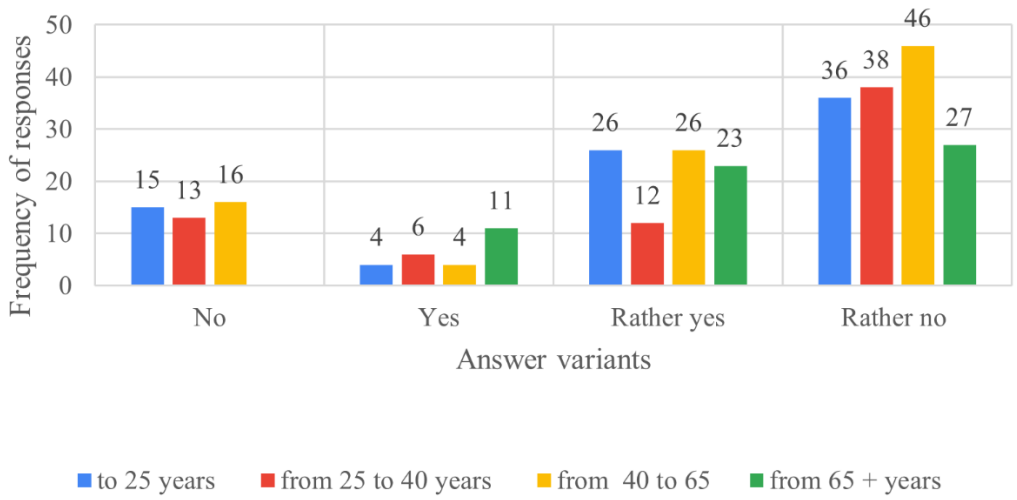
as meaningless. Across all groups, it turned out that respondents did not perceive the current situation agriculture as sustainable. Today's agriculture is considered the most sustainable by the oldest age group.

Figure 4 Answers to question 31 The concept of agricultural sustainability is defined as: it does not limit the needs of the current generation and at the same time does not endanger the next generation. Do you think that is current agriculture sustainable by this definition?



CONCLUSION

It follows from the above finding that the respondents answered the questions of the basic issues that do not require deeper knowledge in accordance with the professional literature. However, for more complex issues, they differed more and more from practice and professional literature. Regarding the issue of soil protection, the respondents perceived water erosion, pesticide residues and species composition of crops as the most fundamental problems. Regarding the question concerning the occurrence of GMO crops in the Czech Republic, most respondents, regardless of age, believed that they are grown in our country to a much greater extent than is actually the case. The planned ban on cage laying hens is perceived by respondents as a problem and they believe that conditions should be set equally throughout the EU. 56.1% answered this way respondents by age categories. The results also show that respondents perceived the current state of agriculture as poorly sustainable, considered the older age group to be the most sustainable. The age groups of the respondents played a relatively crucial role in some questions from the point of view of the issue. It was recommended for all age groups work in an acceptable way in education for the category.

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Historical and contemporary endangered wetland species of the southeastern part of the Bohemian-Moravian Highlands

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Abstract: Wetlands are among the most endangered ecosystems in Central Europe. Therefore, large number of wetland organisms are endangered at the same time. Frequency of 94 red-list species were evaluated in the studied area of the south-eastern part of the Bohemian-Moravian Highlands. Historical data were taken from literature, botanical surveys, and databases. Recent occurrences are the result of the own field survey. Almost half of the evaluated species are recently considered as disappeared, or extinct in the area. *Carex lasiocarpa* and *Pedicularis palustris* are plants of high conservancy importance and at the same time belongs to recently missing species, with high probability of extinction, in the studied region. *Drosera rotundifolia* survives only at one locality. Prevailing decreasing number of species localities is associated mainly with the loss of suitable low-productive aquatic and wetland habitats. The study points to the continuing negative trend of reducing the occurrence of most of the evaluated endangered species and the related degradation of natural habitats in the selected area.

Key Words: degradation of habitats, nature protection, plant survey, species extinction

INTRODUCTION

The decrease of wetland species occurrence, in some cases also extinction of species, fully corresponds to the degradation and decrease in the number of wetland localities. Most endangered wetlands are included in the red list of endangered habitats of the Czech Republic. The main threats to endangered wetland habitats are abandonment of traditional management, nutrients inputs from surrounding agricultural land, invasion of non-native species and atmospheric deposition (Chytrý et al. 2019). Thanks to human activity, the processes of succession have been facilitated and accelerated, which leads to a significant transformation of wetland ecosystems towards terrestrial (Szabó et al. 2017).

The biggest problem in comparing the historical occurrence of endangered species (Grulich and Chobot 2017) with the current one is the lack of available historical data. Many current endangered species have been relatively abundant in the past, so they have not received much attention. In study area, there is availability of comparisons with historical data due to the extensive surveys of Filip Lysák in 1990–2010s (Lysák 2000). Therefore, assessment of the development of the number of localities with occurrences of endangered plant species is possible, contrary to the other areas. The main goal of this study is to compare the lists of endangered species associated with wetland habitats that have occurred in the past and in the present.

MATERIAL AND METHODS

South-eastern part of the Bohemian-Moravian Highlands is located in the middle of the Czech Republic, north of the town of Velké Meziříčí and is delimited by four mapping quadrates of the Central European Basic Area (CEBA): 6561,6562,6661,6662.

Occurrence data of endangered wetland species were obtained from Lysák's diploma thesis (Lysák 2000), available botanical literature and databases (Kaplan et al. 2015–2021, Čech et al. 2017, Wild 2019, AOPK 2021) and from our own field surveys. For each species, the number of localities

in which it occurs was counted separately for four time periods: historical records until 1995, records from 1996–2005, records from 2006–2015 and records from 2016 to the present. The possible extinction of the species is supplemented by the year of the last record of occurrence. For non-found species, we distinguish between *disappeared* and *extinct* depending on the probability whether the species can survive secretly in the locality or not.

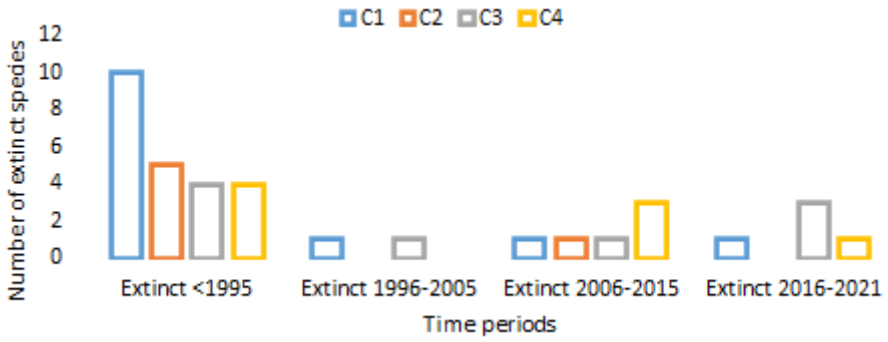
An overview table was created for all endangered species. Species nomenclature is unified according to Kubát et al. (2002), the category of threat follow the red list of vascular plants of the Czech Republic (Grulich and Chobot 2017) and regional red list of vascular plants of the Vysočina (Čech et al. 2017). Czech red list categories as well as red list categories created for Vysočina region correspond approximately to the IUCN red list categories as follows: C1 = CR (critically endangered); C2 = EN (endangered); C3 = VU (vulnerable); C4 = NT (near threatened). The table also contains the numbers of species localities and various notes concerning occurrence or extinction of the species. The optimal habitat for each species was determined based on data from the PLADIAS database (Sádlo et al. 2007). In the case of a larger number of optimal habits, the one that best corresponds to the occurrence in the studied area was selected. Habitat names were taken from the habitat catalogue of the Czech Republic (Chytrý et al. 2010).

RESULTS AND DISCUSSION

Based on our study, a total of 94 wetland vascular plants are included in the list of endangered species (Table 1). Of this number, a total of 15 species are in the critically endangered category (C1), a total of 22 species are in the category of endangered species (C2), 28 species are in the category of vulnerable species (C3) and 29 species are in the category of species near threatened (C4).

The disappearance and probably extinction was found for 29 vascular plants. Only a part of the species evaluated as disappeared have higher probability to survive and next field resurveys are highly recommended, eg. *Hypericum humifusum*. The mentioned species was considered as extinct until 2010, after which it was not verified at all in the following years. Similarly, *Scirpus radicans, Potamogeton alpinus* or *Lysimachia thyrsiflora* were found even though they were considered extinct (Table 1). The extinction of species itself corresponds to the categories of endangerment. Figure 1 shows the preferential extinction of critically endangered species until 1995. In the last 25 years, relatively less endangered species of the Czech Republic have disappeared.

Figure 1 Extinct species by Red List threat category and period of negative finding



The decrease in the number of localities is evident in 31 species. On the other hand, the increase in the number of localities was also found. *Tephroseris crispa, Carex flava* and *Trientalis europaea* were recorded on higher number localities contrary to the historical periods. However, these data may be also affected by less attention given to the overall plant inventarisations in the history contrary to the recent.

For some species reduction of abundance in the last few decades is significant, which can be illustrated in the case of *Drosera rotundifolia*. Occurrence in history was common at majority of fen meadows. At nowadays there is only one last isolated locality. This phenomenon is similar for several species, which are very sensitive to changes in the habitat environment and become extinct in the event of a significant negative intervention, eg. abandonment of traditional management. For some species, survival in the locality is typical despite the negative intervention, which significantly changed

the natural conditions of the locality and for the species the locality became unsuitable. For example, *Dactylorhiza majalis, Menyanthes trifoliata* or *Comarum palustre* have been surviving for many years at degraded localities, then finally disappeared.

Table 1 List of endangered wetland plant species with number of localities of occurrence in time periods

Species	RLCZ	RLV	Number of sites				Condition
			<1995	1996–2005	2006–2015	2016–2021	
Arnoseris minima	C1	A	4	0	0	0	extinct (1905)
Carex dioica	C1	C1	1	0	0	0	uncertain, extinct (1911)
Centunculus minimus	C1	A	2	0	0	0	extinct (1905)
Dactylorhiza incarnata	C1	C1	1	0	0	0	extinct (1887)
Eleocharis quinqueflora	C1	C1	4	0	0	0	extinct (1935)
Juncus capitatus	C1	A	1	0	0	0	extinct (1947)
Nymphaea alba	C1	C1	2	0	0	0	extinct (1996)
Nymphaea candida	C1	C2	1	0	0	0	uncertain, extinct (1911)
Pedicularis palustris	C1	C1	2	2	1	0	disappeared (2014)
Pseudognaphalium luteoalbum	C1	A	3	0	0	0	extinct (1968)
Radiola linoides	C1	A	3	1	0	0	extinct (1997)
Sedum villosum	C1	A	7	0	0	0	extinct (1991)
Taraxacum paucilobum	C1	not	1	0	0	0	extinct (1898)
Taraxacum vindobonense	C1	not	-	8	3	3	decrease
Tillaea aquatica	C1	C2	2	10	4	2	fluctuations
Blysmus compressus	C2	C1	4	2	2	2	decrease
Bolboschoenus maritimus	C2	C3	5	3	3	2	decrease
Carex diandra	C2	C3	19	9	8	5	decrease
Carex elata	C2	C3	4	4	6	5	without change
Cnidium dubium	C2	C1	-	1	0	0	extinct (1999)
Elatine hexandra	C2	C2	2	0	0	0	uncertain, extinct (1935)
Eleocharis uniglumis	C2	C1	2	0	0	0	uncertain, extinct (1935)
Eriophorum latifolium	C2	C2	7	4	3	2	decrease
Gratiola officinalis	C2	C2	1	0	0	0	uncertain, extinct (1930)
Montia hallii	C2	C2	10	3	3	1	decrease
Myosotis discolor	C2	C4	-	-	3	3	without change
Ophioglossum vulgatum	C2	C1	-	4	4	3	decrease
Parnassia palustris	C2	C2	11	15	8	6	decrease
Pedicularis sylvatica	C2	C3	23	12	5	1	decrease
Pilosella lactucella	C2	C3	-	4	2	1	decrease
Pinus uncinata subsp.uliginosa	C2	C1	1	0	0	0	uncertain, extinct (1947)
Potamogeton alpinus	C2	C2	5	0	0	1	decrease
Spergularia echinosperma	C2	C2	3	3	10	5	increase
Thalictrum flavum	C2	C1	-	2	2	2	non native, without change
Trifolium spadiceum	C2	C3	15	4	4	1	decrease
Triglochin palustre	C2	C2	5	2	1	1	decrease
Utricularia minor	C2	C2	3	1	0	0	uncertain, extinct (1947)
Potamogeton acutifolius	C3	C1	11	0	0	0	uncertain, extinct (1935)

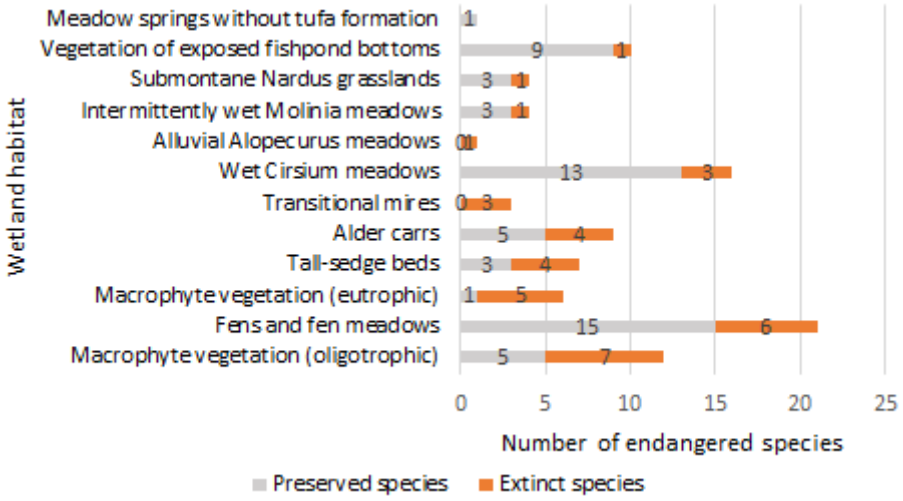
Calla palustris	C3	C3	-	1	2	2	increase
Carex curvata	C3	C2	-	-	-	1	uncertain
Carex distans	C3	C1	-	2	1	1	decrease
Carex lasiocarpa	C3	C3	-	1	1	0	extinct (2006)
Coleanthus subtilis	C3	C3	15	33	27	6	fluctuations
Dactylorhiza majalis	C3	C3	ab.	49	31	24	decrease
Drosera rotundifolia	C3	C3	17	1	1	1	decrease
Elatine hydropiper	C3	C3	6	2	1	0	extinct (1997)
Elatine triandra	C3	C3	7	37	14	8	fluctuations
Hypericum humifusum	C3	C3	3	0	1	0	disappeared (2010)
Iris sibirica	C3	C1	-	-	-	1	unoriginal
Isolepis setacea	C3	C3	8	4	6	4	fluctuations
Juncus alpinoarticulatus	C3	C1	2	1	1	0	disappeared (2007)
Laserpitium prutenicum	C3	C2	1	0	0	0	extinct (1910)
Leersia oryzoides	C3	C3	4	3	4	4	without change
Leucojum vernum	C3	C3	1	0	0	0	extinct (1932)
Lysimachia thyrsiflora	C3	C2	2	5	3	3	decrease
Menyanthes trifoliata	C3	C3	28	13	9	7	decrease
Platanthera bifolia	C3	C3	-	10	3	3	decrease
Poa remota	C3	C4	1	4	4	4	without change
Potamogeton lucens	C3	C2	5	1	0	0	extinct (1935)
Potamogeton obtusifolius	C3	C3	-	4	4	1	decrease
Potamogeton trichoides	C3	C3	7	0	4	3	decrease
Salix rosmarinifolia	C3	C3	6	8	5	4	decrease
Scirpus radicans	C3	C3	7	1	3	1	decrease
Soldanella montana	C3	C3	2	3	3	3	without change
Thelypteris palustris	C3	C1	1	0	0	0	extinct (1924)
Carex bohemica	C4	C4	11	45	48	42	fluctuations, increase
Carex buekii	C4	C3	-	1	0	0	disappeared (2000)
Carex cespitosa	C4	C3	3	2	1	0	disappeared (2011)
Carex disticha	C4	C3	1	0	0	0	extinct (1907)
Carex flava	C4	not	1	2	4	5	increase
Carex hartmanii	C4	C4	-	2	2	0	disappeared (2010)
Carex paniculata	C4	C2	-	1	0	1	disappeared (2004)
Carex pseudocyperus	C4	C3	-	1	2	1	little fluctuations
Comarum palustre	C4	C4	ab.	49	34	18	decrease
Eleocharis mamillata	C4	C4	1	9	6	3	fluctuations
Eleocharis ovata	C4	C4	11	44	27	16	decrease
Epilobium palustre	C4	C4	21	14	29	12	fluctuations or decrease
Galium boreale	C4	C3	1	0	0	0	extinct (1910)
Limosella aquatica	C4	C3	10	8	26	9	fluctuations
Listera ovata	C4	C3	-	5	3	3	decrease
Myosotis caespitosa	C4	C4	-	6	16	8	fluctuations
Salix pentandra	C4	C4	-	10	6	6	decrease
Scorzonera humilis	C4	C4	2	0	0	0	extinct (1911)
Scrophularia umbrosa	C4	C2	ab.	0	0	0	extinct (1892)
Schoenoplectus lacustris	C4	C3	ab.	5	3	1	decrease

Taraxacum nordstedtii	C4	C3	5	14	6	4	fluctuations
Tephroseris crispa	C4	C4	1	29	33	22	increase
Trientalis europaea	C4	C3	2	7	15	13	increase
Utricularia australis	C4	C3	4	9	9	5	decrease
Valeriana dioica	C4	C4	ab.	63	38	31	decrease
Valeriana excelsa	C4	not	-	1	7	5	decrease
Veronica scutellata	C4	C4	3	28	29	28	increase
Cirsium heterophyllum	not	C4	2	5	3	2	decrease
Cirsium rivulare	not	C4	2	6	3	3	little fluctuations

Explanatory notes: "RL CZ" threat category from Red List of vascular plants of Czech republic, "RL V" threat category from Red List of vascular plants of Vysočina region, "extinct" certain extinction, long-term missing and recent survival very unlikely, "disappeared" missing, recent extinction with high probability, but contrary to the previous point the plant species is less conspicuous and few individuals can survive hidden in vegetation or seed bank and yet can be found again in case of more suitable conditions or after restoration activity, "uncertain" species with problematic determination and uncertain historical occurrence, "non-native" planted or unintentional dispersion from near culture, "ab." abundant, "-"no record, "0" no historical record, or no confirmation during field survey

The largest disappearance or extinction of species is evident in the aquatic macrophyte vegetation of oligotrophic waters and from fens and fen meadows. As the area is struggling with the supply of nutrients from agricultural activities and intensive fish production, the habitat is being lost together with the related specific flora. Fens in the area are rare and degraded due to drainage. In the case of alluvial meadows and transitional mires, no threatened plant species occurred here due to the significant degradation of these habitats.

Figure 2 Habitats of occurrence of recorded species. Color-coded are species that have become extinct in a particular habitat. Recent occurrences of species are shown in grey.



In long-term studies of wetland habitats, changes of vegetation have been recorded, characterized mainly by a decrease in the abundance of many species. Today's species composition is not in balance with environmental conditions and therefore the extinction of some species can be expected (Koch and Jurasinski 2014). Current surveys show extinction preferentially in small populations or small localities, while larger ones remain (Deane et al. 2017). In our studied area there are mostly smaller localities of wetland habitats.

For most species, the main reason for extinction is the loss of habitat, or environmental condition change. Global influences such as climate change may be the reason for population decline of some sensitive species. For example, we recorded a significant decrease in the population of *Pedicularis sylvatica* after the dry period between years 2014–2019. The related species *Pedicularis longiflora* is expected to decline in China due to climate change (Cao et al. 2020).

The data contained in the PLADIAS database are less numerous than the data in the nature protection finding database of the Czech Republic (AOPK 2021). Without own field research, these