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Minor Treatments Can Play a Significant Role in Preserving Natural Habitats and Protected Species on the Shore of a Central European Lake

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Abstract: Semi-natural grasslands were previously established through traditional land use and maintained by active management, but their extension nowadays is declining rapidly, particularly in areas that also have tourism potential. In parallel, the conservation value of the remaining areas is increasing. The shore of Lake Balaton is a particularly good example, as Lake Balaton is an area highly affected by tourism, yet there have been valuable habitats able to survive and provide refuge for many vulnerable, protected species. Fortunately, we have reliable information about the vegetation of the area from two decades ago. Comparing these data with our recent surveys we investigated the changes in habitats and the distribution of protected plant species in connection with the active conservation treatments such as grazing or cutting. Our results show that in areas where treatments are still ongoing, protected plant species are more likely to survive, or even other species can appear, which is in clear contrast with conditions experienced in abandoned areas, where at least seven protected species have disappeared. According to our results, minor, but appropriately chosen and well-executed management interventions, can help in the long-term maintenance of species-rich habitats and improving the conservation status of threatened species.

Keywords: nature conservation; grassland management; habitat loss; semi-natural habitats; reed bed

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1. Introduction

Most semi-natural habitats in Europe have been traditionally maintained by anthropogenic activities, such as grazing or mowing [1–7]. Since the 1950s grassland abandonment became a general phenomenon in Europe. The factors driving the abandonment were complex but mainly associated with the increasing agricultural intensification, along with socio-economic and political changes [8]. This process was particularly pronounced in areas with considerable tourism potentials [9,10]. After recognizing the negative effects of abandonment on wildlife in the 1980s, the restoration of grasslands began primarily for nature conservation purposes [11,12].

Lake Balaton is the largest lake in Central Europe. In surrounding areas, and on its shores, grasslands had great importance until the 1950s [13]. With the development of the bathing culture, which emerged at the beginning of the 20th century, livelihood from agriculture was replaced by tourism. This led to the establishment of beaches, harbours, and recreational areas in places of reed [*Phragmites australis* (Cav.) Trin. ex Steud.] beds and grasslands. Livestock farming in coastal settlements was restricted from 1969 by law to support the expansion of tourism, thus coastal grazing was almost completely abolished [14].

The shore of Lake Balaton at Fenékpuszta was a rare exception to this as cattle were grazing there until 1983, therefore a ~3 km long coastline remained in a close-to-nature

state with wet grasslands and wide reed beds connected to them. The natural value of the area was first recognized by ornithologists and a bird-ringing station was established in the area in 1985. They also began the systematic investigation of the botanical value and began to preserve this with minor conservation treatments from 1987 [15]. The most thorough management took place between 1999 and 2002, when 5–28 cattle were grazing in the area [16]. Detailed monitoring and documentation of the botanical value were carried out during this period [15,17]. Later, the intensity and the extent of grazing decreased and became less documented, but in still ongoing to this day.

Our aim was to assess the current natural condition of the area and to summarize the changes in habitats and the distribution of protected species occurring since 2002, in connection with the treatments carried out after. We attempted to identify what changes could be detected in the vegetation and plant species distribution of the treated and untreated areas after 18 years and what conditions are currently characterizing them. We seek to demonstrate that even in an area highly affected by tourism, botanical value and semi-natural habitats could be preserved in the long-term with minor treatments only.

2. Materials and Methods

2.1. Study Area

The study area is located on the western coast of Lake Balaton near the town of Keszthely (Hungary) (Figure 1). The examined area is 3 km long and its width ranges between 320–820 m, covering 130 hectares altogether. It is bordered by the stream Csókakői (North), by River Zala (South), by road number 71 (West), and by Lake Balaton (East). Most of the study area is part of the Natura 2000 site Balaton (N2K HUBF30002), which is a Special Area of Conservation and a Special Protected Area. Despite the intensive use of Lake Balaton for touristic purposes, the shores of the lake at Fenékpuszta remained in a relatively natural state [16].

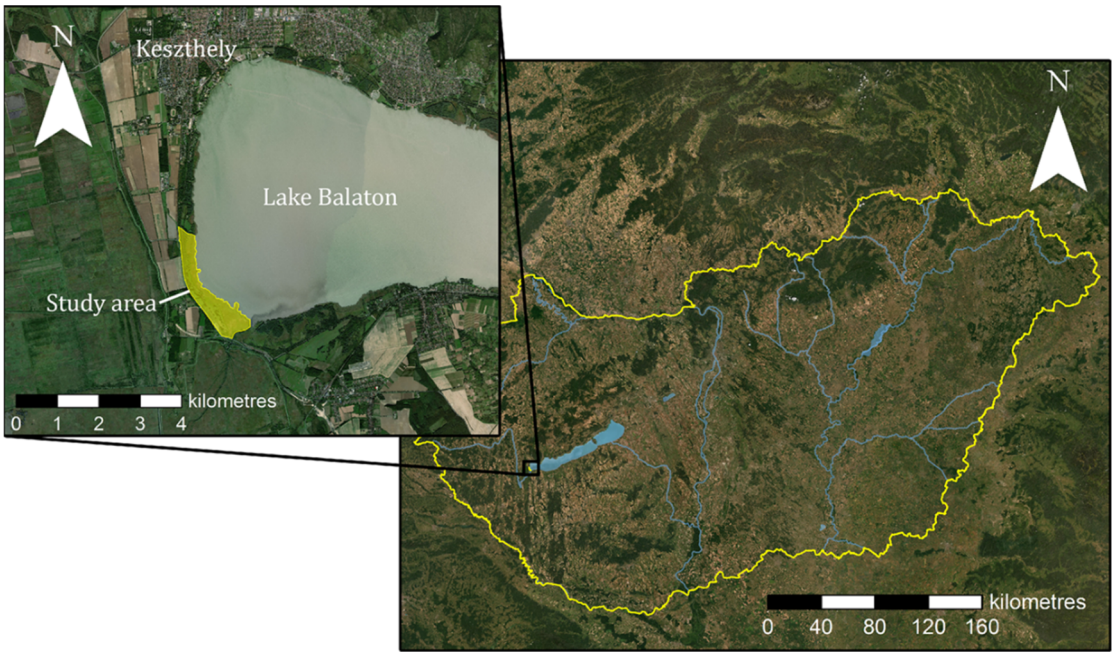
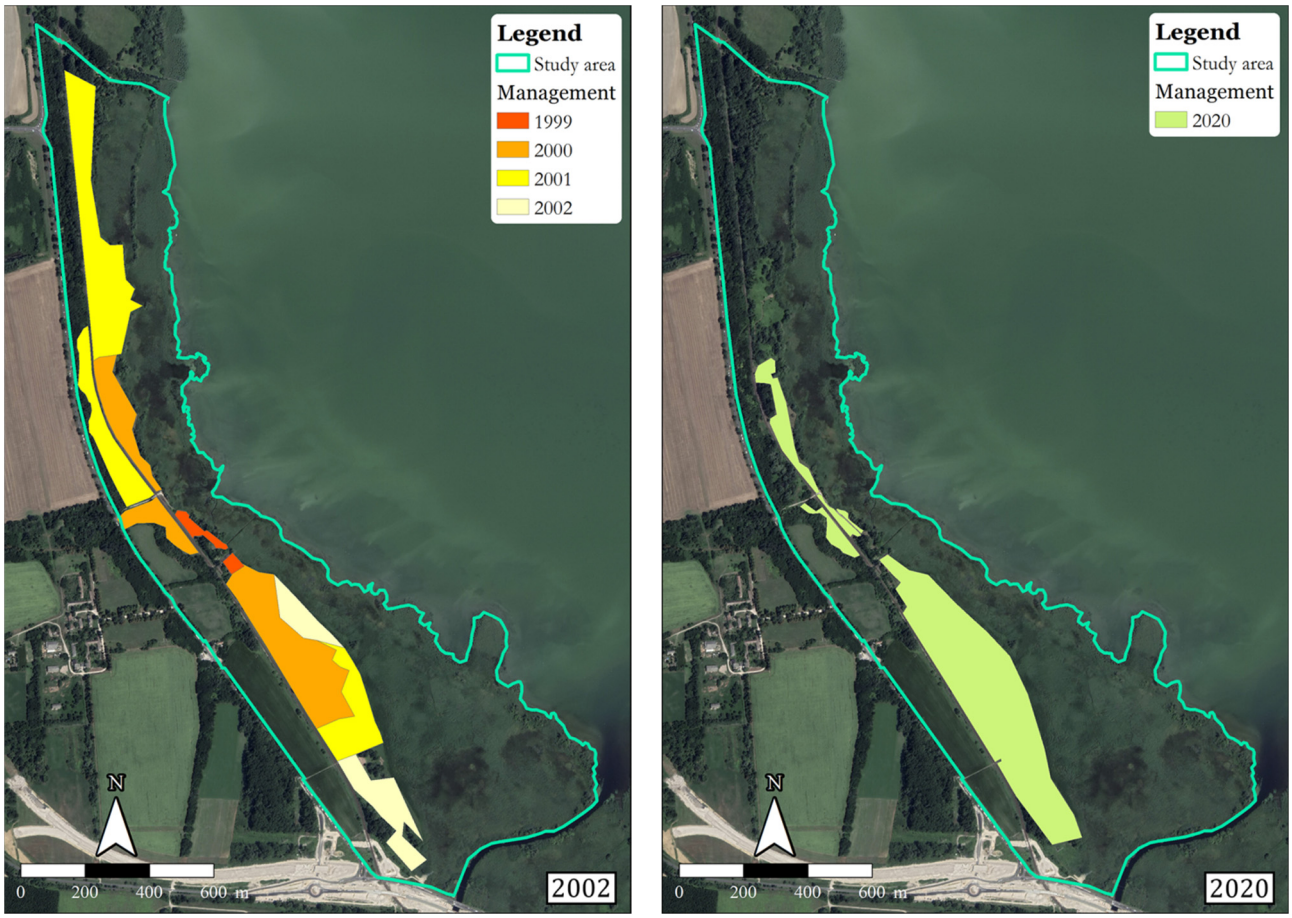


Figure 1. Location of the study area.

Zentai [15] offered us a detailed description of the implementation of conservation management in Fenékpuszta between 1999 and 2002. The shore of Lake Balaton at Fenékpuszta was a traditional pasture area for centuries but the grazing ended in 1983 [17]. After the years of abandonment, grazing was recommenced in 1999 with five cattle at the middle part of the study area. In the following years, the grazed area gradually

increased, and by 2002 the total study area had become grazed with the exception of the reed beds.

The size of the cattle herd reached its peak in 2001 with a total of 28 animals [16], after that, their number rapidly decreased, followed by shrinkage of the managed area and the focus of the grazing shifted to the southern parts of the area (Figure 2). In 2020, the northern part of the area had not received treatment for at least 10 years; the central part is mowed once a year and after mowing a very light after-grass grazing takes place there, while the southern part has a constant presence of cattle, which trample and graze the area all year round (Figure 2).



(**a**) (**b**)

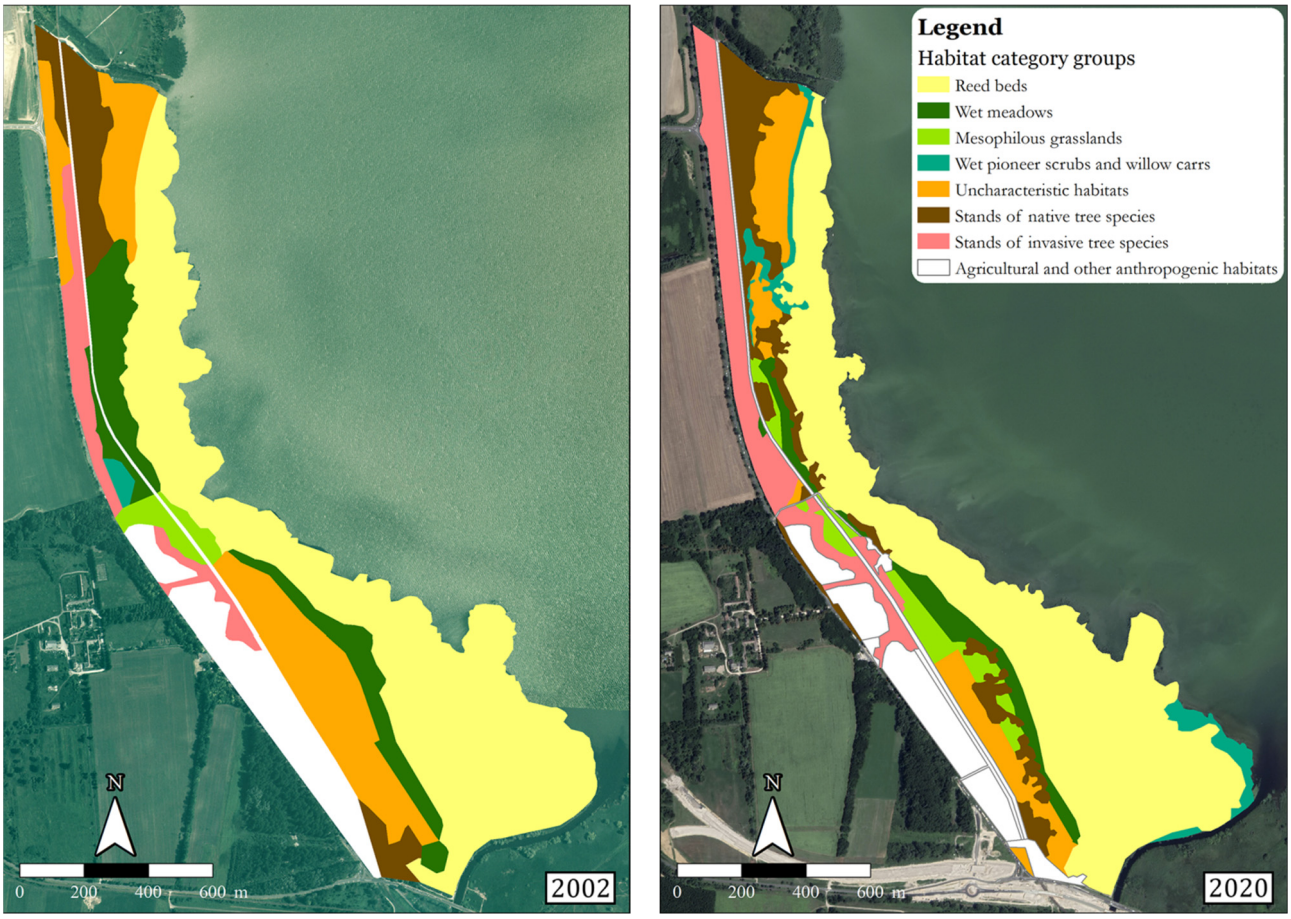
Figure 2. Areas under conservation management (cutting and grazing) in four subsequent years from 1999 to 2002 (**a**) and in 2020 (**b**).

The overall size of the study area decreased by almost 6 hectares between 2002 and 2020 as a result of an average 20-m retreat of the reed beds on the 3 km coastline (Table 1, Figure 3).

To compare the current vegetation and distribution of protected plant species with previous data, we digitalized the habitat and protected species distribution maps of a comprehensive study from 2002 [15] using satellite images (Google Earth) and aerial photographs (Lechner Nonprofit Ltd., Budapest, Hungary), which have become available for public use since then.

Table 1. Area changes of the habitat type categories between 2002 and 2020.

Habitat Type	Area (ha) in 2002	Area (ha) in 2020	Difference (ha)	Difference (%)
Reed beds	63.66	53.76	−9.90	−15.56
Wet meadows	14.80	12.77	−2.03	−13.75
Mesophilous grasslands	2.85	4.94	2.09	73.35
Wet pioneer scrubs and willow carrs	0.80	4.64	3.84	482.42
Uncharacteristic habitats	23.95	12.18	−11.77	−49.15
Stands of native tree species	9.78	13.85	4.07	41.66
Stands of invasive tree species	6.42	13.84	7.42	115.59
Agricultural and other antropogenic habitats	15.02	15.39	0.30	1.99
Total	137.26	131.28	−5.98	−4.36



(**a**) (**b**)

Figure 3. Habitat category groups in 2002 (**a**) and 2020 (**b**).

2.2. Field Work

Identification of the habitats was carried out during the vegetation periods of years 2019 and 2020, which included thorough surveying of the area on land by foot and also by water (with canoe). During these surveys, we collected data on protected plant species by recording GPS coordinates on each occurrence and counting individuals, or in the case of clonal species, such as *Acorus calamus* L. and *Nymphaea alba* L., we estimated the area occupied by each population. The extension and the way of the current management were also mapped during the fieldwork (Figure 2). In 2020, on the southern part of the area, 20 cattle were grazing, and the northern part of the area was cut once a year during summer. The grazing usually started in late April and ended in October.

2.3. Protected Species

Most protected species in the study area are characteristic to sedge- and reed communities. These habitats, although relatively common along the shoreline of Lake Balaton, are mostly in a poor condition and lacking rare species. In 2002, an overall 23 species were recorded in the study area which are protected by law. Among these species, only *Cirsium brachycephalum* Jur. is on the 1992 Habitats Directive Annex II list. In 2020, the number of protected species were decreased to 17, most of which belonged to the family Orchidaceae. Among the protected species, some have greater local importance, like *Hydrocotyle* vulgaris L., as almost all of its occurrences in Hungary are limited to the shoreline of Lake Balaton. *Samolus valerandi* L., *Urtica kioviensis* Rogow., and *Acorus calamus* have considerable portions of their total national population occurring near Lake Balaton as well. Other species, such as *Ranunculus lingua* L. and *Equisetum variegatum* Schleich., are rare and very sporadic across the country, therefore their occurrences at Fenékpuszta have regional importance.

2.4. Data Processing

First, we classified the vegetation data (habitat descriptions of [15] and the current field data as well) into habitat classes, based on the species pool and structure according to the General National Habitat Classification System of Hungary (Á-NÉR) [18]. Then, we merged the similar classes to the generalized habitat categories for better visualization (Table 1). We also plotted the recorded data of the protected plant species occurrences and areas affected by management, according to [15] and current data as well.

3. Results

3.1. Changes in Habitats and Vegetation

Reed beds were that habitat type category which area decreased the most among the categories. This is caused by the die-back from the direction of the open water mentioned earlier, and to a lesser extent by the area loss caused by shrub encroachment and afforestation on land (Table 2).

Table 2. Habitat categories of Á-NÉR occurring in the area and our categorization of them.

Generalized Habitat Category	Á-NÉR/Natura Habitat Category
Reed beds	Eu- and mesotrophic reed and Typha beds (B1a)
Wet meadows	Tussock sedge communities (B4) Non-tussock tall-sedge beds (B5) Rich fens (D1)/7230 Alkaline fens Mesotrophic wet meadows (D34)/ Alluvial meadows of river valleys of the *Cnidion dubii* (6440)
Mesophilous meadows	Arrhenatherum hay meadows (E1)
Wet pioneer scrubs and willow carrs	Willow carrs (J1a)/Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (91E0) Wet and mesic pioneer scrub (P2a)
Uncharacteristic habitats	Uncharacteristic wetlands (OA) Uncharacteristic mesic grasslands (OB) Uncharacteristic dry and semi-dry grasslands (OC) Stands of invasive forbs (OD)
Stands of native tree species	Scattered native trees or narrow tree lines (RA) Uncharacteristic or pioneer softwood forests (RB)
Stands of invasive tree species	Spontaneous stands of non-native tree species (S6)
Agricultural and other anthropogenic habitats	Annual intensive arable fields (T1) Farms (U10) Roads and railroads (U11)

A noticeable decrease in the overall area (−13%) of the wet meadows was also detected (Table 2, Figure 3). The northern part of the study area where the grazing was abandoned on the wet meadows in 2002, had become densely covered by invasive tree species and by native tree and shrub species by 2020 (Figure 4). The highest situated part of the wet meadows, where the grazing management is still ongoing became the mesophilous meadows with the dominance of *Arrhenatherum elatius* (L.) and *Helictotrichon pubescens* (Huds.).

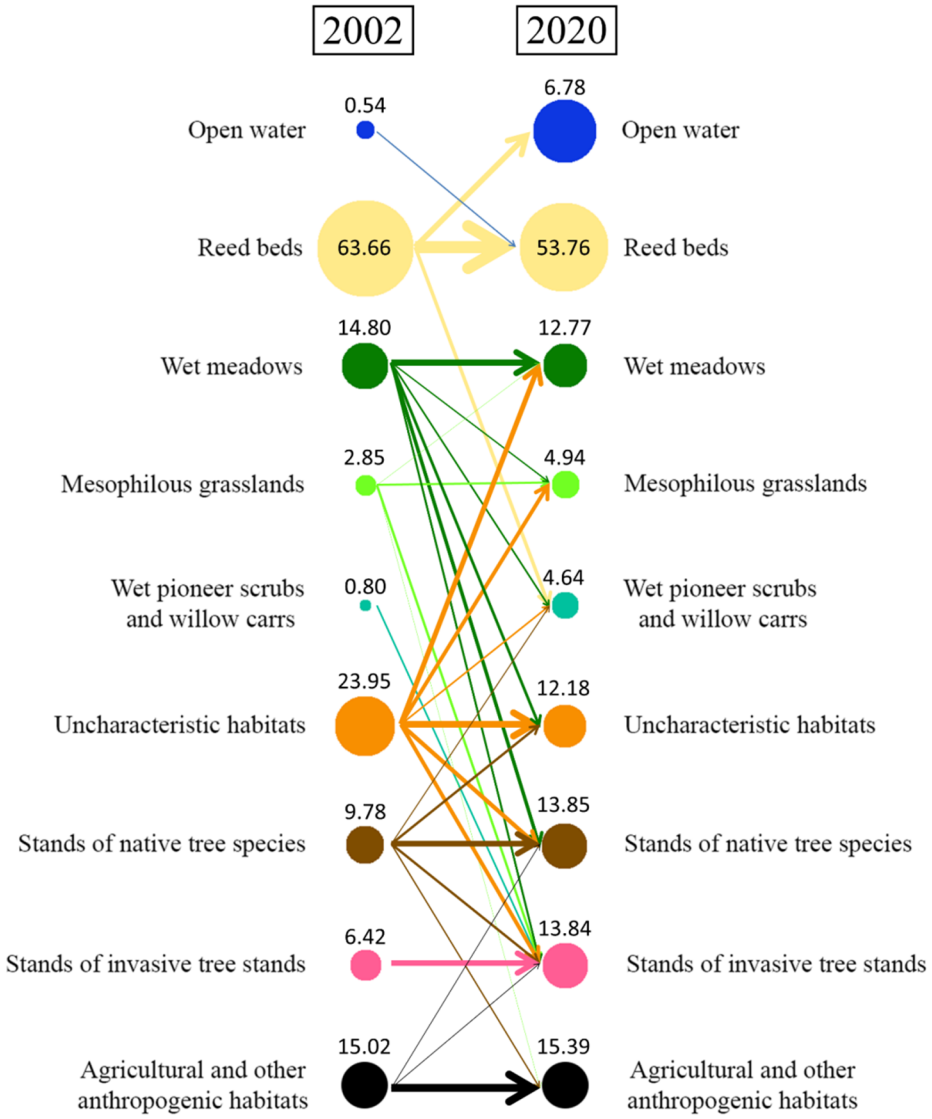


Figure 4. Transitions between habitat category groups in hectares and in percentage of the former area of the original habitat category group.

The advance of woody stands (of both invasive and native species) is also noticeable in the whole area. These habitats had the largest increase in their total area, currently covering more than twice their former area described by an earlier study [15]. Unfortunately, these stands are mostly dominated by invasive alien tree species, such as *Robinia pseudoacacia* L. and *Fraxinus pennsylvanica* Marshall, whereas the most common native tree species in the study area, *Populus* spp. and *Salix alba* L., are present sporadically in these forests or forming small groves.

3.2. Presence and Distribution of the Protected Species

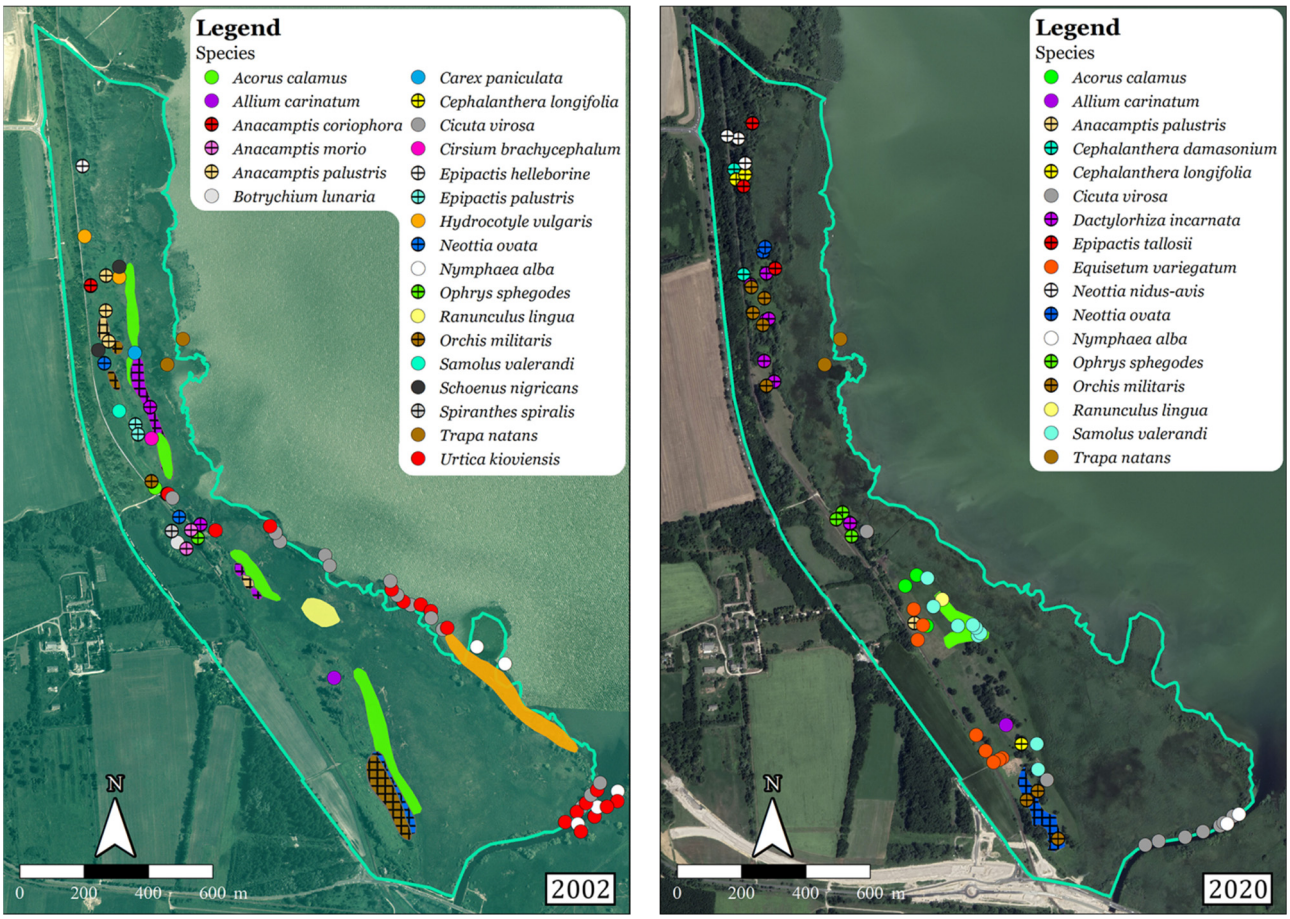
During the 2002 survey, 23 different protected plant species were described from the area. In the year 2020, we found 17 protected plant species (Table 3), from which four species [*Epipactis tallosii* A. Molnár and Robatsch, *Cephalanthera damasonium* (Mill.) Druce, *Equisetum variegatum*, *Neottia nidus-avis* (L.) Rich] were not described previously from the area (Figure 5). Some of the disappeared species were present earlier only by a few individuals: *Anacamptis coriophora* (L.) R.M. Bateman, Pridgeon and M.W. Chase, *Botrychium lunaria* (L.) Sw., *Carex paniculata* L., *Cirsium brachycephalum*, *Epipactis helleborine* (L.) Crantz, *Spiranthes spiralis* (L.) Chevall., but in other cases, considerable populations vanished or we were not able to find them: *Anacamptis morio* (L.) R.M. Bateman, Pridgeon and M.W. Chase, *Epipactis palustris* (L.) Crantz, *Hydrocotyle vulgaris*, *Schoenus nigricans* L., *Urtica kioviensis*.

The majority of the newly appeared species, like *Epipactis tallosii*, *Cephalanthera damasonium*, and *Neottia nidus-avis*, were found with a few individuals under native tree stands. Substantial populations of *Equisetum variegatum* were observed in the southern wet meadow area which is currently grazed.

The 13 species which were observed in the area during both surveys had some changes in their distribution as well.

Table 3. The number of localities and individuals of protected plant species in 2002 and 2020.

Species	Number of Localities		Number of Individuals	
	2002	**2020**	**2002**	**2020**
Acorus calamus	many	18	~1500 m^2	~900 m^2
Allium carinatum	1	1	50–80	45
Anacamptis coriophora	1	–	7	–
Anacamptis morio	1	–	107	–
Anacamptis palustris	2	1	120–140	10
Botrychium lunaria	1	–	2	–
Carex paniculata	1	–	3–5	–
Cephalanthera damasonium	–	2	–	5
Cephalanthera longifolia	3	5	6	10
Cicuta virosa	several	10	few hundred	~100
Cirsium brachycephalum	1	–	10	–
Dactylorhiza incarnata	several	7	400–450	16
Epipactis helleborine	1	–	2	–
Epipactis palustris	few	–	210–250	–
Epipactis tallosii	–	5	–	37
Equisetum variegatum	–	8	–	16 m^2
Hydrocotyle vulgaris	1	–	50 m^2	–
Neottia nidus-avis	–	4	–	9
Neottia ovata	3	12	1000–2000	1536
Nymphaea alba	2	2	500 m^2	~40 m^2
Ophrys sphegodes	1	1	120	150
Orchis militaris	4	9	250–350	112
Ranunculus lingua	4	1	110–165	1
Samolus valerandi	1	9	16	10–15 m^2
Schoenus nigricans	–	–	~200 m^2	–
Spiranthes spiralis	1	–	1	–
Trapa natans	2	1	~200 m^2	
Urtica kioviensis	several	–	few hundred	–



(**a**) (**b**)

Figure 5. Habitat category groups in 2002 (**a**) and 2020 (**b**).

There are species in which populations declined considerably. *Acorus calamus* disappeared from the northern area and also from most of its former localities in the southern area. In 2020, its single large population was located on the grazed wet meadows on the southern part. Large colonies of *Nymphaea alba* were considerably reduced in their extent. *Ranunculus lingua* almost disappeared, and in the last vegetation period only one flowering plant was seen. Among the orchids, populations of *Anacamptis palustris* (Jacq.) R.M. Bateman, Pridgeon and M.W. Chase and *Dactylorhiza incarnata* (L.) Soó suffered the greatest reduction in size, both represented by only 10–20 flowering plants in the area. Reduction in the number of individuals was also apparent in the case of *Orchis militaris* L., its population has decreased to the third of its former size.

Other species retained their populations to roughly the same extent and number. Populations of *Cicuta virosa* L. and *Allium carinatum* L. had not changed substantially, not in location, nor in the number of individuals. The situation is similar in the case of two orchid species, *Ophrys sphegodes* Mill. and *Neottia ovata* (L.) Bluff and Fingerh.

Some species significantly increased in the number of individuals. Former localities of *Cephalanthera longifolia* (L.) Fritsch are still present in the northern part, and the species appeared in the southern area as well. We recorded new occurrences of *Neottia ovata* in the northern area beside the large population in the southern part. The former single small population of *Samolus valerandi* in the northern area went extinct, but the species had appeared in several locations in the southern wet meadows area, mostly on the edges of the grazed area.

4. Discussion

The dieback of the reed beds—which refers to an average 20 m retreat in our case—is a well-known and general problem at Lake Balaton [19]. Although the reeds spread over many other habitats along the coast, these stands cannot be recognized as autochthonous reed beds, as they do not have the species pool, nor the structure characteristic of such stands, and remnants of the original habitat are still present under the newly formed reed cover. As a result, the overall decrease in the size of the reed bed is even greater than the retreat from the direction of the open water, which equals 9.9 hectares.

In the northern areas, a short period of grazing (1999–2003) opened up the structure to the vegetation resulting in a relatively large area of continuous wet meadows [15]. The loss of that habitat type after the abandonment is a consequence of intensive scrubbing and the advance of invasive species [20]. These wet meadows corresponded to the Natura 2000 habitat category '6440 Alluvial meadows of river valleys of the Cnidion dubii', which also indicates that it is a particularly valuable habitat type.

Wet meadows are also threatened by drought in connection with climate change, and large areas of this habitat type turning into mesophilous meadows at the highest situated areas. Despite the rise in the water level of Lake Balaton after 2016, we did not experience this transformation in the opposite direction between these habitat category groups, and the number of helo- and hydrophytes have been reduced, to which the abandonment of management may have synergetic contributions.

On the other hand, grazing is still actively going on in the southern part, which has allowed the transformation of formerly degraded, uncharacteristic habitats to valuable meadows like other areas of Pannonian vegetation [21].

In the central areas due to the targeted conservation management (which is optimized to maintain the population of *Ophrys sphegodes*) this area has remained relatively intact.

Seven species, *Acorus calamus*, *Schoenus nigricans*, *Anacamptis palustris*, *Hydrocotyle vulgaris*, *Anacamptis coriophora*, *Epipactis palustris,* and *Cirsium brachycephalum* have all disappeared from the northern parts in connection with the degradation of the former wet meadows. From all the protected species occurring in the area, only several orchid species are still present in the northern part, as these species can survive for a long time even in unfavorable circumstances [22,23], but their numbers have also decreased significantly.

Although the effect of the water level rise at Lake Balaton was not perceptible in the meadows, it is possible that the high water level was the reason why we were unable to reach the former localities of *Carex paniculata* and *Urtica kioviensis* at the reed beds [19].

Species connected to forest habitats, like *Cephalanthera damasonium* and *Neottia nidus-avis,* appeared in the northern part, most likely because of the spontaneous afforestation of the initial habitats.

As one of the new *Epipactis tallosii* occurrences is close to the position of the single former *Epipactis helleborine* locality, and we could not find the latter species in the area, we suppose that this new taxon for the area is just a result of a recent change in taxonomy. *Epipactis tallosii* was described in 1997 [24], and by the turn of the millennium, almost all individuals of *E. tallosii* have still been identified as *E. helleborine*.

At the central part of the study area, a major proportion of the mesophilic meadows were afforested by invasive tree species, which finally led to the disappearance of *Botrychium lunaria*, *Anacamptis morio,* and *Spiranthes spiralis*.

On the actively grazed field of the southern part, we detected some areas covered by *Equisetum variegatum,* which this species had not been reported earlier from the area. We suspect that this was only an overlooking as it is a very small and inconspicuous plant. The number of individuals of *Samolus valerandi* has increased significantly and its occurrences have shifted from the northern parts to the southern region. This species clearly found its living conditions as a result of grazing, typically below the electric fence on the edges of grazed areas.

In 2020, most former patches of *Acorus calamus* had already disappeared in the whole area, but a new one appeared in the currently grazed area. Cattle typically do not con-

sume this species, so it can spread over actively grazed areas. On the western part, the sizeable patch of *Neottia ovata* and the population of *Orchis militaris* are also surviving and their numbers remained roughly the same, despite some of their occurrences outside the managed area.

Overall, our results show that in contrast with the northern part, where the conservational management almost entirely ceased, and many protected species that have disappeared, the southern grazed part offered suitable habitat for them.

5. Conclusions

Our results confirm the results of previous research on wet grasslands in which a complete lack of treatments can lead to habitat depopulation and species decline or even complete extinction [20,25], but according to previous studies, this process might be reversible [2,26]. Therefore, we need to strive for maintaining some appropriate treatment in as large of an area as possible, preferably by grazing, which can be replaced with mowing on areas where grazing is not feasible. This could prevent the loss of biodiversity by maintaining the species pool and preventing the advance of invasive alien species.

The conservation of ecologically valuable coastal reeds must also be given serious emphasis, as their decline in the long-term could mean a serious threat to the ecological status of the lake and even to its use for tourism [19,27].

The shore of Lake Balaton in Fenékpuszta is a good example of the fact that high species richness can occur even in an area that is currently primarily used for touristic purposes. Fortunately, near our sample area, there are other high-diversity habitat patches over the other side of River Zala. We should ensure their permanent connection in order to provide better chances for species to survive. These habitats serve as ecological corridors to larger natural habitats, namely to the Kis-Balaton [28].

Even in development plans determining utilization of the study area, the primary goal should be the preservation of biodiversity. The coast of Lake Balaton at Fenékpuszta could be a great target for eco-tourism and can play an important role in environmental education as well, which has a long tradition in the area [29,30]. It is also worth considering organizing botanical trips besides the bird-ringing programs, but we must not forget to continue the extensive use of the grassland, which can be well aligned with the basic goals of the establishment of the Natura 2000 network. We would also suggest that in the future the overall area of treatments should be increased at least to their previous largest extent (in 2002).

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