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How threatened is the Polish wetland flora?

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Abstract

Wetlands cover almost 14% of the area of Poland, but most of them are in bad condition. This paper aims are compiling an up-to-date Polish list of wetland species based on the data on their distribution and threat status in individual regions. 609 species were analyzed and their respective threat categories were examined in 13 local lists. It has been shown that 65% of the wetland species are classified as threatened taxa in at least one red local list. The data were used to create a formula for calculating the new threat category for each of the species. The resulting red list of wetland species includes 283 taxa.

INTRODUCTION AND OBJECTIVES

Wetlands are among the most endangered of all ecosystems on the Earth (Amezaga et al. 2002; Bobbink et al. 1998; Bronmark, Hansson 2002). It is believed that overall more than half of the world's wetlands may have been destroyed in the 20th century (Ramsar Convention Bureau 1996). The figure is even higher in Europe where approximately two thirds of all wetlands were lost (CEC 1995) during the previous century and their number is still decreasing (Finlayson et al. 1992, Groombridge et al. 1998). Between 1950 and 1980 many wetlands were drained in both western and eastern Europe, and converted into forests (68%) and agricultural lands (10%) (Silva et al. 2007). The results of research conducted in Germany and Holland show that the two countries have lost respectively 53% and 48% of their wetlands. The same trend is observed in less densely populated countries, like Finland (EUROSTAT 2009) or Estonia (Kimmel et al. 2010), where wetlands originally covered most of the area.

In Poland natural and drained wetlands cover a total of approximately 4.3 million ha, which is approximately 13.9% of the area (Dembek 2002). Under natural conditions, wetlands were mostly composed of forest communities − ash-alder riparian forests, alder forests and marshy coniferous forests. At present forest and scrub vegetation covers only 15% of these areas. As much as 77% of the wetland area is now covered by grasslands, with fresh meadows and pastures dominating, which indicates that the sites must have been extensively drained. Non-forest marshy communities (reed beds, raised transitional bogs, raised bogs) cover only 8% of the wetland area (Oświęcimska-Piasko et al. 2006) and are one of the most threatened of all ecosystems in Poland (Dembek et al. 2004).

Wetlands have received a lot of scientific

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attention in recent years, not only because they are threatened but also because of their significant ecosystem services (e.g. Costanza et al. 1997; Chen et al. 2008, 2009; Zhou et al. 2009; Zeng and Chen, 2009, 2011) in terms of contaminant degradation, water supply, climate regulation, flood storage, drought resistance, biodiversity conservation, etc. (Mitsch, Gosselink 1993; Schweiger et al. 2002; Haslam 2003; Belyea, Malmer 2004; Bobbink et al. 1998; Zhou et al. 2007).

Due to such a high threat status and their numerous functions, wetlands have been protected worldwide for many years (Amezaga et al. 2002). One of the first comprehensive studies on the threatened flora of the Polish peatlands was written by Jasnowska J. and Jasnowski M. in 1977 (Jasnowska, Jasnowski 1977). The book includes a list of threatened and endangered species of the Polish wetlands, i.e. 172 species assigned to one of the four categories. By now the list has become largely out-of-date. Over the last several years, the amount of chorological data has increased, but at the same time new risk factors have developed and the pre-existing conditions worsened. As a result, it proved necessary to update the list developed over 30 years ago. Moreover, the authors have concluded that the new Polish red list of threatened species (Zarzycki, Szeląg 2006) covering the flora of all habitats fails at some points to provide accurate threat categories for wetland species. This paper aims at creating a new Polish red list of threatened wetland species that would be based on local red lists and comparing it with the existing Polish red list of threatened plant species (Zarzycki, Szeląg 2006). Moreover, the authors aimed at comparing the Polish red list with the individual local red lists. The new list could be used to undertake the actions needed to provide better protection for the threatened species (Brito et al. 2010).

METHODS

The list of species was prepared by first compiling a synoptic view of the regional Red Lists and then by selecting the species using two criteria. For the purpose of creating the Polish red list of threatened wetland species, taxa meeting one of the two criteria were selected:

1. taxa occurring at moist, wet or aquatic sites, with the wetness index "W" over 4 (Zarzycki et al. 2002).
2. taxa specific to one of the following syntaxa: *Lemnetea, Thero-Salicornietea, Asteretea tripolium, Potametea, Phragmitetea, Isoeto-Nanojuncetea, Bitentetea tripartiti, Littorelletea uniflorae, Montio-Cardamintetea, Utricularietea intermedio-minoris, Molinietalia, Trifolio fragiferae-Agrostietalia stoloniferea, Scheucerio-Caricetea fusce, Oxycocco-Sphagnetea, Alnetea glutinose, Salicetea purpureae, Alno-Ulmion, Vaccinio uliginosi-Pinetum* (Matuszkiewicz 2001).

The species' threat category was examined both for Poland as a whole (Jasnowska, Jasnowski 1977; Zarzycki, Szeląg 2006) and for individual regions for which local red lists of threatened species were available.

The criteria for selecting the lists for analysis were as follows:

- the most recent lists or books were analyzed,
- no lists from smaller regions within the geographic ranges of lists from a larger region were analyzed,
- both lists created for central Poland were taken into account, i.e. one listing natural and semi-natural habitats and the other comprising segetal plants.

As a result, threatened species from 13 regions were analyzed:

In detail, the following local red lists were included (region abbreviations are used further in the text):

PZ − Pomorze Zachodnie (Western Pomerania) (Żukowski, Jackowiak 1995),
PG − Pomorze Gdańskie (Gdańsk Pomerania) (Markowski, Buliński 2004),
W − Wielkopolska (Jackowiak et al. 2007),
KP − Kujawsko-Pomorskie (Kujawy-Pomerania Province) (Rutkowski 1997),
PS − Polska Środkowa (Central Poland) (Jakubowska-Gabara, Kucharski 1999; Warcholińska 2004),
NPP – Nizina Południowopodlaska (Południowopodlaska Lowland) (Głowacki et al. 2003),
DSl − Dolny Śląsk (Lower Silesia) (Kącki et al. 2003),
OP – Opolskie Province (Nowak et al. 2003),
Sl − Górny Śląsk (Upper Silesia) (Bernacki et al. 2000),
WM – Małopolska Upland (Bróż, Przemyski 2009),
R – Roztocze and Lubelska Upland (Kucharczyk, Wójciak 1995),
KR – former Krakowskie Province (Zając M, Zając A. 1998)

KTY – the Carpathian Mountains (Mirek, Piękoś-Mirkowa 2008).

Moreover, two Polish lists were analyzed, namely: **PL** – the Red list of plants and fungi in Poland (Zarzycki, Szeląg 2006) and **TORF** – Zagrożone gatunki flory torfowisk (Threatened species of peatland flora) (Jasnowska, Jasnowski 1977).
To compare a threat category in different regions, various threat categories were replaced with numbers. For the purpose of statistical analyses, the IUCN categories (1976, 1994) were translated as shown in the table (Table 1).

Table 1

Numerical values assigned to individual threat categories.

Threat category	Numerical value
Ex and EW	10
CR	8
E	7
EN	6
VU and V	4
LR and R	1
DD	3

A three-step procedure was applied for the purpose of creating the final list of threatened species.

Step 1:

For each of the 609 taxa meeting the criteria 1 and 2 defined above, the average threat (AT) was calculated using our own formula (1).

$$AT = \frac{\sum Tc}{n} \quad (1)$$

where:
Tc – threat category given as a numerical value (Table 1)
n – number of local red lists with analyzed species

List no. 1 was created based on the parameter calculated (*AT*), by replacing the numerical values with threat categories as per Table 2.

Step 2:

The threat index (*TI*) was calculated based on species distribution in Poland (Zając et al. 2001), using our own formula (2).

$$TI = (AT) \times (RI) \quad (2)$$

Table 2

Average threat (AT) or Threat index (TI) transformed into different threat categories.

At and TI value	New category
10	EX
7.5-9.9	CR
5.0-7.4	EN
2.5-4.9	VU
1.5-2.4	LR

The reduction index (*RI*) was calculated by determining the number of regions (within the geographic range of the analyzed lists) inhabited by each of the species. The result was then divided by 13, i.e. by the number of the analyzed local red lists.
List no. 2 was drawn up based on the calculated parameter (*TI*) for which numerical values were changed into threat categories as per Table 2.

Step 3:

Threat categories provided in list no. 2 were corrected arbitrarily for species:

- with numerous stands in regions for which no local lists were prepared,
- not included in the "Distribution Atlas…" (Zając et al. 2001),
- "DD" or "I" threat category assigned in most of the regions – in that case, irrespective of the index value, the species were assigned the DD category.

It was particularly important to adjust threat categories for species having numerous stands in north-eastern Poland. The most recent floristic studies were analyzed for the region (e.g. Bednarek-Ochyra et al. 2001; Pawlikowski 2008a,b,c; Pawlikowski et al. 2009) in an effort to gather information concerning the threat categories of the species.

In that way the final list of threatened wetland species was prepared − list no. 3 (**NPL**).

RESULTS

Analysis of the existing lists

The vascular flora in Poland comprises 2490 species (Zając M, Zając A. 2003), including 609 wetland species, which were thoroughly analyzed. Thirteen local red lists and two Polish lists (Jasnowska, Jasnowski 1977; Zarzycki, Szeląg 2006) were consulted for information concerning the said species. The analysis has shown that 65% of the wetland species (393) are taxa listed as threatened in

at least one of the local red lists. Species included in 1 to 4 lists are the most numerous group – altogether they constitute over 50% of 393 species (Fig. 1).

The least numerous group are taxa listed as threatened in all of the 13 regions, and the group includes the following three species: *Drosera anglica, Iris sibirica* and *Salvinia natans.*

The number of wetland species in individual local red lists is also very different (Fig. 2), with the lists for north-western and western Poland being the most numerous ones, and those for the eastern part composed of fewer species.

The two analyzed Polish lists comprise 172 (Jasnowska, Jasnowski 1977) and 159 (Zarzycki, Szeląg 2006) wetland species. The 1977 list is a peatland (**TORF**) species list, therefore it might not include all of the species that would meet the criteria for wetland species defined now by the authors. The 2006 list (**PL**) comprises 504 taxa, out of which over 30% are taxa of moist and marshy habitats.

New list

List no. 1 is the longest one and comprises 366 species. With the reduction index (*RI*) applied, the number was reduced to 261, and many species were assigned lower threat categories (List no. 2). The final list (**NPL**) comprises 283 species (Appendix no. 1), including 23 species with the DD category assigned. The differences in the number of species with specific threat categories assigned in each of the three lists are presented in Fig. 3.

Comparison of the lists

Further analyses were conducted using the new list (**NPL**), which best reflected the actual risk for Polish wetland species. The comparison of the 2006 list (**PL**) and the new list (**NPL**) showed in particular a significant increase in the number of "E/CR and EN" and "R/LR" species (Fig. 4). It should be noted that the new list (**NPL**) comprises three additional species that are listed as extinct in Poland, namely *Apium innundatum, Carex punctata* and *Eleogiton fluitans.* These species are also listed as extinct in local red lists with only single stands recorded in the respective regions (Zając, Zając 2001).

The new list (**NPL**) comprises 125 new species not mentioned in the PL list (Zarzycki, Szeląg 2006). One new critically endangered species *Hypericum pulchrum* L. appeared in the list, along with as many as 14 species listed as EN (Fig. 5).

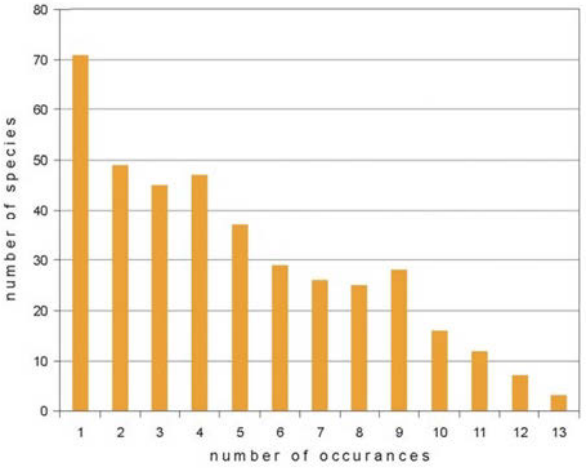

Fig. 1. Number of occurrences of individual species in 13 local red lists.

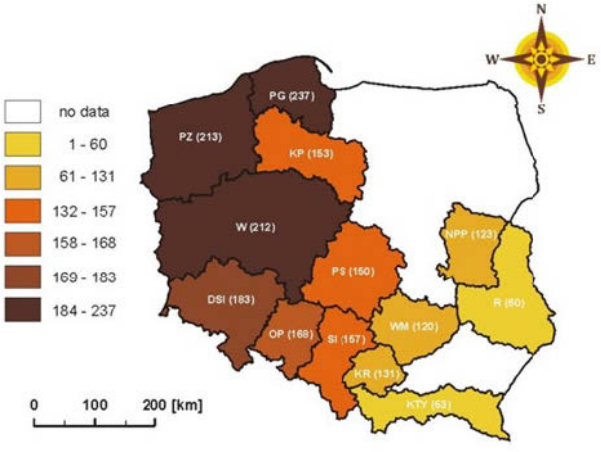

Fig. 2. Number of threatened species in 13 local red lists.

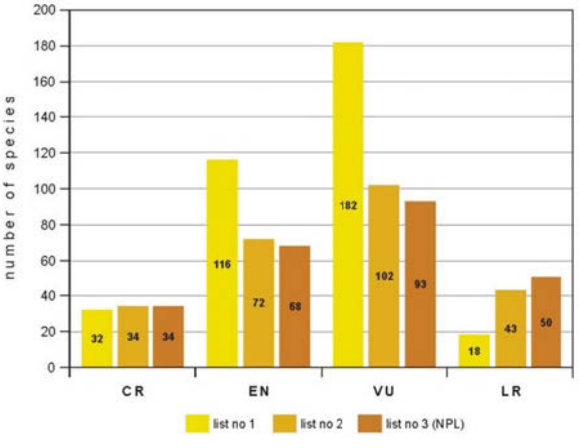

Fig. 3. Number of endangered and threatened species listed in the three different new lists.

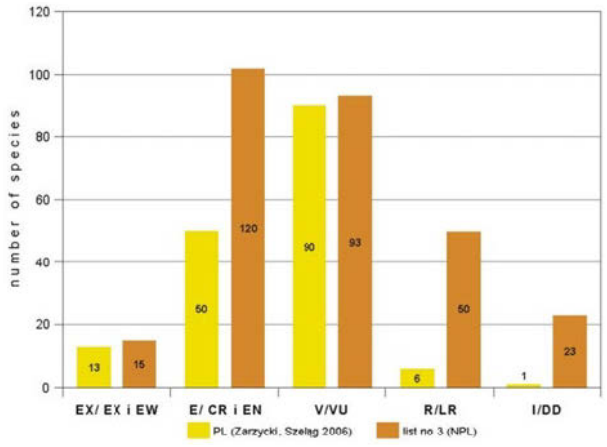

Fig. 4. Comparison of species richness per threat category in PL list and the new red list (NPL).

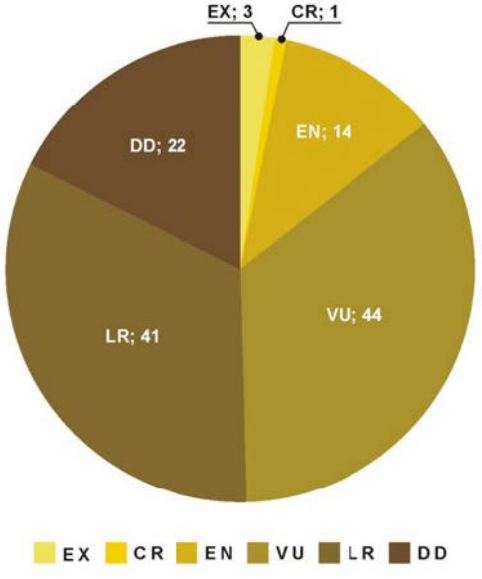

Fig. 5. Threat status of the 125 new species not included in the 2006 list.

Out of 158 species included in both red lists, 104 species did not have their threat status changed, 13 species were assigned a lower threat category and 42 were assigned a higher one (Fig. 6). All of the 13 species had their threat category reduced by one. Special attention should be paid to *Anacamptis piramidalis*, the orchid which was considered extinct in Poland until 2009 and was now assigned CR category. Out of 42 species that had their threat category increased, 4 taxa were assigned a category that was higher by more than one category and these were: *Viola elatior, Juncus triglumis, Juncus tenageia, Glaux maritima*. *Viola elatior* is the only species which was

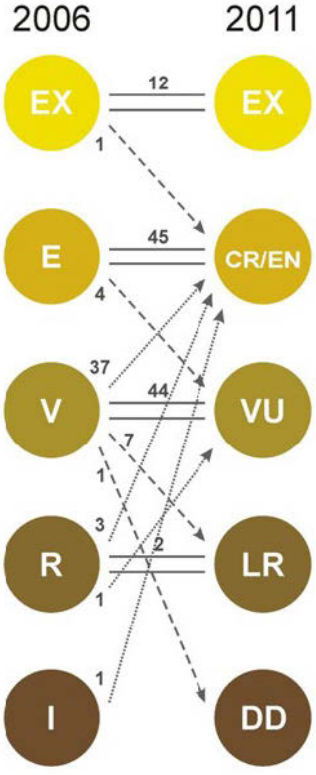

Fig. 6. Changes of threat categories of 158 species included in both (PL and NPL) lists.

assigned threat category I in the PL list, and a specific threat category in most of the lists, which made it possible to eventually determine its threat category as EN.

The only species that was not included in the new list and had a threat category assigned in the **PL** 2006 list is *Ranunculus lingua*. It was assigned VU threat category despite being present all over Poland and listed as threatened in only 2 lists with the threat index (**TI**) of 1.2.

Similarities between the lists and the main gradients making the lists different were checked by the *Principal Component Analysis* (PCA). The first ordination axis accounts for 28%, and the other one for 14.1% of the variation in the red lists' set. Axis I differentiates the lists based on the number of wetland species, while axis II reflects their geographical distance. The Polish lists: **PL** (Zarzycka, Szeląg 2006) and the new list (**NPL**) are located next to each other and, at the same time, are most similar to local lists from north-western Poland, while the TORF list (Jasnowska, Jasnowski 1977) is most similar to the lists for Kujawsko-Pomorskie (the Kujawy-Pomerania Province; Fig. 7).

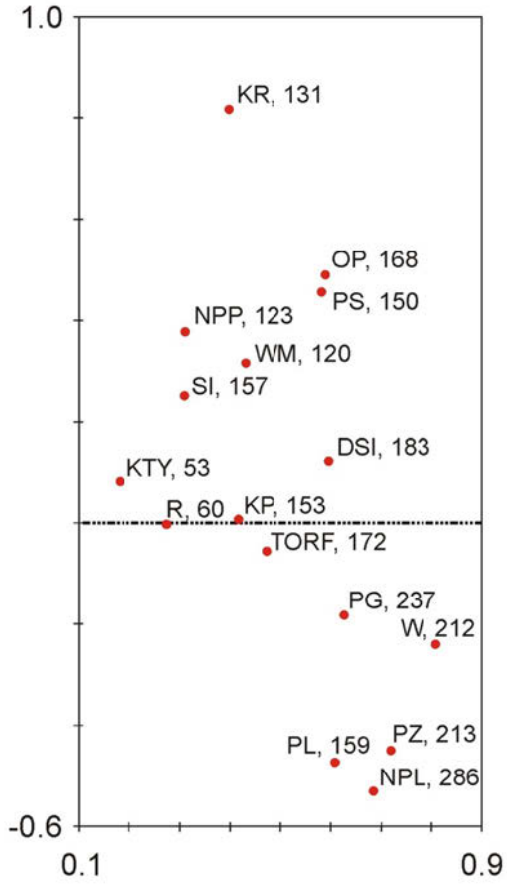

Fig. 7. Principal Component Analysis (PCA) of all 13 local red lists and Polish lists of 1977 and 2006 and the proposed new one. The number that follows the abbreviation indicates the number of wetland species in individual lists. The abbreviations explained on pages 2-3.

DISCUSSION

The wetland flora comprises 24% of the total number of vascular plant species recorded in Poland. Almost half (46%) of them are species listed as threatened as per new list (**NPL**). At the same time, all of the species threatened in Poland comprise only 20% of the entire flora (Zarzycki, Szeląg 2006). This implies a very serious threat to this type of habitats and, at the same time, stresses their key role in preserving the flora biodiversity of the whole country. A similar situation is observed in most European countries and the rest of the world. Approximately two thirds of all European wetlands have been lost since the beginning of the last century (Amezaga et al. 2002), and this increasing tendency continues (Jantke et al. 2010). Disappearance of wetlands is especially a problem in EU countries, such as Estonia (Kimmel et al. 2010), where habitats (especially peatlands) have their primary location. The tendency is further confirmed by the fact that out of 283 species listed as threatened in Poland and included in the new list (**NPL**), as many as 81 taxa (almost 30%) are also classified as threatened in Central Europe (Schnittler, Günther 1999). Out of this number, special attention should be paid to the following taxon groups:

(1) species listed as vulnerable (VU) in Central Europe and not listed as threatened in Poland, i.e. *Calla palustris*, *Carex cespitosa*, *Cicuta virosa*, *Pedicularis silvatica* and *Ranunculus linqua*. All of these species are present all over Poland, and are listed as threatened in only few local lists, most often with a low threat category.
(2) species whose threat category is much higher in Central Europe than in Poland, such as *Carex chordorhiza*, *Juncus capitatus*.
(3) species with a high threat category (CE) in Central Europe, with the DD category assigned in Poland, such as *Carex haleonastes*, *Dactylorhiza traunsteineri*.
(4) species that are particularly or very important in Central Europe for the worldwide survival of plant species, such as *Juncus capitatus* and *Carex davalliana*.

Poland is particularly responsible for the maintenance of the first two groups for Europe, and therefore the country needs to monitor the population abundance and undertake protective measures as required. The same applies to species from group (3) whose distribution and threat category in Poland should be analyzed as soon as possible.

Critical analysis of Polish lists

Comparison of the Polish list (**PL**) with the new list (**NPL**) created based on the analysis of local lists shows many differences. They may be grouped into three categories:

Group 1. Species that were not included in the Polish red list and should be included there due to a small number of stands in Poland and the dynamics of their population.
Group 2. Species that were assigned too low threat categories in the Polish lists despite the fact

that they have a small number of stands in Poland and are assigned high threat categories in most local lists.

Group 3. Species that were assigned too high threat categories in Polish lists despite the fact that they are present all over Poland and are listed as threatened in only few local lists, most often with a low threat category.

The differences are mostly due to the lack of detailed floristic information, which should serve as the basis for assigning the IUCN categories (IUCN, 2003). This fact is also pointed out by authors analyzing the red lists of other groups of organisms (Dahlberg, Mueller 2011; Milner-Gulland et al. 2006; Garcia, Marini 2006; von May 2008). Local lists covering much smaller areas are created by naturalists who have in-depth knowledge of threats posed to local populations. That is why the Polish list prepared based on the analysis of the local lists seems to be burdened with a smaller error. At the same time, the new list (**NPL**) proved to be most similar to the list for NW Poland, which is probably due to the rich wetland flora in this region. This stems from the fact that it is an early post-glacial area characterized by a relatively large number of wetland habitats in particular peatlands (Oświęcimska-Piasko et al. 2006).

The new list (**NPL**) differs from the Polish list (**PL**) by a higher number of species with the undetermined threat category (DD). It mostly comprises species that were not included in the Polish list PL, and were included in numerous local lists with the DD category assigned. This again confirms the fact that local lists add new information about potential threats to species in Poland (Załuski 2009).

The fundamental first step in conservation planning and prioritization is to evaluate the status of species according to their extinction risk (Mace, Lande 1991; IUCN 2001; Miller et al. 2006, 2007). Also in Poland vascular plant species are assigned their conservation status, mainly based on the information about the risk they face. Out of 397 species of vascular plants that are protected in Poland, 230 taxa (58%) are also endangered as per the PL list (Kopeć et al. 2008). The important message is that the improved red lists may be expected to provide more effective protection for species at risk.

Appendix 1

The new red list (NPL) of Polish wetland flora.

Species	New category (NPL)	Threat index (TI)	Number of occurence on local red lists	Category of threatment in Central Europe	Responsability for Central Europe
Aldrovanda vesiculosa L.	CR	9	5	EN	
Alisma gramineum Lej.	VU	2.7	6	VU (Hu)	!
Alisma lanceolatum With.	VU	4.2	10		
Allium angulosum L.	VU	3.8	10		
Allium sibiricum L.	VU	2	1		
Anacamptis piramidalis (L.) Rich.	CR	nd	nd	EN	!
Andromeda polifolia L.	LR	3.2	10	VU	
Apium innundatum (L.) Rchb.	EX	10	1		
Apium repens (Jacq.) Lag.	CR	7.5	2	EN	!!
Aster amellus L.	LR	3.1	7		
Aster tripolium L.	EN	7	5		
Baeothryon alpinum (L.) T. V. Egorowa	EN	7.2	5	VU	!
Baeothryon cespitosum s.l. (L.) A. Dietr.	EN	5	4		
Baldellia ranunculoides (L.) Parl.	EN	7	1		
Bartsia alpina L.	VU	3	1		
Batrachium baudotii (Godr.) Bosch	EN	5.3	3		
Batrachium fluitans (Lam.) Wimm.	LR	1.1	4		
Batrachium hederaceum (L.) Gray	DD	nd	1		
Batrachium peltatum Schrank	LR	nd	1		
Batrachium penicillatum Dumort.	VU	4	1		
Beckmannia eruciformis Host	LR	0.8	1		
Betula humilis Schrank	VU	6	8	VU	
Betula nana L.	CR	8.5	3	EN	(!!!)
Blysmus compressus (L.) Panz. ex Link	LR	0.8	3		
Blysmus rufus (Huds.) Link	CR	8.2	5		
Bromus racemosus L.	LR	2	7		
Bulboschoenus maritimus (Retz.) A. Braun ex W.D. J. Koch (*Scirpus maritimus*)	LR	2.1	5		
Calamagrostis pseudophragmites (Haller F.) Koeler	DD	1.2	3		
Caldesia parnassifolia (L.) Parl.	CR	9.3	3	CR	
Callitriche autumnalis L. em. Wahlenb.	VU	4.3	7		
Callitriche hamulata Kütz. ex W. D. J. Koch	DD	2.5	8		
Callitriche stagnalis Scop.	VU	4	9		
Carex atherodes Spreng.	EN	6.7	3		
Carex bohemica Schreb	VU	4.2	10		
Carex brachystachys Schrank & K. Moll	LR	nd	nd		
Carex brunnescens (Pers.) Poir.	DD	3	2		
Carex buekii Wimm.	CR	7.5	4	VU	
Carex buxbaumii Wahlenb.	EN	nd	9	EN	
Carex capillaris L.	EN	4	1		
Carex chordorrhiza L.	VU	4.4	8	CR	
Carex cuprina (I. Sandor ex Heuff.) Nendtv. ex A. Kern.	DD	nd	3		
Carex davalliana Sm.	VU	4.3	9	VU	!!!
Carex demissa Hornem.	VU	nd	3		
Carex diandra Schrank	VU	3.1	9	VU	!
Carex dioica L.	VU	4.4	11	VU	!
Carex extensa Gooden.	EX	10	1		
Carex globularis L.	CR	8	2		
Carex hartmanii Cajander	VU	nd	9	VU	
Carex heleonastes Ehrh. In L. f.	DD	5	6	CR	
Carex hostiana DC.	EN	5.6	10		
Carex lasiocarpa Ehrh.	LR	1.8	6		
Carex limosa L.	VU	4.4	11	VU	!
Carex loliacea L.	CR	10	1		
Carex magellanica Lam.	VU	4	1		

Carex microglochin Wahlenb.	EX	nd	nd	EN	(!!!)
Carex pauciflora Lightf.	VU	4.8	5	VU	!
Carex pendula Huds.	DD	2.4	2		
Carex pulicaris L.	EN	7.4	11	VU	!!
Carex punctata Gaudin	EX	10	2		
Carex secalina Wahlenb.	CR	9	2	EN	
Carex strigosa Huds.	EN	6.8	6		
Carex tomentosa L.	LR	2.5	9		
Catabrosa aquatica (L.) P. Beauv.	VU	2.6	7		
Centaurium litorale (Turner) Gilmour	EN	5	2		
Centaurium pulchellum (Sw.) Druce	LR	2.3	7		
Centunculus minimus L.	LR	2.5	7		
Chamaedaphne calyculata (L.) Moench	CR	8.3	3		
Chrysosplenium oppositifolium L.	CR	8.7	4		
Circaea intermedia Ehrh.	LR	1.5	7		
Cirsium canum (L.) All.	LR	2.1	6		
Cladium mariscus (L.) Pohl	VU	4	9		
Cnidium dubium (Schkuhr) Thell.	VU	4.8	12	VU	
Cochlearia polonica E. Frohl.	EX	10	1		
Colchicum autumnale L.	LR	3.8	6		
Corrigiola litoralis L.	CR	8.3	4	VU	
Cortusa matthioli L.	VU	4.5	2		
Cyperus flavescens L.	VU	5.2	10		
Dactylorhiza baltica (Klinge) N.I.Orlova	CR	8	4		
Dactylorhiza incarnata s.l. (L.) Soó	VU	3.8	10	VU	!!
Dactylorhiza maculata (L.) Soó	VU	3.2	9		
Dactylorhiza traunsteineri (Saut.) Soó	DD	nd	3	VU	
Deschampsia setacea (Huds.) Hack.	EX	10	2		
Dianthus superbus L.	VU	4.6	12		
Drosera anglica Huds.	EN	6.5	13	EN	!
Drosera intermedia Hayne	EN	6	11	VU	!
Drosera rotundifolia L.	LR	2.2	8	VU	
Drosera x *obovata* Mert. & W.D.J.Koch	LR	nd	4		
Dryopteris cristata (L.) A. Grey	LR	3.6	12	VU	!
Elatine alsinastrum L.	EN	7	10	EN	!
Elatine hexandra (Lapierre) DC.	VU	3.3	5		
Elatine hydropiper L. Emend. Oeder	EN	6.1	10		
Elatine triandra Schkuhr	EN	5.3	6	VU	!
Eleocharis carniolica W. D. J. Koch	VU	4	1		
Eleocharis mamillata (H. Lindb.) H. Lindb. ex Dorfl. s. l.	VU	3.5	9		
Eleocharis multicaulis Sm.	CR	7.8	4		
Eleocharis ovata (Roth) Roem. & Schult.	VU	4	9		
Eleocharis quinqueflora (Hartmann) O. Schwarz	VU	2.7	9		
Eleogiton fluitans (L.) Link.	EX	nd	1		
Epilobium alpestre (Jacq.) Krock.	LR	1.3	1		
Epilobium anagallidifolium Lam.	VU	3.3	2		
Epilobium nutans F. W. Schmidt	EN	5.3	3		
Epipactis palustris (L.) Crantz	VU	3.8	11	VU	!
Equisetum variegatum Schleich.	VU	3.8	10		
Erica tetralix L.	VU	4.3	5		
Eriophorum gracile W. D. J. Koch	EN	6.2	9	CR	!
Eriophorum latifolium Hoppe	VU	3.4	9		
Euphorbia lucida Walds. & Kit.	VU	4.1	7	VU	
Euphorbia palustris L.	VU	4.6	7		
Euphorbia villosa Waldst. & Kit. ex Willd.	EN	5.4	5		
Fritillaria meleagris L.	CR	10	2	VU	!
Gentiana pneumonanthae L.	VU	4.7	12	VU	!
Gladiolus imbricatus L.	VU	3.9	10	VU	
Gladiolus paluster Gaudin	CR	8	7	CR	!!
Glaux maritima L.	EN	6.8	6		
Glyceria declinata Breb.	VU	3.8	8		
Glyceria nemoralis (R. Uechtr.) R. Uechtr. & Korn.	LR	2.1	10		
Gnaphalium luteo-album L.	LR	1.9	6		
Gratiola officinalis L.	EN	5.2	10	VU	!
Groenlandia densa (L.) Fourr. [= *Potamogeton densus* L.]	EN	7.2	5	EN	
Halimione pedunculata (L.) Aellen	EX	10	2		
Hammarbya paludosa (L.) Kuntze	CR	7.9	9	CR	!
Herminium monorchis (L.) R. Br.	CR	10	4	VU	!

Hierochloe odorata (L.) P. Beauv.	VU	4.3	10		
Hippuris vulgaris L.	VU	3.8	10		
Hydrilla verticillata (L. f.) Royle	EN	10	1		
Hypericum hirsutum L.	LR	2.4	4		
Hypericum pulchrum L.	CR	9	2		
Illecebrum verticillatum L.	VU	4.2	9	VU	
Iris sibirica L.	VU	4.9	13	VU	!!
Isoëtes echinospora Durieu	EN	6.5	2		
Isoëtes lacustris L.	EN	6	5		
Isolepis setacea (L.) R. Br.	VU	4.2	11		
Isolepis supina (L.) R.Br.	EX	10	3		
Juncus acutiflorus Ehrh. ex Hoffm.	VU	3.1	6		
Juncus alpino-articulatus Chaix	LR	1.8	8		
Juncus atratus Krock.	EN	5.2	9	EN (Hu)	
Juncus bulbosus L.	LR	1	5		
Juncus capitatus Weigel.	LR	1.8	8	EN	!!
Juncus filiformis L.	LR	3.2	8		
Juncus gerardi Loisel.	EN	5.8	4		
Juncus ranarius J. O. E. Perrier & Songeon	DD	nd	5		
Juncus subnodulosus Schrank	VU	3	3		
Juncus tenageia Ehrh.	EN	5.4	7	EN	
Juncus triglumis L.	CR	8	1		
Laserpitium prutenicum L.	VU	3.8	11		
Lathyrus palustris L.	VU	4	10		
Leersia oryzoides (L.) Sw.	LR	2.1	9		
Ligularia sibirica (L.) Cass.	CR	8	4	CR	(!!!)
Limosella aquatica L.	LR	1.6	6		
Lindernia procumbens (Krock.) Borbas	EN	6.8	5	CR	!
Liparis loeselii (L.) Rich.	VU	6.9	12	EN	!!
Littorella uniflora (L.) Asch.	CR	7.9	7	EN	
Lobelia dortmanna L.	VU	4	3		
Ludwigia palustris (L.) Elliott	EX	nd	1	CR	
Luronium natans (L.) Raf. [= *Elisma natans* (L.) Buchenau]	EN	6.4	5		
Lycopodiella inundata (L.) Holub	VU	5.5	11		
Lythrum hysopifolia L.	VU	4.2	9	VU (Hu)	!
Malaxis monophyllos (L.) Sw.	EN	7.4	4		
Marsilea quadrifolia L.	EX	10	1	EN	
Matteucia struthiopteris (L.) Tod.	VU	2.9	9		
Mentha pulegium L.	LR	2	4		
Montia fontana L. sl	EN	6.3	7		
Myosotis caespitosa Schultz	LR	nd	5		
Myosurus minimus L.	LR	1.7	6		
Myrica gale L.	EN	5.3	3		
Myricaria germanica (L.) Desv.	VU	6.5	3	VU	
Myriophyllum alternifolium DC.	VU	3.5	2		
Najas flexilis (Willd.) Rostk. & W. L. E. Schmidt	EN	7	1		
Najas marina L.	VU	4.7	10		
Najas minor All.	EN	5.2	9	EN	
Nasturcium officinale R. Br.	LR	1.7	4		
Nuphar pumila (Timm) DC.	EN	6.7	6		
Nymphaea candida C. Presl	DD	8	6		
Nymphoides peltata (S. G. Gmel.) Kuntze	EN	7.3	9	EN	!
Oenanthe fistulosa L.	EN	5.9	7	EN	!!
Oenanthe lachenalii C. C. Gmel.	CR	nd	nd		
Ophioglossum vulgatum L.	LR	3	11		
Orchis palustris Jacq.	CR	9	7		
Orchis tridentata Scop.	EX	8.3	4	VU	
Osmunda regalis L.	VU	4.6	11		
Ostericum palustre Besser	EN	7.8	9	CR	
Oxycoccus microcarpus Turcz. Ex Rupr.	VU	nd	7		
Parnassia palustris L.	LR	1.8	5		
Pedicularis palustris L.	VU	4.2	9		
Pedicularis sceptrum-carolinum L.	CR	7.8	8		
Pedicularis sudetica L.	EN	6	1	CR	(!!!)
Peplis portula L.	LR	0.8	3		
Pilularia globulifera L.	CR	9.5	4	EN	!
Pinguicula vulgaris L. *subsp. bicolor* (Wol.) Á. Löve & D. Löve	EN	4.8	4		
Pinguicula vulgaris L. *subsp. vulgaris*	EN	6.6	10		

Pinus x *rhetica* Brugger	VU	nd	1		
Plantago coronopus L.	CR	8.5	2		
Plantago maritima L. s. str.	EN	6	3		
Plantago winteri Wirtg.	DD	nd	1		
Poa remota Forselles	LR	1.7	7		
Polemonium caeruleum L.	EN	5.9	9		
Potamogeton acutifolius Link	VU	3.4	8		
Potamogeton alpinus Balb.	VU	3.8	12		
Potamogeton berchtoldii Fieber	DD	nd	3		
Potamogeton compressus L.	VU	2.7	7	EN	
Potamogeton filiformis Pers.	EN	6.3	5		
Potamogeton friesii Rupr.	VU	4	8		
Potamogeton gramineus L.	LR	3.4	5		
Potamogeton nodosus Poir.	DD	2.5	7		
Potamogeton obtusifolius Mert. & W. D. J. Koch	VU	3.1	9		
Potamogeton polygonifolius Pourr.	EN	5.2	4	VU	
Potamogeton praelongus Wulfen	VU	2.6	6	EN	!
Potamogeton pusillus L.	LR	1.7	5		
Potamogeton rutilus Wolfg.	VU	4	5		
Potamogeton trichoides Cham. & Schltdl.	VU	2.8	7	VU	!!
Potamogeton x *angustifolius* J. Presl. [*P.x zizii* Mert. & W. D. J. Koch]	DD	1.3	3		
Potamogeton x *nitens* Weber	DD	3.4	5		
Primula farinosa L.	CR	9.5	4		
Puccinellia maritima (Huds.) Parl.	EN	6.5	2		
Pulicaria dysenterica (L.) Bernh.	LR	2	1		
Radiola linoides Roth	VU	3.1	8		
Ranunculus reptans L.	DD	nd	3		
Rhynchospora alba (L.) Vahl.	VU	3.5	11		
Rhynchospora fusca (L.) W. T. Aiton.	EN	6.6	7	EN	!
Rubus chamaemorus L.	EN	7	3		
Rumex ucranicus Besser ex Spreng.	EN	6.7	4		
Ruppia maritima L.	EN	6.5	2		
Sagina maritima Don	EX	10	1		
Sagina saginoides (L.) H. Karst.	DD	1	1		
Salicornia europaea L.	CR	7	5		
Salix daphnoides Vill.	DD	2.8	2		
Salix lapponum L.	EN	7.3	4	EN	(!!!)
Salix myrsinifolia Salisb.	VU	2.7	4		
Salix myrtilloides L.	EN	6.3	10	CR	
Salix starkeana Willd.	LR	1.9	3		
Salvinia natans (L.) All.	VU	5	13	VU	
Samolus valerandi L.	CR	7	4	EN (Hu)	!
Saxifraga hirculus L.	CR	9.1	9	CR	
Scheuchzeria palustris L.	VU	5.2	11		
Schoenoplectus americanus (Pers.) Volkart	EX	10	1		
Schoenoplectus mucronatus (L.) Palla [= *Scirpus mucronatus* L.]	CR	8.7	3		
Schoenoplectus tabernaemontani (C. C. Gmel.) Palla	LR	1.1	4		
Schoenoplectus x *kalmusii* (Abrom., Asch. & Graebn.) Palla	DD	1.5	1		
Schoenus ferrugineus L.	EN	6.2	5	VU	!
Schoenus nigricans L.	CR	7.5	2		
Scirpoides holoschoenus (L.) Soják	VU	4.6	4		
Scirpus radicans Schkuhr	VU	4.4	12	VU	
Scolochloa festucacea (Willd.) Link	LR	2.2	4		
Scutellaria hastifolia L.	VU	4.2	7		
Sedum villosum L.	CR	9.7	6	EN	!
Senecio aquaticus Hill.	EN	5.7	6		
Senecio erucifolius L.	DD	nd	7		
Senecio fluviatilis Wallr.	LR	2.8	8		
Senecio ovatus (P.Gaertn., B.Mey. & Scherb.) Willd.	DD	nd	1		
Silaum silaus (L.) Schinz & Thell.	VU	3.4	8		
Sonchus palustris L.	LR	1.9	3		
Sparganium angustifolium F. Michx.	EN	6.5	5		
Sparganium minimum Wallr.	VU	3.8	11	VU	!
Sparganium neglectum Beeby	VU	3.3	6		
Spergularia echinosperma Celak.	DD	nd	1		
Spergularia salina J. Presl. & C. Presl.	VU	4.3	5		
Stellaria crassifolia Ehrh.	EN	9.3	7		
Suaeda maritima ssp. (L.) Dumort.	EX	10	1		
Succisella inflexa (Kluk) Beck	VU	4.5	4		
Swertia perennis s.l. L.	EN	7.2	7		
Taraxacum palustre (Lyons) Symons	DD	1.8	5		
Tetragonolobus maritimus s. l. (L.) Roth	LR	2.6	6		
Teucrium scordium L.	LR	2.5	9		
Tofieldia calyculata (L.) Wahlenb.	EN	5.5	11		
Tozzia alpina L.	LR	0.5	1		
Trapa natans L.	EN	7	8	EN (Hu)	!
Triglochin maritimum L.	VU	4.1	7		
Triglochin palustre L.	LR	1.2	4		
Trollius altissimus Crantz	EN	5	3		
Trollius europaeus L. s. str.	VU	3.9	12		
Utricularia australis R. Br.	VU	2.9	10		
Utricularia intermedia Hayne	VU	3.8	11		
Utricularia minor L.	VU	3.5	11		
Utricularia ochroleuca R. W. Hartm.	EN	5.9	8	EN	!
Valeriana simplicifolia (Rchb.) Kabath.	LR	1.9	5		
Viola elatior Fr.	EN	6.2	6	EN (Hu)	
Viola epipsila Ledeb.	EN	6.3	6		
Viola pumilia Chaix	EN	5	3	EN	
Viola stagnina Kit.	VU	4.5	9		
Viola uliginosa Besser	EN	5.4	5		
Zannichellia palustris L. s.l	VU	3	9		
Zostera marina L.	VU	3.5	2		
Zostera noltii Hornem	VU	3.5	2		

Explanation:

!!! - particular responsability; !! - high responsibility; ! - responsibility; (!!!) - responsible for isolated outposts
nd - no data to account TI (no data on local red lists or conected with distribution in Poland).

REFERENCES

Amezaga, J.M., Santamaría, L. & Green, A.J. (2002). Biotic wetland connectivity—supporting a new approach for wetland Policy. *Acta Oecologica* 23, 213–222

Bednarek-Ochyra, H., Kłosowski S.& Ochyra, R. (2001). Pinguicula vulgaris w północno-wschodniej Polsce. *Fragm. Flor. Geobot. Polonica* 8, 105-111 (in Polish)

Belyea, L.R. & Malmer, N. (2004). Carbon sequestration in peatland: patterns and mechanisms of response to climate change. *Global Change Biology* 10, 1043–1052. DOI: 10.1111/j.1529-8817.2003.00783.x

Bernacki, L., Nowak, T., Urbisz, A., Urbisz, A. & Tokarska-Guzik, B. (2000). Rośliny chronione, zagrożone i rzadkie we florze woj. śląskiego. *Acta Biologica Silesiana* 35(52), 78-106 (in Polish with English summary)

Bobbink, R., Hornung, M. & Roelofs, J.G.M. (1998). The effects of air-borne pollutants on species diversity in natural and seminatural European vegetation. *J. Ecol.* 86, 717–738

Brito, D., Ambal, R., G., Brooks, T., De Silva, N., Foster, M., Hao, W., Hilton-Taylor, C., Paglia, A., Rodriguez, J., P. & Rodrigez J., V. (2010). How similar are national red lists and the IUCN Red List? *Biological Conservation* 143, 1154–1158. DOI: 10.1016/j.biocon.2010.02.015

Bronmark, C. & Hansson, L.A. (2002). Environmental issues in lakes and ponds: current state and perspectives. *Environmental Conservation* 29, 290–307

Bróż, E. & Przemyski, A. (2009). The red list of vascular plants in the Wyżyna Małopolska upland (S Poland). In Z. Mirek, A. Nikel & W. Szafer (Eds.), *Rare, relict and endangered plants and fungi in Poland* (pp. 123-136). Kraków, Poland: Institute of Botany Polish Academy of Sciences

CEC (1995). *Wise Use and Conservation of Wetlands*, COM (95) 18 a Final. Luxembourg: Office for Official Publications of the European Communities

Chen, B., Chen, Z.M., Zhou, Y., Zhou, J.B. & Chen, G.Q. (2009). Emergy as embodied energy based assessment for local sustainability of a constructed wetland in Beijing. *Commun. Nonlinear Sci. Numer. Simul.* 14, 622–635. DOI: 10.1016/j.cnsns.2007.05.035

Chen, Z.M., Chen, B., Zhou, J.B., Li, Z., Zhou, Y., Xi, X.R., Lin, C. & Chen G.Q. (2008). A vertical subsurface-flow constructed wetland in Beijing. *Commun. Nonlinear Sci. Numer. Simul.* 13, 1986–1997. DOI: 10.1016/j.cnsns.2007.02.009

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P. & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature* 387, 253–260

Dahlberg, A. & Mueller, G., M. (2011). Applying IUCN red-listing criteria for assessing and reporting on the conservation status of fungal species. *Fungal Ecology* 4, 147-162. DOI: 10.1016/j.funeco.2010.11.001

Dembek, W. (2002). Wetlands in Poland: present threats and perspectives for protection. *Journal of Water and Land Development* 6, 3-17

Dembek, W., Pawlaczyk, P., Sienkiewicz, J. & Dzierża, P. (2004). *Obszary wodno-błotne w Polsce.* Falenty, Poland: Wyd. IMUZ (in Polish with English summary)

Finlayson, C.M., Hollis, G.E. & Davis, T.J. (1992). Managing Mediterranean wetlands and their birds. Proc. Symp., Grado, Italy 1991, IWRB Spec. Publs, No. 20

Garcia, F.I. & Marini, M.A. (2006). Comparative study between the global, national and state lists of threatened birds in Brazil. *Natureza & Conservação* 4, 138–163

Głowacki, Z., Falkowski, M., Krechowski, J., Marciniuk, J., Marciniuk, P., Nowicka-Falkowska, K. & Wierzba, M. (2003). Czerwona lista roślin naczyniowych Niziny Południowopodlaskiej. *Chrońmy Przyr. Ojcz.* 59 (2), 5-41 (in Polish with English summary)

Groombridge, B. & Jenkins, M. (1998). *Freshwater Biodiversity: a Preliminary Global Assessment*. Cambridge, UK: World Conservation Monitoring Centre World Conservation Press

Haslam, S.M. (2003). *Understanding Wetlands: Fen, Bog, and Marsh*. London, UK: Taylor & Francis

IUCN (1976). *IUCN Threatened Plants Committee Secretariat. How to Use the IUCN Red Data Book Categories*. London, UK: Kew Royal Botanical Gardens

IUCN (1994). *IUCN Red List Categories. As Approved by the 40th Meeting of the IUCN Council.* Gland, Switzerland: IUCN Species Survival Commission World Conservation Union

IUCN (2001). *IUCN Red List Categories and Criteria* Version 3.1. Gland, Switzerland: IUCN Species Survival Commission

IUCN (2003). *Guidelines for Application of IUCN Red list Criteria at Regional Levels*. Version 3.0. Gland, Switzerland: IUCN Species Survival Commission

Jackowiak, B., Celka, Z., Chmiel, J., Latowski, K. & Żukowski, W. (2007). Red list of vascular flora of Wielkopolska (Poland). *Biodiv. Res. Conserv.* 5-8, 95-127

Jakubowska-Gabara, J. & Kucharski, L. (1999). Ginące i zagrożone gatunki flory naczyniowej zbiorowisk naturalnych i półnaturalnych Polski środkowej. *Fragm. Flor. Geobot. Ser. Polonica* 6, 55-74 (in Polish with English summary)

Jantke, K., Schleupner, C. & Schneider, U. (2010). Gap analysis of European wetland species: priority regions for expanding the Natura 2000 network. *Biodiversity and Conservation* 20(3), 581-605. DOI : 10.10071s10531-010-9968-9

Jasnowska, J. & Jasnowski, M. (1977). Zagrożone gatunki flory torfowisk. *Chrońmy Przyr. Ojcz.* 33(4), 5-14. (in Polish)

Kącki, Z., Dajdok, Z. & Szczęśniak, E. (2003). Czerwona lista roślin naczyniowych Dolnego Śląska. In Z. Kącki (Eds.), *Zagrożone gatunki flory naczyniowej Dolnego Śląska* (pp. 9-65) Wrocław, Poland: Instytut Biologii Roślin UW (in Polish with English summary)

Kimmel, K., Kull, A., Salm, J. & Mander, U. (2010). The status, conservation and sustainable use of Estonian wetlands. *Wetlands Ecol. Manage* 18, 375–395. DOI: 10.1007/s11273-008-9129-z

Kopeć, D., Ratajczyk, N. & Sieradzki, J. (2008). Krytyczne uwagi o aktualnej liście chronionych gatunków roślin naczyniowych w Polsce. In D. Kopeć, N. Ratajczyk (Eds.) *Prawo Ochrony Przyrody. Stan, Problemy, Perspektywy* (pp. 241 – 250). Łódź, Poland: Towarzystwo Przyrodników Ziemi Łódzkiej (in Polish)

Kucharczyk, M. & Wójciak, J. (1995). Ginące i zagrożone gatunki roślin naczyniowych Wyżyny Lubelskiej, Roztocza, Wołynia Zachodniego i Polesia Lubelskiego. *Ochr. Przyr.* 52, 33-46 (in Polish with English summary)

Mace, G.M. & Lande, R. (1991). Assessing extinction threats: toward a revaluation of IUCN threatened species categories. *Conservation Biology* 5, 148–157

Markowski, R. & Buliński, M. (2004). Ginące i zagrożone rośliny naczyniowe Pomorza Gdańskiego. *Acta Bot. Cassub. Monographiae* 1, 1-175 (in Polish with English summary)

Matuszkiewicz, W. (2001). *Przewodnik do oznaczania zbiorowisk roślinnych Polski*. Warszawa, Poland: PWN (in Polish)

Miller, R.M., Rodríguez, J.P., Aniskowicz-Fowler, T., Bambaradeniya, C., Boles, R., Eaton, M.A., Gärdenfors, U., Keller, V., Molur, S., Walker, S. & Pollock, C. (2006). Extinction risk and conservation priorities. *Science* 313; 441

Miller, R.M., Rodríguez, J.P., Aniskowicz-Fowler, T., Bambaradeniya, C., Boles, R., Eaton, M.A., Gärdenfors, U., Keller, V., Molur, S., Walker, S. & Pollock, C. (2007). National threatened species listing base on IUCN criteria and regional guidelines: current status and future perspectives. *Conservation Biology* 21, 684–696

Milner-Gulland, E.J., Kreuzberg-Mukhina, E., Grebot, B., Ling, S., Bykova, E., Abdusalamov, I., Bekenov, A., Gärdenfors, U., Hilton-Taylor, C., Salnikov, V. & Stogova, L. (2006). Application of IUCN red listing criteria at the regional and national levels: a case study from central Asia. *Biodiversity and Conservation* 15, 1873–1886 DOI: 10.1007/s10531-005-4304-5

Mirek, Z. & Piękoś-Mirkowa, H. (2008). Eds., *Czerwona Księga Karpat Polskich. Rośliny Naczyniowe*. Kraków, Poland: Wyd. Inst. Botaniki (in Polish with English summary)

Mitsch, W.J. &, Gosselink, J.G. (1993). *Wetlands*. (2nd ed.). New York, USA: Van Nostrand Reinhold

Nowak, A., Nowak, S. & Spałek, K. (2003). Red list of vascular plants of Opole Province. *Opole Scientific Society, Nature Journal* 36, 5-20

Oświęcimska-Piasko, Z., Piórkowski, H., Dembek, W., Ostrzyżek, S., Jakubowski, W., Rycharski, M., Szewczyk, M., Siedlecki, T. & Grotek, A. (2006). *System Informacji Przestrzennej o Mokradłach Polski*. from http://www.gis-mokradla.info (in Polish)

Pawlikowski, P. (2008a). Nowe stanowiska zagrożonych gatunków torfowiskowych roślin naczyniowych i mszaków w Suwalskim Parku Krajobrazowym i jego otulinie. *Fragm. Flor.*

Geobot. Polonica 15(1), 43-50 (in Polish with English summary)

Pawlikowski, P. (2008b). Rzadkie i zagrożone rośliny naczyniowe torfowisk w dolinie Kunisianki na Pojezierzu Sejneńskim. *Fragm. Flor. Geobot. Polonica* 15(2), 205-212 (in Polish with English summary)

Pawlikowski, P. (2008c). Distribution and population size of the threatened fen orchid Liparis Loeselli (L.) Rich. in the Lithuanian lake district (NE Poland). *Roczniki Akademii Rolniczej w Poznaniu CCCLXXXVII, Botanika – Steciana* 12, 53-59 (in Polish with English summary)

Pawlikowski, P., Jarzombkowski, F., Wołkowycki, D., Kozub, Ł., Zaniewski, P., Bakanowska, O., Banasiak, Ł., Barańska, K., Bielska, A., Bierieżon, U., Galus, M., Grzybowska, M., Kapler, A., Karpowicz, J., Sadowska, I. & Zarzecki, R. (2009). Rare and threatend plants of the mires in the intensively managed landscape of the Góry Sudawskie region (north-eastern Poland). *Roczniki Akademii Rolniczej w Poznaniu CCCLXXXVIII, Botanika – Steciana,* 13: 29-36. (in Polish with English summary)

Ramsar Convention Bureau (1996) *Wetlands and Biological Diversity*: *Cooperation between The Convention of Wetlands of International Importance especially as Waterfowl Habitat (Ramsar, Iran,1971) and The Convention on Biological Diversity*, Document UNEP/CBD/COP/3/Inf.21

Rutkowski, L. (1997). *II Rośliny naczyniowe - Tracheophyta.* [in]: *Czerwona lista roślin i zwierząt ginących i zagrożonych w regionie Kujawsko-Pomorskim*. Acta Univ. Nicol. Copernici. Biologia 53 supl. Nauki Mat.-Przyr., 98: 5-19 (in Polish)

Schnittler, M. & Günther, K., F. (1999). Central European vascular plants requiring priority conservation measures - an analysis from national Red Lists and distribution maps. *Biodiversity and Conservation* 8, 891-925

Schweiger, E.W., Leibowitz, S.G., Hyman, J.B., Foster, W.E. & Downing, M.C. (2002). Synoptic assessment of wetland function: a planning tool for protection of wetland species biodiversity. *Biodiversity and Conservation* 11; 379–406

Silva, J.P., Phillips, L., Jones, W., Eldridge, J. & O'Hara, E. (2007). *Life and Europe's wetlands, restoring a vital ecosystem*. Luxembourg: Office for Official Publications of the European Communities

von May, R., Catenazzi, A., Angulo, A., Brown, J.L., Carrillo, J., Chávez, G., Córdova, J.H., Curo, A., Delgado, A., Enciso, M.A., Gutiérrez, R., Lehr, E., Martínez, J.L., Medina-Muller, M., Miranda, A., Neira, D.R., Ochoa, J.A., Quiroz, A.J., Rodríguez, D.A., Rodríguez, L.O., Salas, A.W., Seimon, T., Seimon, A., Siu-Ting, K., Suárez, J., Torres, C. & Twomey, E. (2008). Current state of conservation knowledge on threatened amphibian species in Peru. *Tropical Conservation Science* 1, 397–416

Warcholińska, A. (2004). Flora segetalna Polski Środkowej. *Acta Agrobotanica* 57 (1-2), 327-352 (in Polish)

Zając, A. & Zając, M. (Eds.) (2001). *Distribution Atlas of Vascular Plants in Poland*. Kraków, Poland: Nakł. Prac. Chorologii Komput. Inst. Bot. UJ

Zając, M. & Zając, A. (1998). Czerwona lista roślin naczyniowych byłego województwa krakowskiego. *Ochr. Przyr.* 55, 25-35 (in Polish)

Zając, M. & Zając, A. (2003). Różnorodność gatunkowa – rośliny naczyniowe i inne. In R. Andrzejewski & A. Weigle (Eds.), *Różnorodność biologiczna Polski* (pp. 67-82) Warszawa, Poland: Narodowa Fundacja Ochrony Środowiska (in Polish with English summary)

Zaluski, T. (2009) A voice in the discussion on threatened species. [in:] In Z. Mirek & A. Nikel (Eds.). *Rare, relict and endangered plants and fungi in Poland* (pp. 61-76). Kraków, Poland: Szafer Institute of Botany Polish Academy of Sciences

Zarzycki, K., Trzcińska-Tacik, H., Różański, W., Szeląg, Z., Wołek, J. & Korzeniak, U. (2002) *Ecological indicator values of vascular plants of Poland*. Kraków, Poland: W. Szafer Insitute of Botany, Polish Academy of Sciences

Zarzycki, K. & Szeląg, Z. (2006). Red list of the vascular plants in Poland. In Z. Mirek, K. Zarzycki, W. Wojewoda & Z. Szeląg (Eds.), *Red list of plants and fungi in Poland* (pp. 9-20). Kraków, Poland: W. Szafer Insitute of Botany, Polish Academy of Sciences

Zeng, L. & Chen, G.Q. (2009). Notes on modeling of environmental transport in wetland. *Commun. Nonlinear Sci. Numer. Simul.* 14, 1334–1345. DOI: 10.1016/j.cnsns.2010/12.002

Zeng, L. & Chen, G., Q. (2011). Ecological degradation and hydraulic dispersion of contaminant in wetland. *Ecological Modelling* 222, 293–300 DOI: 10.1016/j.ecolmodel.2009.10.024

Zhou, J.B., Jiang, M.M., Chen, B. & Chen, G.Q. (2009). Emergy evaluations for constructed wetland and conventional wastewater treatments. *Commun. Nonlinear Sci. Numer. Simul.* 14, 1781–1789. DOI: 10.1016/j.cnsns.2007.08.010

Zhou, N.Q., Wang, Y. & Li, C.X. (2007). Carbon cycle in wetlands and its relationship with global change. In T.D. Bullen & Y. Wang (Eds.), *Water–Rock Interaction* (pp. 1517–1590), London, UK: Taylor & Francis

Żukowski, W. & Jackowiak, B. (1995). Lista roślin naczyniowych ginących i zagrożonych na Pomorzu Zachodnim i w Wielkopolsce. In W. Żukowski & B. Jackowiak (Eds.), *Ginące i zagrożone rośliny naczyniowe Pomorza Zachodniego i Wielkopolski*. Prace Zakładu Taksonomii Roślin UAM, Poznań 3, 9-96 (in Polish with English summary)