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Preparation of biotic studies of fish and bird indicators for the LifelineMDD Project

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I. Introduction

1.1. Basic information about the research area

The Danube, through its course through Serbia, has several areas that are in the flood zone and as such represent natural units of exceptional importance for the preservation of wild species and the protection of coastal floodplains. In this study, two floodplain pilot areas along the Danube through Serbia were selected, namely the Gornje Podunavlje and Bukinski rit. Both areas are within protected areas. Gornje Podunavlje is part of SRP "Gornje Podunavlje", while Bukinski rit is part of SRP "Karađorđevo".

The special nature reserve "Gornje Podunavlje" received this status in 2001 and covers an area of 19648 hectares, of which over 24% are water surfaces. In addition to this protection status, the Gornje Podunavlje region has several international protection statuses: IBA (Important Bird Area), IPA (Internationally Important Plant Areas), PBA (Prime Butterfly Areas), Ramsar and Emerald Area. Also, since 2017, this area has been an integral part of the "Backo Podunavlje" Biosphere Reserve. The Gornje Podunavlje is a clearly demarcated and compact marsh complex. It is located in the northwestern part of Bačka in the area of the upper course of the Danube through Serbia on its left side from 1367 km to 1433 km, and next to the settlements of Bogojevo, Sonta, Apatin, Kupusina, Bački Monoštor, Bezdan, Kolut and Bački Breg. On the north side, it is bordered by the state border with Hungary, on the east side, it consists of the Bajski Kanal, the DTD canal, the Danube tributary and the defensive embankment. In the south and west towards the Republic of Croatia, the border of the area is the river Danube. As such, the Upper Danube region is the largest marsh complex in Serbia (Figure 1). Within the protected area, 4771.97 hectares are represented by water surfaces, of which 3203.97 ha are old streams of the Danube, tributaries and canals, while 1568 ha is the main course of the Danube. As such, this area is extremely important for the survival and conservation of indigenous fish species. Many species of fish can be found here, which are under a certain type of protection according to both national and international legislation. There are several species of loaches such as weatherfish (*Misgurnus fossilis*) and Spined loach (*Cobitis elongatoides*), Tench (*Tinca tinca*), Crucian carp (*Carassius carassius*), gavčica (*Rhodeus sericeus*) and other carp species. In addition, historically, sturgeon species (*Acipenser gueldenstaedtii* - Danube sturgeon, *Acipenser nudiventris* - Bastard sturgeon, *Acipenser stellatus* - Sterlet) were recorded in the main course of the Danube. All these sturgeon species are critically endangered according to the IUCN categorization, and according to Serban legislation, they are strictly protected species under a permanent ban on fishing.

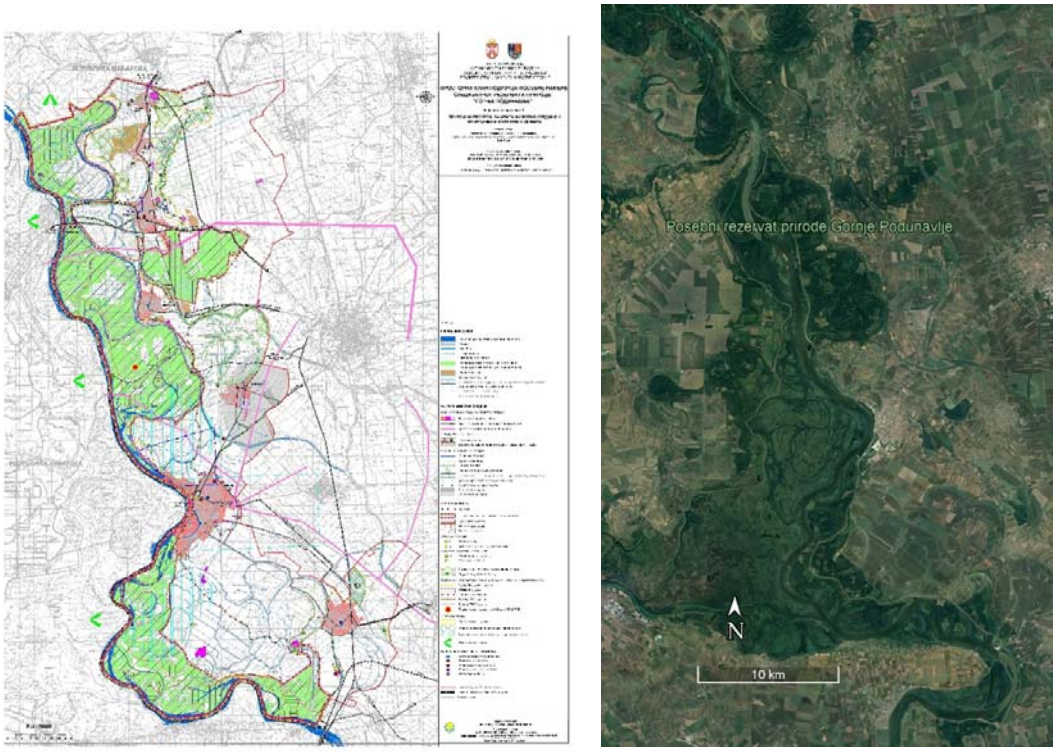

Figure 1. SRP "Gornje Podunavlje", left map (source: JP Institute for Urbanism of Vojvodina), right satellite image (source: Google Earth Pro ver. 7.3.4.8248)

The Karađorđevo Special Nature Reserve was protected in 1997 by a Decree of the Government of the Republic of Serbia, as a natural asset of great importance, in the II category of protection. The protection decree covers Bukinski rit, Guvnište and Vranjak. This area is a preserved marsh complex, which is mostly located in the flood zone of the Danube, in its middle course through Serbia. It spreads in the southwestern part of Backa, on the territory of the municipalities of Bac and Backa Palanka. The position of the Reserve is connected to two rivers, which determined the characteristics of its ecosystems - the Danube and the Mostonga. The protected natural asset encompasses two natural units, which are connected by a small and swampy stream of the Mostonga. According to the special forest-economic basis, these are the management units "Bukinski rit" and "Mostonga". The natural entirety "Bukinski rit" stretches west and northwest of the municipal center of Backa Palanka, and south of the edge of the village of Mladenovo. This unit is located in the alluvial plain, along the left bank of the Danube River, from 1308 km to 1315 km. (Figure 2). As it is in the floodplain of the Danube, it is subject to its high and flood waters. This whole includes the area of Mladenovski or Bukinski rit, in the shape of a horseshoe. Further, it occupies the belt of Šugavica and Donji rit. The total area of SRP "Karađorđevo" is 2,955 ha. In addition to the status of the reserve, the Special Nature Reserve "Karađorđevo", with a tradition of protection longer than 20 years, since 2017 is an integral part of the Biosphere Reserve "Bačko Podunavlje". In the same year, the UNESCO Biosphere Reserve was declared in the wider area of the Danube region in Bačka, from Bački Breg to Bačka Palanka. In addition to this status, Bukinski rit was also declared an IBA (Important Bird Area).

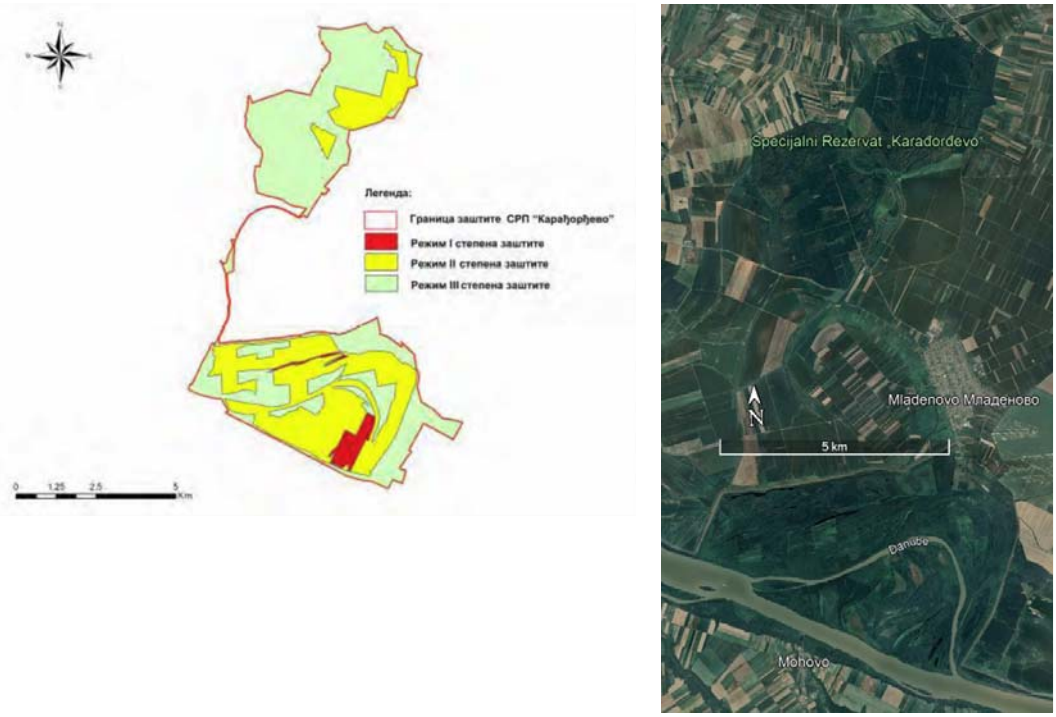

Figure 2 SRP "Karađorđevo" left map (source: Institute for Nature Protection), right right satellite image (source: Google Earth Pro ver. 7.3.4.8248)

1.2 Selected pilot sites

Within each protected pilot area, 3 research sites were selected. The locations were chosen so that they were at a different distance from the main course of the Danube, ie that the degree of connection with the Danube was at a different level. Within the SRP "Gornje Podunavlje", the location closest to the Danube was Sakajtaš, in the middle distance was Mrtva Baračka, while the farthest was the Bajski kanal (Figure 5). Within the SRP "Karađorđevo", the nearest location was Dunavac, in the middle distance was Lovrenac-Račva and the farthest was Lovrenac. All selected locations within the SRP "Karađorđevo" are located in the zone of active flooding, ie they are located between the embankment and the main course of the Danube, while within the SRP " Gornje Podunavlje " this is the case only with the locality Sakajtaš. The Labudnjača pond was part of the planned research sites in the Upper Danube region, but the findings in the field confirmed that parts of the site completely dried up, while the rest was overgrown with endless reeds. Labudnjača and drainage channels were also completely overgrown and inaccessible for sampling or were dry (Figures 3 and 4). Also, one of the planned sampling sites within the SRP "Karađorđevo" was Široka Bara, but at this time of year it was inaccessible by water and it was not possible to transport the boat to it by forest roads (Figure 9). Instead of Široka Bara, the location "Lovrenac - Račva" was chosen, which is physically closest to Široka Bara and actually represents the beginning of the same.

In each pilot area, in addition to 3 sampling sites by distance, 5 different meso-habitats were selected where separate sampling should be performed within each of these sites. Meso-habitats were selected on the basis of available data on the areas themselves and differed slightly

between the two pilot areas. Sample collection is planned in two rounds, during high and during low water levels.

Figure 3. Labudnjača drainage channe

Figure 4. Labudnjača

1.2.1 SRP „Gornje Podunavlje“

U okviru pilot područja Gornje Podunavlje odabrano je 5 tipova mezostaništa i oni su dalje izlistani zajedno sa kodovima koji su korišćeni u istraživanju (dokument u prilogu):

TO) zones with a reed belt along the bank

OD) zones with forest along the bank (most often white willow-*Salix alba*, poplar-*Populus* sp., Ash-*Fraxinus* sp., Acacia-*Amorpha fruticosa* etc.)

PV) water surfaces densely overgrown with submerged or floating vegetation (thrush-*Ceratophylum* sp., White water lily-*Nymphaea alba*, yellow water lily-*Nuphar luteum*, water nut-*Trapa natans*, etc.)

BV) slow-flowing open waters without vegetation

POD) shallow ponds with drainage channels

Figure 5. Locations in the pilot area „Gornje Podunavlje“

1.2.1.1 Sakajtaš

Sakajtaš is a pond located in the undefended zone of the Danube, ie it is located between the embankment in Bezdan and the main course of the Danube. It is about 700 meters away from the Danube by air. This relatively small pond, with an area of about 5 hectares, is periodically replenished with fresh water during higher water levels. At a water level of over 400 cm at the Bezdan water meter station, water begins to fill the supply channels, while at a water level of about 450 cm, water actively enters the Sakajtash from the Danube. (Figs. 5, 6). Within this locality, zones with woody species along the coast dominated, and water surfaces were densely overgrown with submerged or floating vegetation. There are also slow-flowing open waters without vegetation, as well as shallow ponds with drainage channels. Zones with a reed belt along the coast were rare in this locality, and during the research only one reed belt was observed, which was available for sampling.

Figure 6. Sakajtaš

1.2.1.2 Mrtva Baračka

The Mrtva Baračka represents the former meander of the Danube and together with the Bajski Kanal in the past it was a part of the living course of the Danube. Hydro amelioration works and backfilling form an elongated pond with a total length of about 3 km. It is most often filled with atmospheric waters and corporal from the surrounding higher land, but it also communicates in its western part through the canal with Živa Baračka and the main course of the Danube (Figure 5). The water level of Mrtva Baračka itself is mostly independent of the level of the Danube and does not change significantly during the year. Mrtva Baračka abounds in floating vegetation and zones with a reed belt along the coast (Figure 7). Since the water body is elongated along the southern coast, the presence of woody vegetation is frequent. In addition to this, in the middle part of Mrtva Baračka, there is an open water surface throughout the year.

Figure 7. Mrtva Baračka

1.2.1.3 Bajski kanal

The Bajski Kanal is a former tributary of the Danube, which remained separated from the main course by changing the course of the river. Due to its length of 44 km, of which 11 are located in Serbia, and its great average depth, it has been used as a waterway for transporting goods for many years. The Bajski canal is rich in reed belts that dominate along the right bank of the canal, while zones with woody species along the coast dominate along the left bank of the canal where the Karapandža forest rests on it (Figure 5). Given the average width of about 50 m, floating aquatic vegetation almost never covers the surface of the canal and in the middle of the canal there are open aquatic habitats without vegetation (Figure 8). Since the inflow of water into the Bajski Canal is controlled through the floodgate, the water level of the canal itself is independent of the main course of the Danube River. The Bajski canal flows into the Veliki Bački canal and the connection with it is also controlled through the floodgate.

Figure 8. Bajski kanal

1.2.2 SRP „Karađorđevo“

Within the pilot area of Karađorđevo, 5 types of meso-habitats were selected and they are further listed together with the codes used in the research (attached document):

PM) shallow water surfaces with sandy or muddy bottom (up to 1.5 m deep)

TO) zones with a reed belt along the bank

OD) water bank with poorly developed herbaceous vegetation in the presence of wood species (most often white willow-*Salix alba*, poplar-*Populus* sp., Ash-*Fraxinus* sp., Acacia-*Amorpha fruticosa*, etc.)

PV) water surfaces densely overgrown with submerged or floating vegetation (thrush-*Ceratophylum* sp., White water lily-*Nymphaea alba*, yellow water lily-*Nuphar luteum*, water nut-*Trapa natans*, etc.)

DV) standing or slow-flowing open water surfaces with sporadic vegetation (over 2 m depth)

Figure 9. Sampling locations within the pilot area of SRP "Karađorđevo"

1.2.2.1 Dunavac

The Dunavac is a body of water that connects it with the "Hagla" tributary at a distance of less than 1 km from the main course of the Danube. In this way, the Danube is in contact with the Danube throughout the year, and that connection is not interrupted even at the lowest water levels. Water starts to enter the Dunavac from Hagla at a water level of about 200 cm by the measuring station Backa Palanka, while a rise in the water level is already noticeable at 250 cm and flows further towards Lovrenc. The site itself is densely overgrown with forest (Figure 10) and similar to the Sakajtaš pond within the SRP "Gornje Podunavlje", there are rare reed belts along the coast. In addition, only a few locations are areas densely overgrown with submerged or floating vegetation. The Dunavac is a little over 4.5 km long, and its width ranges from 30-50 m. As it moves away from the Hagla watercourse, its width decreases drastically and becomes almost impassable at lower water levels.

Slika 10. Dunavac

1.2.2.2 Lovrenac – Račva

Račva is a swampy aquatic habitat located at the crossing of Široka bara and Lovrenac. It is characterized by a small depth of water, a large amount of submerged and floating aquatic vegetation and mostly silted bottom. The open water area is sporadically represented in the widest parts. Fallen trees and alluvium are often brought with high water levels that are retained in this part (Figure 11). The width of Račva itself is almost 70 meters, but it soon decreases drastically as you go towards Lovrenac, where it reaches only about 20 m. This is a locality through which, during higher water levels, the water reaches Lovrenc via the Danube. The site ends with a bridge that narrows the watercourse to only 5 meters

Figure 11. Lovrenac - Račva

1.2.2.3 Lovrenac

Lovrenac with its length of about 4.5 km and width ranging from 20 to 80 meters is one of the largest and most diverse habitats of water bodies within the SRP "Karadjordjevo". All 5 types of mesohabitats on which sampling is planned by this study are equally represented in this locality (Figure 12).

Slika 12 Lovrenac

1.3 Aims of the study

This study encompasses several goals:

- collecting basic data on ichthyofauna in both pilot areas, as well as determining the frequency of individual species in the total ichthyofauna
- determination of biomass and size of fish populations based on catches per unit of effort (CPUE), optimally at 20 m per individual habitat
- determination of ecological and reproductive guilds for each individual species
- comparison of the state of ichthyofauna between different meso habitats
- comparison of the impact of different distances from the main course of the Danube and between the pilot areas themselves on the state of ichthyfauna.
- comparison of collected data (list of species, relative and total number, biomass, age structure, presence / absence of individual species) for the same types of mesohabitats by individual pilot area (Karađorađevo and Gornje Podunavlje).
- water level analysis for the period 2016-2020. year for measuring stations Bezdan, Bogojevo and Backa Palanka

II. Methodology

Each sampling was coordinated with the users of the fishing areas and representatives of the fish protection services of each user were present all the time in the field. Sampling in both pilot areas was performed on two occasions (rounds). In each case, in each pilot area, sampling transects were performed from 5 defined mesohabitats at all three localities. Due to the size of the locality and due to the inhomogeneous distribution of fish at the localities Bajski kanal and Mrtva Baračka within the SRP "Gornje Podunavlje" during the second trurn, the number of samples increased by 6 in those meso-habitats that proved productive with fish fauna. Sampling dates, at individual sites within each shift, are shown in Table 1.

Table 1. Display of sampling dates and number of samples within each pilot area

Pilot area	Locality	date	round	number of transects
SRP "Karađorđevo"	Lovrenac	20.07.2021.	1	5
SRP "Karađorđevo"	Dunavac	21.07.2021.	1	5
SRP "Karađorđevo"	Lovrenac - Račva	22.07.2021.	1	5
SRP "Gornje Podunavlje"	Bajski kanal-Karapandža	26.07.2021.	1	5
SRP "Gornje Podunavlje"	Sakajtaš	27.07.2021.	1	5
SRP "Gornje Podunavlje"	Mrtva Baračka	28.07.2021.	1	5
SRP "Karađorđevo"	Dunavac	17.08.2021.	2	5
SRP "Karađorđevo"	Lovrenac - Račva	18.08.2021.	2	5
SRP "Karađorđevo"	Lovrenac	19.08.2021.	2	5
SRP "Gornje Podunavlje"	Bajski kanal-Karapandža	30.08.2021.	2	11
SRP "Gornje Podunavlje"	Mrtva Baračka	31.08.2021.	2	11
SRP "Gornje Podunavlje"	Sakajtaš	01.09.2021.	2	5
TOTAL				72

Ichthyofauna samples were collected by the hydrobiological team of the Department of Biology and Ecology, Faculty of Sciences, University of Novi Sad, using a battery-powered electric fishing apparatus with direct-pulsed output current, voltage 400 V, power 5 kW. During the hunt, CPUE (Catch Per Unit Effort), the number of caught individuals and biomass per unit area (kg / ha) were recorded. The nominal transect length of 20 meters in most cases was not sufficient for an adequate sample, which is most likely a consequence of the spotted distribution of the populations in the habitat in the summer period. Therefore, the transects were in most cases extended to about 50m, and in some cases up to 100m. Standard keys were used to determine individual families, genera and species (Simonović, 2001; Kottelat & Freyhof, 2007).

During sampling, the Global Positioning System (GPS) was used to accurately determine the sampling location using the Garmin GPSmap 60CSx. In addition, transects were recorded with the help of the mobile application "Geo Tracker". Physico-chemical parameters were measured using several devices specialized for these purposes. Conductivity and temperature were measured using a WTW conductivity meter (model: Cond 3110), dissolved oxygen and saturation were measured using a WTW oximeter (model: Oxi 3205), while pH was determined using a Testo pH meter (model: 206). Transparency was determined using a

Secci disk, while depth was determined using a Speedtest depth gauge. The mass of the units was measured using a technical scale with a precision of 0.1 g, Ohaus Navigator 2100. Total length (TL) and standard length (SL) of the body were measured using a ruler with an accuracy of 1 mm (Figure 13). The sex of the individuals was not determined, as this was not possible while using non-invasive methods. All individuals, except for the representatives of non-native species, were returned to the water after the measurement. Ecological and reproductive guilds were determined on the basis of reference literature (Kovač, 2015). All collected data were submitted on CD Annex are contained in the excel documents (VRSTE _list, MDD fish study data) and KML document (Lifeline, sampling).

III. Results

3.1 SRP "Gornje Podunavlje"

3.1.1 Physico-chemical parameters

Physico-chemical parameters within the SRP "Gornje Podunavlje" did not vary drastically within one locality in one sampling round, but certain parameters showed significant variations when the localities were compared within one round. Also, if we compare the parameters within one locality between two rounds, we can also notice larger variations of some parameters (Table 2). Specifically, during the 1st round, an extremely high water temperature was recorded. The lowest was on Sakajtaš, while on the sites of Bajski kanal - Karapandža and Mrtva Baračka, the average was identical. At Mrtva Baračka, however, the highest temperature of 29 °C was recorded. During the second round, the average temperatures were significantly more balanced and ranged from 19 - 22 °C. Conductivity during both shifts did not vary significantly within the locality, but it was constantly the highest at the Mrtva Baračka locality. This indicates the possibility of increased leaching of minerals from the surrounding soil and/or weaker water exchange cycles in this water body. This is also indicated by the transparency of the water, which was constantly the lowest in the locality of Mrtva Baračka. Oxygen, which was significantly higher at the sites of Bajski kanal - Karapandža and Mrtva Baračka, returned to average values for this period of the year in the second round with a drop in water temperature. This indicates that with the drop in temperature, the production of phytoplankton most likely decreased.

Table 2. Average values of physical and chemical parameters within the SRP "Upper Danube"

Locality	Round	T (°C)	Con (µS/cm)	Sat (%)	O_2 (mg/l)	pH	transparencyt (cm)	depth (cm)
Bajski kanal-Karapandža	1	27.90	379.60	75.08	5.81	8.30	123.80	232.60
Mrtva Baračka	1	27.90	577.60	74.50	5.84	8.31	43.00	125.40
Sakajtaš	1	26.08	372.40	34.60	2.89	7.87	113.00	184.00
PROSEK I turnus	**1**	**27.29**	**443.20**	**61.39**	**4.85**	**8.16**	**93.27**	**180.67**
Bajski kanal-Karapandža	2	21.68	398.18	34.51	2.93	8.01	125.91	211.00
Mrtva Baračka	2	20.52	573.00	40.75	3.57	8.11	46.18	129.82
Sakajtaš	2	19.78	362.80	34.40	3.16	8.32	73.00	144.60
PROSEK II turnus	**2**	**20.82**	**459.28**	**36.94**	**3.23**	**8.12**	**83.25**	**164.88**

3.1.2. Ichthyofauna of SRP "Gornje Podunavlje"

Within both sampling rounds in the pilot area within the SRP "Gornje Podunavlje", a total of 21 species of fish were recorded (Table 3). Based on the insight into ecological guilds, it can be seen that a large number of species (9) are eurytopic, meaning that they do not have special preferences for water flow. It is also noticed that 7 recorded species are rheophilic (species that prefer liquid aquatic ecosystems, but seasonally inhabit floodplains). Other species are limnophilous. It is important to note that some of the species that inhabit the SRP "Gornje Podunavlje" during these surveys were not registered, and their presence is regularly recorded by monitoring in the past decade. These are *Misgurnus fossilis*, *Barbus barbus*, *Hypophthalmichthys molitrix*, *Neogobius melanostomus* and *Silurus glanis*. All these species are less often caught by electric fishing techniques and therefore we believe that they are still present in this area.

Table 3 List of recorded species in the pilot area within the SRP "Upper Danube" with a review of ecological and reproductive guilds

No.	Species - latin	Vernacular name (Serbian)	Vernacular name (English)	Ecological guild	Reproductive guild
1	*Abramis brama*	deverika	Bream	RB	A.1.4
2	*Alburnus alburnus*	uklija	Bleak	EU	A.1.4
3	*Ameiurus melas*	crni patuljasti som	Black bullhead	LI	B.2.7
4	*Aspius aspius*	bucov	Asp	RB	A.1.3
5	*Ballerus ballerus*	kesega	Blue bream	RB	A.1.4
6	*Blicca bjoerkna*	krupatica	White bream	RB	A.1.5
7	*Carassius gibelio*	babuška	Prucian carp	EU	A.1.5
8	*Cyprinus carpio*	šaran	Carp	EU	A.1.5
9	*Esox lucius*	štuka	Northern pike	EU	A.1.5
10	*Lepomis gibbosus*	sunčanica	Pumpkinseed	LI	B.2.2
11	*Leuciscus idus*	jaz	Ide	RB	A.1.4
12	*Micropterus salmoides*	velikousti bas	Largemouth black bass		
13	*Neogobius fluviatilis*	glavoč peskar	Monkey goby	RB	B.1.3
14	*Perca fluviatilis*	bandar	European perch	EU	A.1.4
15	*Proterorhinus semilunaris*	glavoč cevonos	Western tubenose goby	EU	B.2.7
16	*Pseudorasbora parva*	amurski čebačok	Stone moroko	EU	A.2.2
17	*Rhodeus sericeus*	gavčica	Bitterling	EU	A.2.5
18	*Rutilus rutilus*	bodorka	Roach	EU	A.1.4
19	*Sander lucioperca*	smuđ	Pike-perch	RB	B.2.5
20	*Scardinius erythrophthalmus*	crvemperka	Rudd	LI	A.1.5
21	*Tinca tinca*	linjak	Tench	LI	A.1.5

Insight into the composition of the ichthyofauna of the pilot area of the SRP " Gornje Podunavlje " shows that the numerical share is dominated by species from the carp family (Cyprinidae). The most present are *Alburnus alburnus* and *Rutilus rutilus* with over 36% and over 16% share in the total abudance of fish stock, respectively (Table 4). The high number of two invasive species *Ameiurus melas* (15.36%) and *Lepomis gibbosus* (12.02%) is worrying. In the mass share, the dominant species is *Carassius gibelio* with almost 20% share in the total mass of the sample, while *Rutilus rutilus* and *Alburnus alburnus* follow it with 14% and 11% mass share. We consider that the mass fraction of *Micropterus salmoides* of 17.47% is an exception, because one extremely large individual (1300 g) was caught during sampling, which affects this result.

Table 4. Representation and biomass of individual species within the SRP „Gornje Podunavlje“

Latin name	Vernacular name (Serbian)	Vernacular name (English)	Abuncance	Biomass (g)	Relative abundance (%)	Mass share (%)
Abramis brama	deverika	Bream	22	147.4	2.62	1.50
Alburnus alburnus	uklija	Bleak	309	1083.28	36.79	11.01
Ameiurus melas	crni patuljasti som	Black bullhead	129	791.5	15.36	8.05
Aspius aspius	bucov	Asp	11	971	1.31	9.87
Ballerus ballerus	kesega	Blue bream	6	7.1	0.71	0.07
Blicca bjoerkna	krupatica	White bream	1	9	0.12	0.09
Carassius gibelio	babuška	Prucian carp	43	1940.9	5.12	19.73
Cyprinus carpio	šaran	Carp	1	15.3	0.12	0.16
Esox lucius	štuka	Northern pike	3	569.3	0.36	5.79
Lepomis gibbosus	sunčanica	Pumpkinseed	101	880.5	12.02	8.95
Leuciscus idus	jaz	Ide	9	29.6	1.07	0.30
Micropterus salmoides	velikousti bas	Largemouth black bass	10	1718.7	1.19	17.47
Neogobius fluviatilis	glavoč peskar	Monkey goby	2	4.9	0.24	0.05
Perca fluviatilis	bandar	European perch	2	2.8	0.24	0.03
Proterorhinus semilunaris	glavoč cevonos	Western tubenose goby	4	2	0.48	0.02
Pseudorasbora parva	amurski čebačok	Stone moroko	8	7.2	0.95	0.07
Rhodeus sericeus	gavčica	Bitterling	12	20.5	1.43	0.21
Rutilus rutilus	bodorka	Roach	140	1337.1	16.67	13.59
Sander lucioperca	smuđ	Pike-perch	2	86.6	0.24	0.88
Scardinius erythrophthalmus	crvemperka	Rudd	24	185.7	2.86	1.89
Tinca tinca	linjak	Tench	1	26.1	0.12	0.27
TOTAL			840	9836.48	100.00	100.00

When observing the representation of species by localities within the SRP "Upper Danube", some species are observed with a larger share in localities closer to the main course of the Danube, and as we move away from the Danube, their number decreases or they are not present at all (Table 5). *Alburnus alburnus*, for example, is present with almost 50% in the abudance of the Sakajtaš locality, its abudance decreases as we move away from the Danube. On the other hand, in the same locality, its biomass is the smallest, which implies that there much younger specimens here and that this locality is a good breeding area for this species.

Ballerus ballerus was detected only in the locality Sakajtaš, with a significant mass share of 15.48%. Roach is present in all localities, but its abudance and biomass are the least in the Sakajtađ locality. The Tench was detected only at the Mrtva Baračka site, which is expected considering that this site has the most characteristics of a limnophilous habitat. Only 8 species were detected at all three localities, which implies that the connection between habitats is not at the highest level, or that that living conditions in habitats differ to a greater extent.

Table 5 Representation of species by localities in the pilot area of SRP "Gornje Podunavlje"

Species - latin	Bajski kanal-Karapandža		Mrtva Baračka		Sakajtaš	
	abudance (%)	biomass (%)	abudance (%)	biomass (%)	abudance (%)	biomass (%)
Abramis brama	3.23	2.48	2.36	1.15	1.94	0.27
Alburnus alburnus	25.51	11.91	40.88	13.33	49.03	2.91
Ameiurus melas	25.81	15.83	13.85	4.73	0.00	0.00
Aspius aspius	0.00	0.00	1.35	21.75	3.40	1.01
Ballerus ballerus	0.00	0.00	0.00	0.00	4.37	15.48
Blicca bjoerkna	0.29	0.24	0.00	0.00	0.00	0.00
Carassius gibelio	0.59	12.53	4.05	3.42	14.08	63.53
Cyprinus carpio	0.00	0.00	0.00	0.00	0.49	0.73
Esox lucius	0.59	14.75	0.34	0.55	0.00	0.00
Lepomis gibbosus	20.23	13.28	2.36	3.36	12.14	11.61
Leuciscus idus	0.00	0.00	1.35	0.41	2.43	0.56
Micropterus salmoides	0.88	7.02	2.36	33.42	0.00	0.00
Neogobius fluviatilis	0.59	0.13	0.00	0.00	0.00	0.00
Perca fluviatilis	0.59	0.08	0.00	0.00	0.00	0.00
Proterorhinus semilunaris	0.59	0.02	0.34	0.01	0.49	0.04
Pseudorasbora parva	0.00	0.00	0.00	0.00	3.88	0.34
Rhodeus sericeus	1.47	0.17	1.35	0.21	1.46	0.24
Rutilus rutilus	16.72	19.66	24.66	12.78	4.85	2.50
Sander lucioperca	0.00	0.00	0.34	1.88	0.49	0.22
Scardinius erythrophthalmus	2.93	1.88	4.05	2.40	0.97	0.55
Tinca tinca	0.00	0.00	0.34	0.60	0.00	0.00

3.2 SRP "Karađorđevo"

3.2.1 Physico-chemical parameters

Physico-chemical parameters within the SRP "Karađorđevo", at some locations showed variations within the location (data available in the Annex), while between the localities could be observed variations that were due to a fast rise in water levels during the first round, as well as the water level drops during the second sampling round. On both occasions of sampling, the Lovrenac site showed the largest variations in terms of electrical conductivity, as well as in terms of oxygen concentration. At the same time, the highest average values of the mentioned parameters were recorded at this locality (Table 6). In the first round, both the highest and the lowest oxygen concentration were measured at this locality (14.99 mg/l and 2.38 mg/l). This suggests that there is little water movement in this locality and that certain zones are suitable for hyperproduction, while some zones tend to have anoxic conditions, which can be detrimental to fish populations. At the Lovrenac - Račva locality, in the first round, we detect almost identical value of electrical conductivity as at the Danube locality, which implies that the water level rise (382 cm near Bogojevo at the time of sampling) reached this locality. Also, during the second round we noticed significantly lower oxygen concentrations at this locality (1.44 mg/l on average). The average sampling depth, although not a reflection of the average depth of the habitat, is worryingly low at the Lovrenac - Račva site. At the Dunavac site, during the second round of sampling, it can be seen that the values of conductivity are higher, which implies that at that moment the water is withdrawing from the floodplain (273 cm near Bogojevo and a water drop of 31 cm).

Table 6. Average values of physical and chemical parameters within SRP "Karađorđevo"

Lokalitet	Turnus	T (°C)	Con (µS/cm)	Sat (%)	O_2 (mg/l)	pH	providnost (cm)	dubina (cm)
Lovrenac	1	27.20	575.80	93.78	7.02	8.70	33.60	68.90
Lovrenac - Račva	1	24.58	359.20	56.92	4.73	8.34	39.20	67.60
Dunavac	1	24.96	354.80	77.74	6.37	8.63	50.80	156.60
PROSEK I turnus	**1**	**25.58**	**429.93**	**76.15**	**6.04**	**8.55**	**41.20**	**97.70**
Lovrenac	2	23.94	512.60	56.30	4.63	8.26	36.80	69.40
Lovrenac - Račva	2	23.10	405.20	17.10	1.44	7.72	36.00	44.80
Dunavac	2	25.56	380.20	38.52	3.11	7.85	45.20	174.00
PROSEK II turnus	**2**	**24.20**	**432.67**	**37.31**	**3.06**	**7.94**	**39.33**	**96.07**

3.2.2. Ichthyofauna "SRP Karadjordjevo"

Within both sampling rounds in the pilot area within the SRP "Karađorđevo", a total of 24 species were recorded. Based on the insight into ecological guilds, it can be seen that 10 species are eurytopic, ie that they do not have special preferences for water flow. Nine species are rheophilic (RB or RA), while other species are limnophils (LI) (Table 7). Some of the species recorded during regular monitoring in this area in the last decade have not been identified during this research. These are: *Ballerus ballerus*, *Misgurnus fossilis*, *Gymnocephalus schraetser*. *Ballerus ballerus* and *Gymnocephalus schraetser* are less common in floodplains, while *Misgurnus fossilis* is a species that is rarely caught by electrofishing. It is

important to note that during this research, some of the rare and endangered species were recorded (Figures 14 and 15).

Table 7. List of recorded species in the pilot area within the SRP "Karađorđevo" with reference to ecological and reproductive guilds

No.	Species - latin	Vernacular name (Serbian)	Vernacular name (English)	Ecological guild	Reproductive guild
1	*Abramis brama*	deverika	Bream	RB	A.1.4
2	*Alburnus alburnus*	uklija	Bleak	EU	A.1.4
3	*Ameiurus melas*	crni patuljasti som	Black bullhead	RB	A.1.5
4	*Aspius aspius*	bucov	Asp	RB	A.1.3
5	*Blicca bjoerkna*	krupatica	White bream	RB	A.1.5
6	*Carassius gibelio*	babuška	Prucian carp	EU	A.1.5
7	*Chondrostoma nasus*	skobalj	Nase	RA	A.1.3
8	*Cobitis elongatoides*	vijun	Spined loach	RB	A.1.5
9	*Cyprinus carpio*	šaran	Carp	EU	A.1.5
10	*Esox lucius*	štuka	Northern pike	EU	A.1.5
11	*Gymnocephalus cernuus*	balavac	Ruffe	RB	A.1.4
12	*Hypophthalmichthys molitrix*	beli tolstolobik	White bighead	LI	A.1.1
13	*Lepomis gibbosus*	sunčanica	Pumpkinseed	LI	B.2.2
14	*Leuciscus idus*	jaz	Ide	RB	A.1.4
15	*Perca fluviatilis*	bandar	European perch	EU	A.1.4
16	*Proterorhinus semilunaris*	glavoč cevonos	Western tubenose goby	EU	B.2.7
17	*Pseudorasbora parva*	amurski čebačok	Stone moroko	EU	A.2.2
18	*Rhodeus sericeus*	gavčica	Bitterling	EU	A.2.5
19	*Rutilus rutilus*	bodorka	Roach	EU	A.1.4
20	*Sander lucioperca*	smuđ	Pike-perch	RB	B.2.5
21	*Scardinius erythrophthalmus*	crvemperka	Rudd	LI	A.1.5
22	*Silurus glanis*	som	Wels catfish	EU	B.1.4
23	*Squalius cephalus*	klen	Chub	EU	A.1.3
24	*Tinca tinca*	linjak	Tench	LI	A.1.5

Figure 14. *Cobitis elongatoides*

Figure 15 *Tinca tinca*

Insight into the composition of the ichthyofauna of the pilot area of SRP "Karađorđevo" shows that the pilot area is dominated by species from the carp family (Cyprinidae). The most common are *Alburnus alburnus* and *Rutilus rutilus* with 33.61 and over 14.29% share in the total abudance of fish stock (Table 8). The presence of *Carassius gibelio* with almost 12% abudance is also significant, while *Blicca bjoerkna* (slightly above 7%) and *Abramis brama* with 6.05% are next. Carp (*Cyprinus carpio*) dominates in the mass share with 28.89%, while *Carassius gibelio* has a slightly lower value of mass share (26.35%). The presence of a large predator (*Esox lucius*) with over 12% share in the total mass of the sample is not negligible, while *Rutilus rutilus* is present with over 9% (Table 8).

Table 8. Representation and biomass of individual species within the SRP "Karađorđevo"

Latin name	Vernacular name (Serbian)	Vernacular name (English)	Abuncance	Biomass (g)	Relative abundance (%)	Mass share (%)
Abramis brama	deverika	Bream	72	269.1	6.05	1.15
Alburnus alburnus	uklija	Bleak	400	1209.47	33.61	5.19
Ameiurus melas	crni patuljasti som	Black bullhead	6	105.5	0.50	0.45
Aspius aspius	bucov	Asp	47	330.9	3.95	1.42
Blicca bjoerkna	krupatica	White bream	85	774.5	7.14	3.32
Carassius gibelio	babuška	Prucian carp	139	6140.8	11.68	26.35
Chondrostoma nasus	skobalj	Nase	5	28.1	0.42	0.12
Cobitis elongatoides	vijun	Spined loach	13	46.7	1.09	0.20
Cyprinus carpio	šaran	Carp	29	6733.8	2.44	28.89
Esox lucius	štuka	Northern pike	8	2815.2	0.67	12.08
Gymnocephalus cernuus	balavac	Ruffe	1	3	0.08	0.01
Hypophthalmichthys molitrix	beli tolstolobik	White bighead	9	4.4	0.76	0.02
Lepomis gibbosus	sunčanica	Pumpkinseed	58	1554.3	4.87	6.67
Leuciscus idus	jaz	Ide	35	507.2	2.94	2.18
Perca fluviatilis	bandar	European perch	5	93.6	0.42	0.40
Proterorhinus semilunaris	glavoč cevonos	Western tubenose goby	5	2.1	0.42	0.01
Pseudorasbora parva	amurski čebačok	Stone moroko	41	76.2	3.45	0.33
Rhodeus sericeus	gavčica	Bitterling	30	30.4	2.52	0.13
Rutilus rutilus	bodorka	Roach	170	2113	14.29	9.07
Sander lucioperca	smuđ	Pike-perch	5	59.1	0.42	0.25
Scardinius erythrophthalmus	crvemperka	Rudd	20	225.1	1.68	0.97
Silurus glanis	som	Wels catfish	1	10	0.08	0.04
Squalius cephalus	klen	Chub	3	117.3	0.25	0.50
Tinca tinca	linjak	Tench	3	54.7	0.25	0.23
TOTAL			1190	23304.47	100.00	100.00

When observing the representation of species by localities within the SRP "Karađorđevo", some species are observed with a larger share in localities closer to the main course of the Danube, and as we move away from the Danube, their number decreases or they area absent (Table 9). *Chondrostoma nasus* and *Gymnocephalus cernuus* were detected only at the Dunavac site, which is also closest to the main course of the Danube. This is to be expected since both species are rheophilic. On the other hand, the Tench was found in both localities that are further away from the main course of the Danube River, which is also expected considering that it is a limnophilous species. A large number of species has been recorded at all three localities (15), which indicates a relatively good connection of habitats.

Table 9. Representation of species by localities in the pilot area of SRP "Karađorđevo"

Species - latin	Lovrenac		Lovrenac - Račva		Dunavac	
	abudance (%)	biomass (%)	abudance (%)	biomass (%)	abudance (%)	biomass (%)
Abramis brama	0.97	0.18	3.77	0.78	13.91	2.46
Alburnus alburnus	27.49	3.56	39.70	6.56	33.86	5.58
Ameiurus melas	1.46	1.32	0.00	0.00	0.00	0.00
Aspius aspius	5.35	1.64	0.75	1.03	5.77	1.55
Blicca bjoerkna	8.27	2.28	12.31	7.70	0.52	0.44
Carassius gibelio	17.27	21.00	8.79	19.00	8.66	38.24
Chondrostoma nasus	0.00	0.00	0.00	0.00	1.31	0.35
Cobitis elongatoides	0.00	0.00	2.26	0.50	1.05	0.13
Cyprinus carpio	2.68	32.28	3.02	36.84	1.57	18.44
Esox lucius	0.73	1.36	0.25	16.62	1.05	18.65
Gymnocephalus cernuus	0.00	0.00	0.00	0.00	0.26	0.04
Hypophthalmichthys molitrix	0.24	0.01	0.00	0.00	2.10	0.04
Lepomis gibbosus	12.65	16.83	0.75	1.51	0.79	1.21
Leuciscus idus	1.46	2.70	3.77	1.27	3.67	2.47
Perca fluviatilis	0.24	0.49	0.25	0.22	0.79	0.48
Proterorhinus semilunaris	0.24	0.00	0.00	0.00	1.05	0.02
Pseudorasbora parva	2.68	0.35	5.28	0.43	2.36	0.21
Rhodeus sericeus	3.16	0.14	4.02	0.20	0.26	0.06
Rutilus rutilus	10.46	12.17	13.82	6.67	18.90	8.13
Sander lucioperca	0.24	0.17	0.25	0.29	0.79	0.29
Scardinius erythrophthalmus	3.41	1.71	0.50	0.02	1.05	1.07
Silurus glanis	0.00	0.00	0.00	0.00	0.26	0.12
Squalius cephalus	0.73	1.46	0.00	0.00	0.00	0.00
Tinca tinca	0.24	0.34	0.50	0.38	0.00	0.00

3.3 Analysis of water levels at measuring stations Bezdan, Bogojevo and Backa Palanka during the period from 2016. to 2020. year

Insight into the changes in water levels in the last 5 years provides a better picture of the dynamics of flooding and individual localities within both pilot areas. Within the SRP " Gornje Podunavlje ", only the locality Sakajtaš is located in the zone that is exposed to regular flooding by the Danube. On the other hand, the localities Bajski kanal - Karapandža and Mrtva Baračka are protected by an embankment, their water changes are regulated by the floodgate, ie by pumps. According to fisheries keepers reports, the Sakajtash site is exposed to flooding when the Danube crosses an elevation of 400 cm at the Bezdan measuring station. While observing into the changes in the water level near Bezdan in the last 5 years (Figure 15), we can notice that the Danube sporadically floods this locality. Smaller floods occur in the period of high spring waters, and in the summer period during 2016 and 2019, larger floods were present. From this analysis, however, it can be seen that the Sakajtaš site has been cut off from the main course of the Danube for most of the year, and if flooding occurs, they are short-lived.

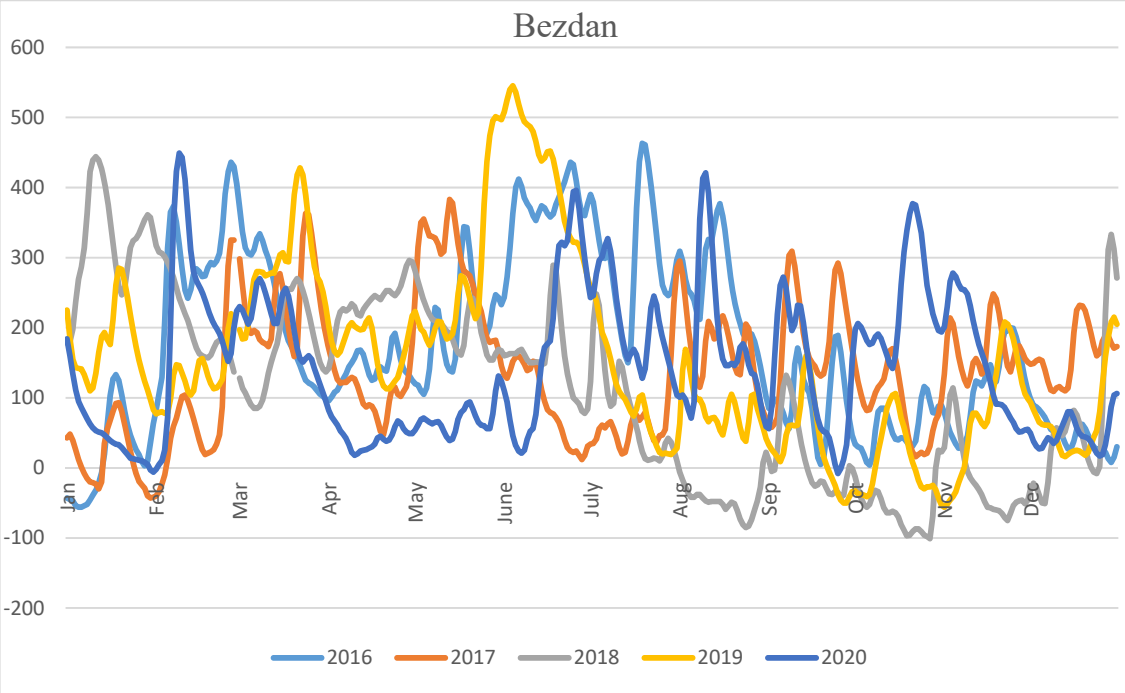

Figure 15. Changes in the water level of the Danube near Bezdan in the last 5 years

According to the reports of the fish protection services in the pilot area within the SRP "Karađorđevo", the locality Dunavac never loses its connection with the backwaters of the Hagla, ie the Danube. According to their announcements, the water enters the Danube at a water level of about 200 cm near Backa Palanka, and further inflow towards Lovrenac is noticeable at a water level of 250 cm. Based on the insight into the water level near Backa Palanka in the last 5 years (Figure 16), it is evident that SRP "Karađorđevo" receives a regular inflow of fresh water through the Dunavac site. Considering that all sites within the SRP "Karađorđevo" are in the zone of direct flooding, during each major increase in water, the entire pilot area should be supplied with fresh water.

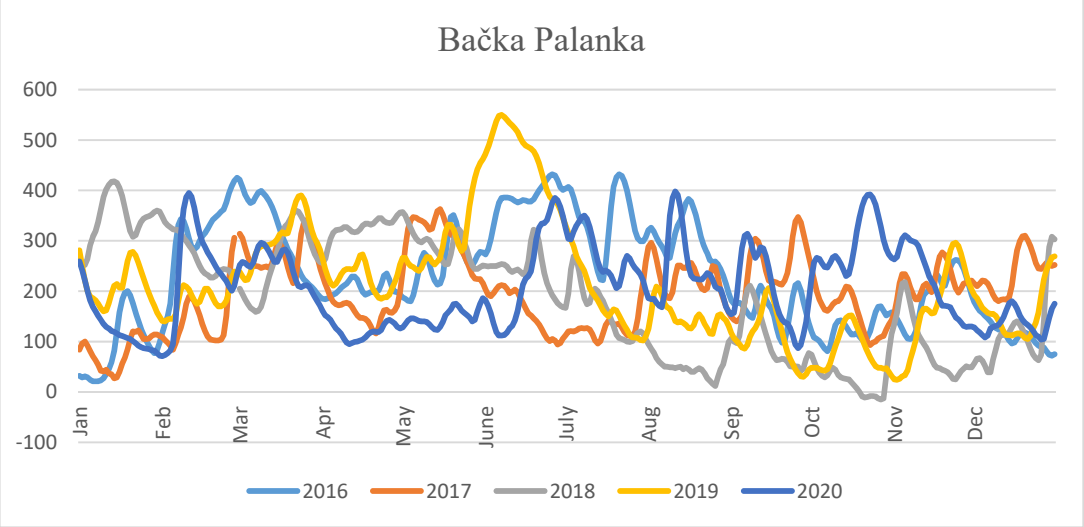

Figure 16. Changes in the water level of the Danube near Backa Palanka in the last 5 years

IV. Discussion

Summarizing the results, it is evident that both pilot areas, although basically representing the same habitat type, have a lot of differences. In the pilot area within the SRP “Karadjordjevo”, a larger number of species was recorded, autochthonous and endangered species were present in larger numbers and biomass. An insight into the total biomass of the sample within the SRP "Karađorđevo" (23304.47 g) in relation to the SRP "Upper Danube" (9836.48) shows that the sample was collected at the sites of the first pilot area richer in biomass. Carp stood out as the dominant species in the mass share within the SRP "Karađorđevo", while the dominant species in biomass within the SRP "Upper Danube" are *Alburnus alburnus*, *Carassius gibelio*, *Micropterus salmoides* and *Rutilus rutilus*, of which two are invasive fish species. Within the SRP "Karađorđevo", 15 out of 24 (62.5%) species were recorded at all three localities, while within the SRP "Gornje Podunavlje" only 8 out of 21 species (38%) were recorded at all three localities. *Alburnus alburnus* and *Rutilus rutilus* were common species in both pilot areas, which supports the character of lowland floodplains. Considering the connection with the main course of the Danube River regarding the sites within the SRP "Gornje Podunavlje", only natural connection has been established at the site Sakajtaš, which, however, depends on high flood waters. Bajski kanal and Mrtva Baračka are completely separated from the Danube, and their water level is regulated by human activity. At the sites within the SRP "Karađorđevo", all sites are exposed to flood waves. On the other hand, based on the physical and chemical parameters, it is evident that the Lovrenac locality, which is the furthest from the Danube, is the least exposed to water renewal and that the processes of accelerated eutrophication are pronounced in this area. Also, the locality Lovrenac-Račva, although it has a satisfactory composition of ichthyofauna, is extremely shallow and swampy and in danger of being completely buried in the future due to the accumulation of sediment.

V. Conclusions & actions recommendations

Within the SRP " Gornje Podunavlje ", the regulation of water levels in the locality Bajski kanal - Krapandža should be subordinated to natural oscillations at the level of the Danube and thus enable more successful spawning for autochthonous fish species. The Baračka site should be more actively supplied with fresh water in order to slow down the eutrophication processes. The Sakajtaš site should be maintained in its current condition and, if possible, water should be allowed to enter at lower water levels. Also, the Labudnjača site should, if possible, be connecteed by the supply channels with the Danube.

Within the SRP "Karađorđevo", it is necessary to enable the unimpeded flow of fresh water at higher water levels within all localities. This is especially true of the Lovrenac - Račva site, which is extremely shallow and swampy, and in addition has a narrowing in the form of a bridge that is a potential bottleneck for water flow. Expansion of this bridge would encourage better water and sediment flow during higher flood waves. There is also a bridge at the Lovrenac site, the widening of which would encourage a better flow of water and sediment. Siltation of

these localities would deepen the riverbed and enable the inflow of fresh water even at lower water levels. Further research should determine whether excavating these sites is feasible.

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