICAL RANGE LIMIT

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ABSTRACT: The present study was focused on *Potamogeton polygonifolius* – the species considered to be endangered in Germany, the Czech Republic, Poland and Switzerland. Field studies were carried out in the Lower Silesia and Lusatia in southwestern Poland in order to verify the current distribution of the species along the eastern edge of its general range and to assess the threat status of *P. polygonifolius* in that area and in general at Poland. The historical range of the species in the Lower Silesia was investigated, mainly within the Lower Silesia Forest (Bory Dolnośląskie). In total, 18, currently existing populations of *P. polygonifolius* were found. The Lower Silesian populations were assessed using the IUCN criteria. The species was assigned to NT category in the Lower Silesia as well as in Poland. *Potamogeton polygonifolius* as valuable element of Polish flora should be legally protected, monitored, and, if necessary, actively managed.

KEY WORDS: *Potamogeton polygonifolius*, distribution range, aquatic plants, marginal population

Introduction

The range of *Potamogeton polygonifolius* Poirr. includes northern, western, central and southern Europe, as well as northern Africa, the Azores, Madeira and northeastern North America (Hultén, 1958, Meusel et al. 1965, Hultén and Fries, 1986, Wiegleb and Kaplan 1998). The species is not found in Greenland and Iceland, what suggests that the range is subatlantic-mediterranean rather, than amphiatlantic. It grows in Newfoundland as well, but appears to have been introduced there. In the Czech Republic, *P. polygonifolius* is found only on a few sites in the north-western part of the country, close to the population located in Saxony, on German side of the border (Nevečeřal and Krahulec 1994). In Poland, it has been recorded in the Lower Silesia and Lusatia in the southwestern part of the country, in Białogóra and Gąski in the northern part and in Ostrów Lubelski in the eastern part of Poland. These sites constitute the eastern edge of the geographical range of *P. polygonifolius* in Europe (Zalewska-Gałosz 2008).

On the edges of its range *Potamogeton polygonifolius* is considered to be an endangered species. For example, in whole Germany, it is listed as a vulnerable species (VU). As far as the individual regions (Landes) are concerned, it is listed as critically endangered (CR) in Saxony-Anhalt, and endangered (EN) in Saxony and Brandenburg (Korneck et al. 1996). It is also listed as critically endangered in the Czech Republic, endangered in Switzerland, and vulnerable in Italy (Procházka 2001, Moser et al. 2002, Conti et al. 1997). Until recently, *P. polygonifolius* had been found very rarely on isolated sites in Poland and was thus listed as critically endangered (Zalewska-Gałosz 2001; Zarzycki and Szeląg 2006). On the red list for the province of the Lower Silesia, however, it is categorized as data deficient (DD), what indicates that further study is needed to determine its proper category (Kącki et al. 2003).

The present study focused on *Potamogeton polygonifolius* in the Lower Silesia and Lusatia in Poland were carried out in order to settle current distribution of the species along the eastern edge of its general range and to determine the threat status of *P. polygonifolius* in the Lower Silesia and in Poland.

Materials and Methods

Most of the sites of *Potamogeton polygonifolius* known from south-western Poland (Lusatia, the Lower Silesia) have been reported at the beginning of the twentieth century (Schube 1903, 1906, 1909, 1910, 1912, 1919, 1932; Tab. 1). To confirm these historical locations, in August 2007 and June 2008 the potential habitats of *P. polygonifolius* within the former range were inventoried. Determining location of the exact sites was difficult because Schube reported only the names of adjacent settlements without any additional information. Therefore, all possible habitats of *P. polygonifolius* near the given historical sites were visited in mentioned survey, including rivers, small ponds, canals, sandpits, peat bogs, swamps and ditches in the watersheds of such rivers as: Nysa Łużycka, Kwisa, Czerna Wielka, Czerna Mała and Bóbr.

The study area covers the historical regions of the Lower Silesia and fragment of Lusatia on the Polish side of the present-day Polish-German border. The study area is located within current boundaries of the Lower Silesia province. The area, where the data were collected is demarcated by the following municipalities: Zgorzelec, Pieńsk, Gozdnicza, Świętoszów, Bolesławiec, Nowogrodziec and Lubań.

The species nomenclature follows Mirek et al. (2002). Material collected was deposited in the herbarium of the Institute of Botany of Jagiellonian University (KRA).

Acronyms of herbaria are in accordance with those proposed by Holmgren and Holmgren (1998). Threat categories were determined with use of the method proposed by the IUCN (2001).

Results and discussion

Distribution of *Potamogeton polygonifolius* in the study area

Until the present study, *Potamogeton polygonifolius* has been known on twenty sites in southwestern Poland (first part of Table 1). It is difficult to determine to what extent that number reflects the manner in which the control points for the floristic surveys had been selected. There is lack of data concerning individual populations of the species from 1945 till the end of the twentieth century. Eighteen sites were discovered during the present study (second part of Table 1.). It is impossible to determine whether these contemporary sites reflect changes in the local range of the species together with the spread of the species within the range, or whether its reflect the pattern in which data were collected. Lately discovered sites of *P. polygonifolius* usually are situated in relatively short distance from historical locations, and in general within the area demarcated by the historical sites (Fig. 1).

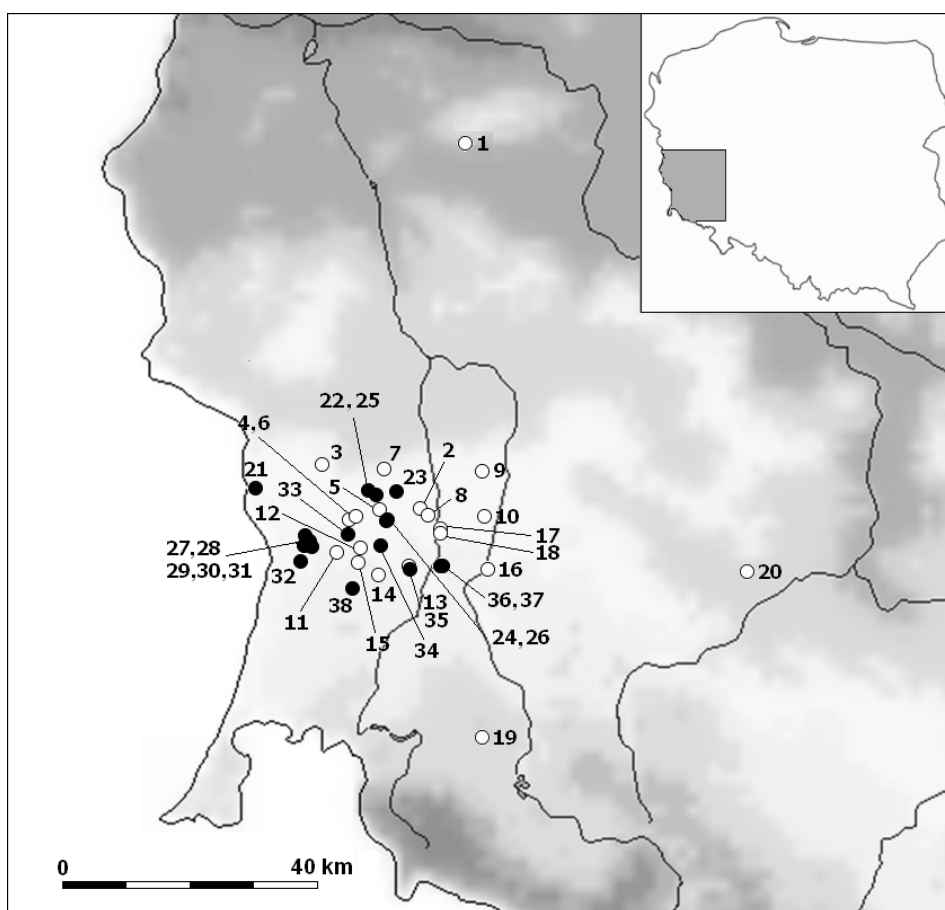


Figure 1. Distribution of *Potamogeton polygonifolius* sites in southwestern Poland: empty circles (numbers 1-20) – historical localities, filled-in circles (numbers 21-38) – current localities. Numbers according to the Table 1.

Table. 1. Historical and current sites on which *Potamogeton polygonifolius* has been found in Poland with ATPOL grid squares (10 × 10 km)

Site	ATPOL grid square	Location and type of habitat	References
HISTORICAL SITES IN SOUTHWESTERN POLAND			
1	AD58	Ochla (Ochelhermsdorf)	Schube, 1903
2	AE07	wetlands northwest of Kliczków (Klitschdorf: Rote Tränke)	Schube, 1909
3	AE06	pond in forest west of Ruszów (Gummichtfluß am Einfluß in Schwemmteich, bei Rauscha)	<i>leg.</i> E. Barber, 1887 (GLM)
4	AE16	ditch near Sarni Pond (Gelbbruchgraben)	Schube, 1903
5	AE16	Ołobok (Mühlbock)	Schube, 1903
6	AE16	ditches near Wolno Stary Pond (Gräben am Wohlen)	<i>leg.</i> E. Glotz, 1940 (GLM)
7	AE17	Poświętne (Klitschdorf: Heiligensee)	Schube, 1909
8	AE17	Kliczków, Ośnica River (Klitschdorf: Hosenitz)	Schube, 1912
9	AE18	Kąty near Trzebieńska Hill (Zumm)	Schube, 1910
10	AE18	Krępnica, most likely ditches near Bawola Hill and Leśna Hill (Kromnitzer Heide)	Schube, 1909
11	AE26	Kolonia Czerwona Woda, Rowina River (Graupengraben)	Schube, 1903
12	AE26	Kolonia Czerwona Woda, north east of village near the road formerly known as the "Birkbrückweg"	Schube, 1903
13	AE26	Czerwona Woda (Rothwasser)	Schube, 1903; <i>leg.</i> E. Barber, 1891 (GLM)
14	AE27	Czerna Wielka, riverbed downstream from the village (Gr. Tschirne = Gross Hammerbach)	Schube, 1903
15	AE27	Wykroty near Bolesławiec (Waldauer Abfindungen)	Schube, 1906
16	AE28	Rakowice (Rotlach = Rothlach)	Schube, 1903
17	AE28	Osieczów (Aschitzau)	Schube, 1903
18	AE28	Tomisław (Thommendorf)	Schube, 1903
19	AE58	Popielów near Lubomierz (Liebenthal: Hennersdorf)	Schube, 1932
20	BE23	Brzezinka, probably now part of Rzeszotary (Briese)	Schube, 1919
CURRENT SITES IN SOUTHWESTERN POLAND			
21	AE15	Toporów, seep on the bank of the old bed of the Nysa Łużycka River	Dajdok & Kaćki, 2008, unpubl.
22	AE16	Parowa, ditch along road through peat bog west of the village	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
23	AE17	Parowa, ditch draining into Ośnica River	<i>leg.</i> J. Zalewska-Gałosz, 2007 (KRA)*
24	AE17	Ołobok, bed of the Czerna Wielka River	<i>leg.</i> J. Zalewska-Gałosz, 2007 (KRA)*
25	AE17	Ołobok, bed of the Czerna Wielka River upstream from the bridge inside the village	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
26	AE17	Ołobok, peat-covered ditch in meadow in the southwest part of the village draining into the Czerna Wielka River	Bena, 2008, unpubl.

27	AE25	Zielonka, Forest Lot 201, ditch draining seepage in the southeast part of the lot	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
28	AE25	Zielonka, Forest Lot 201, edge of forest pond with pits remaining after peat exploitation in the western part of the lot	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
29	AE25	Zielonka, Forest Lot 185, peat bog south of Rygle II Reservoir	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
30	AE25	Zielonka, Forest Lot 185, ditches between rows of pine seedlings on the edge of the peat bog south of Rygle II Reservoir	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
31	AE25	Zielonka, Forest Lot 171, edge of small pond in peat bog north of Rygle I Reservoir	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
32	AE25	Dłużyna Dolna, ditch along railroad tracks crossing the Bielawka Valley north of the village	Dajdok, 2008, unpubl.
33	AE26	Węglińiec, small depression filled with water in the peat bog north of the railroad tracks	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
34	AE27	Zielonka, Forest Lot 201, area flooded by beaver dam with seeps along the edges	Zalewska-Gałosz, Nowak, Dajdok & Bena, 2008, unpubl.
35	AE27	Czarna, ditch in the middle of a meadow draining into the Czarna Wielka River	Dajdok, 2008, unpubl.
36	AE28	Brzeźnik, abandoned peat pit in forest west of the Brzeźnik Preserve	Dajdok & Pender, 2008, unpubl.
37	AE28	Kierzno, edge of a small pond on the edge of the forest south of the village	Dajdok & Pender, 2008, unpubl.
38	AE36	Godziszów, bed of the Czarna Mała River west of the village	Bena & Dajdok, 2009, unpubl.

* Sites mentioned by Zalewska-Gałosz (2008)

Threat status of Potamogeton polygonifolius in Poland

It is clear that *Potamogeton polygonifolius* is not as rare in Poland as it was formerly regarded (Zalewska-Gałosz 2001). Discovery of the new localities of the species within the area, where the old ones were known before 1945, allows to conclude that *P. polygonifolius* still occupies similar area in south-western part of Poland. On the other hand the species reaches in Poland its eastern limit of the general range, so should be treated in our country with a special care. It is generally known (e.g. Pearson et al. 2009) that small, fragmented marginal populations may be threatened because of inherently reduced fitness and lower adaptive capacity in comparison to larger, core populations. Undoubtedly regarding the whole territory of Poland *Potamogeton polygonifolius* should be considered as extremely rare. Rarity is often considered as an indicator of threat status and therefore commonly used in conservation biology (Rabinowitz et al. 1986, Pimm et al. 1988, Gaston 1994, Cofré and Marquet 1999). However there are some nuisances caused by implementation rarity as a main criterion for evaluating the threat status. The first is arbitrary attitude in establishing the grid scale (cartogram size) for rarity assessment and the second includes new coming, alien species within a group of the rarest elements of flora (Gaston 1997). In conservation

literature several kinds of rarity are distinguished regarding the geographical range, habitat requirements as well as population size (Rabinowitz 1981). As a consequence many considerably different definitions of "rarity" are distinguished (Batianoff and Burges 1993, Gaston 1994, Prendergast et al. 1993). In analysis of potential or real threat to the species the most useful, and probably the most important, is the chorological criterion. It shows the actual distribution of the species populations and enables conservationists to select easily the, so called stenochoric taxa. It is hardly possible to consider other effective criteria, like population size or precise occupational area because of lack of the relevant data (e.g. Lozano et al. 2003). Of course geographical (or chorological) rarity of the species is closely related to rarity of its habitat. Thus, in some cases, it would not be a good indicator of the present conservation status of species. In Silesia this regards mainly montane, aquatic and peat-bog species due to very scarce area of potential biotopes. So, it is important to bear in mind the reasons for the distribution of a given plant species. Obviously the chorological rarity depends on the inventory scale and thresholds for the classification. For example, for Inari region in Finland the grid cartogram was implemented with 100 km² as the area of the basic square. Therefore all species which were distributed in no more than 3% of the cartogram squares were categorised as rare (Heikkinen 1998). For the Israel as rare were assigned species which were present in no more than 0,5% of the 10 x 10 km grid squares (Sapir et al. 2003). In Estonia rare species are those which have their locations in no more than 5% of the 10 x 10 km cartogram (Pärtel et al. 2005, Kull et al. 2002). The same threshold was suggested by Hodgson (1986). In theoretical consideration revealed by Gaston (1997) as rarity threshold the value of 25% is proposed. Kącki et al. (2009) suggest for the regional conservation evaluations to consider the detailed area of occupancy not exceeding 20 km². In some works a confined number of rarest species is proposed as delimiting criterion for the group of species of conservation interest. For the flora of Helsinki, 100 rarest species were selected (Pikkiö 2004). In the case of *Potamogeton polygonifolius* it is obvious that the species still fulfils even the most strict criteria of rarity regarding the ATPOL cartogram unit used in Poland.

When the threat evaluation of the species is discussed the habitat degeneration and deterioration should be also considered. In the Lower Silesia *Potamogeton polygonifolius* occurs mainly in threatened vegetation type, namely transitional peat-bogs. This habitat is considerably threatened by drainage and invasion of the alien species – mainly *Spiraea tomentosa* (Kujawa-Pawlaczyk 2009, Dajdok et al. 2011). Also the presence of the other *Potamogeton* species in a close vicinity to populations of *P. polygonifolius* should be analysed. Hybridization between *Potamogeton natans* and *P. polygonifolius*, resulted in creation of *P. ×gessnacensis* G. Fisch. was observed in the Lower Silesia (J. Zalewska-Gałosz, M. Ronikier, A. Nowak, Z. Dajdok, unpubl), therefore possible genetic erosion can not be excluded.. Another risk factor which should be considered is habitat fragmentation (Menges 1992, Murcia 1995, Fischer and Stocklin 1997). The Lower Silesian populations of *P. polygonifolius* are located in 1-5 km distance each from the other, often with habitat barriers between them.

All factors mentioned above, as well as location of the Polish populations of *Potamogeton polygonifolius* on the edge of its geographical range indicates that this species deserves the status of a rare and threatened plantspecies.

However one should take into account that the local range and the number of known locations of *Potamogeton polygonifolius* in the Lower Silesia didn't change considerably during 120 years. Moreover, local populations are numerous and of relatively large size. Some of the locations are protected in nature reserves. Several populations have been found in man-made habitats (drainage ditches, road-side ditches, old excavations) what indicates

the potential ability of the species for adaptation to the habitats under moderate anthropogenic pressure. Considering the conductivity as a degradation indicator of peat-bogs all the Lower Silesian stands should be assessed as degraded (conductivity value above 140-150 $\mu\text{S}/\text{dm}^3$). Despite the anthropogenic changes of habitat conditions *P. polygonifolius* grows there abundantly, producing flowers and fruits (Zalewska-Gałosz et al. 2011). It is also worth notice, that Silesian populations of *P. polygonifolius* are probably a part of the large metapopulation, consisting also of the Germans populations laing in the eastern outskirts of Saxony. In a case of local extinction the species could be recolonised by the diaspores from those German populations. Such possibilities were discussed by Gärdenfors (1996) and Gärdenfors et al. (2001), who suggested decreasing of the threat category when the gene flow is maintained between neighbouring populations.

Considering all these factors and being in accordance with the current methodology of threat assessment of the species (IUCN 2001), *Potamogeton polygonifolius* should be classified to the group of near threatened species (NT) in Poland as well as in the Lower Silesia. The species, although has restricted range within the area of study, is not exposed to apparent threat. Its populations are abundant, stable and, theoretically, without barriers from the other populations located westwards. Considerable are also its ability to colonize the anthropogenic habitats.

Final remarks

During the study *Potamogeton polygonifolius* was found in 18 locations, growing in both natural habitats, like unspoiled peat bogs, as well as in anthropogenic habitats like regenerated after exploitation peat bogs and drainage ditches.

Potamogeton polygonifolius should be categorized as near threatened (NT) in Poland. This category applies to species that, while not yet threatened with extinction, are rare or have a limited range, even though: 1) that range may be stable in terms of area; 2) the species may grow abundantly within that range; 3) the populations are located near other, stable populations outside the borders of the country; and 4) the species is able to colonize anthropogenic habitats and to some extent resistant to men driven transformations of habitat conditions.

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