FLORA, CONSERVATION VALUE AND ECOLOGICAL POTENTIAL OF THE CER BOUNDARY CHANNEL (ŠABAC, SERBIA)

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Abstract
Channels can represent significant areas of plant diversity in urban ecosystems. The aim of this paper is to determine recent flora of aquatic macrophytes as well as determining the conservation values and ecological potential based on the macrophyte in one part of the Cer boundary channel. Field research conducted during the summer of 2020 of total lenghth of 5km upstream from the estuary. Macrophute data was collected according to the standard UKTAG LEAFPACS method. A total of 13 macrophyte species were recorded out of which three species are on the list of endangered and protected species. The ecological potential of the researched part of the channel flow was graded as good and better. Based on the results can conclude that the Cer boundary channel represents an optimal habitat for the development of aquatic vegetation and thus other hydrobionts, as well as for the development of other rare and endangered types of macrophytes. Results confirm the fact that artificial water bodies can play a significant role in biodiversity conservation in urban ecosystems.

Introduction
Artificial water bodies, such as channels, can represent significant areas of plant diversity in urban ecosystems [1]. However, data on flora, species composition, distribution and the numbers of species are rarely published for artificial and modified water bodies [1]. Aquatic macrophytes are an important indicator during monitoring of fresh water ecosystems, whereas macrophyte vegetation represent habitats for development of other groups of aquatic organisms [2, 3]. Macrophytes represent a group of water photosynthesis active organisms (plants) that can be seen with the naked eye [4].
Based on the EU Water Framework Directive (WFD) [5], as well as the national Rulebook on the parameters of ecological and chemical status of surface waters and parameters of chemical and quantitative status of underground waters [6], macrophytes represent a significant biological indicator of quality during grading of the ecological status of natural, i.e. ecological potential of artificial and significantly modified water bodies.
For the estimation of the conservation value of the ecosystem different physical or biological criteria are most often used [7]. Biological criteria are based on the presence of species categorised according to the IUCN Red list [8], or according to the national categorisation of endangered or protected species [9, 10].
Considering everything aforementioned the aim of this paper is to determine the recent flora of aquatic macrophytes in a part of the Cer boundary channel, as well as determining the conservational value and ecological potential based upon the macrophytes flora.

Experimental

The Cer boundary channel is the largest artificial water course on the territory of the town of Šabac, with a total length of 30km, and it flows into the river Sava. The research was carried out during the summer of 2020 at a part of the river flow through the town of Šabac, with a total length of 5 km upstream from the estuary (Figure 1).

Data on the macrophyte vegetation was gathered at approximately 1000 m according to the standard UKTAG LEAFPACS method [11]. The mentioned method is based on choosing a sector along the shoreline approximately of 100 m length. At every 20 m within the sector vegetation records of 1 - 9 m^2 area are taken at depths of 0.25, 0.5, 0.75 and below 0.75 m. At the middle of each sector vegetational records are taken in transect at every 0,5 m of depth increase, beginning with 1 m upto the depth at which the aquatic vegetation spreads [11]. At five sectors (K1 – K5) a total of 100 vegetation records were made based on the described methodology (Figure 1).

Vegetational data was summarized by LEAFPACS sectors, and then the species relative cover (SRC), species richness (SR). The number of protected (NP) and strictly protected (NSP) species is determined according to the Rulebook on declaration and protection strictly protected and protected wild species of plants, animals and fungi [9], after which the relative cover of protected and strictly protected species was calculated. Shannon–Weaver index of diversity (SW) was calculated in CanoDraw software ver. 4.5 [13].

Figure 1 – Researched part of Cer parameter channel on the territory of the town of Šabac with locations of LEFPACS sector (K1 – K5)

In this paper the conservatory value is shown based on the presence and relative cover of strictly protected and protected species (RCPS) [12, 9]. The calculated macrophyte indices NP and NSP give an insight into the conservation value of each LEAFPACS sector.

The ecological potential is determined based on the macrophyte indices SR and SW, according to the Rulebook on parameters of ecological and chemical status of surface waters and parameters of chemical and quantitative status of underground waters [6].

All aforementioned macrophyte indices (SR, SRC, SW, NP, NSP) are summarized at the scale of the entire researched section of the Cer boundary channel.

Results and discussion

On five LEAFPACS sectors a total of 13 macrophyte species were detected (Table 1). In most cases the channels due to their uniform morphology are distinguished by poor species richness and diversity [1] however the results of this paper confirm the opposite thesis, that artificial water bodies can represent centres of floral diversity [14]. According to the results of the study conducted on nine channels, marked as centres of diversity of aquatic macrophytes in Slovakia, the number of species were in range from 11 to 62 [1]. In this research the species with the highest relative cover were: *Lemna minor* L., *Sparganium erectum* L., *Ceratophyllum demersum* L. i *Nuphar lutea* (L.) Sm. The beforementioned species, especially *Lemna minor* and *Ceratophyllum demersum* represent very common findings in eutrophic slow waters, i.e. water ecosystems with high concentrations of nutrients in Europe [1, 15]. Such species findings were recorded in natural water bodies of similar hydromorphological characteristics on the territory of Eastern and Central Europe [15]. In numerous research it was determined that in the channels, due to the ecosystem succession and the process of terrestrification, the most dominant and frequent heliophytes are *Phragmites australis* (Cav.) Trin. Ex and *Typha latifolia* L. [1], as is the case in this research. Namely, by visual monitoring of the entire research area it was determined that the reed and cattail are the most frequent species with the highest cover between LEAFPACS sectors, as well as that those are parts of channels that dried out. On the territory of Serbia, the plant communities with domination of *Typha latifolia* and *Phragmites australis* represent a transition between aquatic and terrestrial vegetation, they are tolerant to a long period of drying, increased salinity and water pollution [16].

Among those identified, three species have conservation value. *Nuphar lutea* has the status of a strictly protected species and is also one of the species with the highest relative cover (12.15%), while *Iris pseudacorus* L. and *Potamogeton nodosus* Poiret. have the status of protected species on the territory of Serbia [9]. At least one protected or strictly protected species was recorded in each sector, which indicates the conservation importance of the investigated section. A large number of protected and endangered species have been recorded in different types of artificial water bodies on the territory of Europe, which places them in the group of ecosystems of conservation importance [1, 17]. The relative cover of protected and strictly protected species at the sector level was in range between 5.26 and 33.37%, while at the level of the entire investigated section it was 18.22%.

The number of species per sector varied between 7 – 9 which indicates a moderate ecological potential (III) of each LEAFPACS sector. SW was within the limits of 1.60 - 1.83, which indicates a good and better (II) ecological potential based on the national Rulebook [6] (Table 2). At the level of the entire investigated section, the ecological potential of the Cer boundary channel can be rated as good or better (II).

Table 1 – Relative cover of species (%) and quantitative indices of macrophyte flora at the scale of individual LEAFPACS sectors (K1-K5) and at the scale of the entire investigated section

Species	K1	K2	K3	K4	K5	Entire section
Ceratophyllum demersum L	26.31	16.67		31.91		15.9
Potamogeton nodosus Poiret. PS				6.38		1.4
Sparganium erectum L.	18.42	20.37	17.15	6.38	22.5	16.8
Nuphar lutea (L.) Sm. SPS	2.63	24.11			30	12.15
Sagitaria sagitifolia L.	10.52					1.87
Lemna minor L.	26.31		11.43	38.31	15	17.76
Iris pseudacorus L. PS	2.63	9.26	8.57	2.12		4.67
Botomus umbellatus L.	2.63		2.86	2.12	2.5	1.87
Phragmites australis (Cav.)Trin. Ex.	7.89		34.29	6.38		8.41
Hydrocharis morsus-ranae L.	2.63	16.67				4.67
Typha latifolia L.		9.27	17.15	6.38	15	9.35
Typha angustifolia L.		3.51	8.57		7.5	3.74
Glyceria maxima (Hartm.) Holmb.					7.5	1.41
SR	9	7	7	8	7	13
SW	1.83	1.83	1.74	1.60	1.75	2.26
NPS	2	2	1	2	1	3
RCPS (%)	5.26	33.37	8.57	8.5	30	18.22

PS–Protected species on the territory of Serbia [9]
SPS–Strictly protected species on the territory of Serbia [9]

Table 2 – The ecological potential of the Cer boundary channel based on the Rulebook on the parameters of the ecological and chemical status of surface waters and the parameters of the chemical and quantitative status of underground waters [6]

	K1	K2	K3	K4	K5	Entire section
SR	II	II	II	II	II	II
SW	III	III	III	III	III	II
Ecological potential	III	III	III	III	III	II

Conclusion

Based on the results it can be concluded that the Cer boundary channel represents an optimal habitat for the development of aquatic vegetation, based upon that other groups of hydrobionts as well and for the development of other rare and endangered macrophyte species. Also, results confirm the fact that artificial water bodies can have a significant role in biodiversity conservation especially in urban ecosystems. The results of this study could be used during designing and work carried out on the maintenance of the channel and flow regulation.

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