



Co-financed by the Connecting Europe Facility of the European Union



Preparing FAIRway 2 works in the Rhine-Danube Corridor

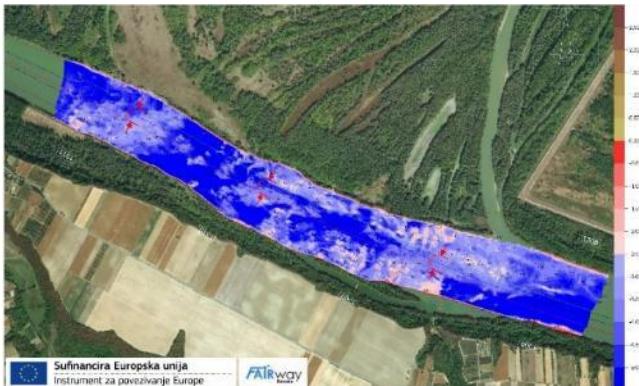
Preparatory activities in the common Croatian-Serbian Danube section

Outcomes from the monitoring activities of the common stretch

03.07.2024, Lidija Hubalek/MMPI, Igor Tadić/Hidroing, Slaven Marasović/VPB, Matija Kresonja, Ana Đanić, Ivona Žiža/Oikon, Tibor Mikuška/HDZZPP

Monitoring of the Croatian/Serbian Danube Common Section

(river km 1433,1 - 1295,5)



Monitoring of the Croatian/Serbian Danube Common Section

(river km 1433,1 - 1295,5)



Implementation plan for monitoring activities

1. MONITORING OF PARAMETERS IMPORTANT FOR WATERWAY MAINTENANCE

- 1.1 Inventorisation of river regulation infrastructure
- 1.2 Riverbed measurement of cross-sections of Danube river
- 1.3 Monitoring and analysis of flow, velocity and sediment transport
- 1.4 Piezometer installation

2. BIODIVERSITY INVENTORY

- 2.1 Fish inventory (monitoring)
- 2.2 Habitat inventory
- 2.3 Bird fauna inventory
- 2.4 River benthic habitats survey

3. ESTABLISHMENT OF A GEOINFORMATION SYSTEM (GIS)

1.1 Inventorisation of river regulation infrastructure



Inventorisation of river regulation infrastructure



Data gathered:

- Geometry data
- Geodetic survey
- Foto-documentation
- Assessment of the current state/functionality
- Identification of extent of damages (where applicable)

Outputs:

- Detailed table overview
- Graphic representation of each infrastructure
- Graphic database
- Elaborate

5. Left bank	Type:	Chainage (r.km)	Length (m)	Crown elevation (m asl)
1430-L2	T-groyne	1430+280	53,36	53,36

Existing documentation

- Cadastre mark 1430/00
- Cadastre page 2/1

Location of the infrastructure

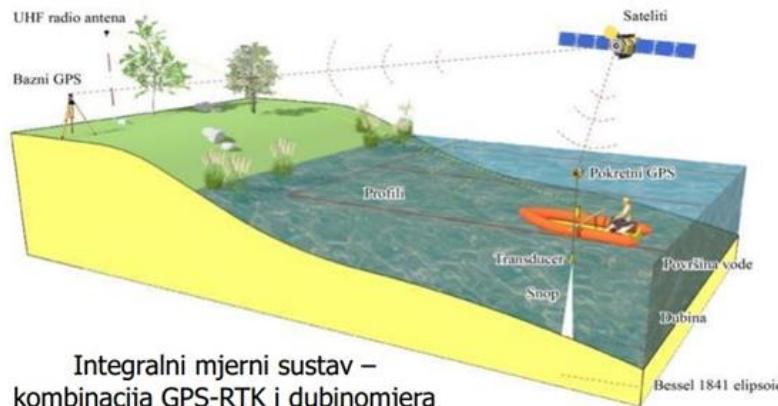
Picture of the infrastructure

Analysis

- Infrastructure in good condition
- Effect of material deposition ongoing (upstream, downstream)
- Material of the infrastructure visible, vegetation present on the beginning of the infrastructure

1.2 Riverbed measurement of cross-sections of Danube river

- Field work of hydrographic riverbed measurements of cross-sections
- Overall length of ~ 140 rkm; 1375 (Danube)+6 (Drava) control profiles (equidistance of 100 m); 2 sets of measurements (yearly)



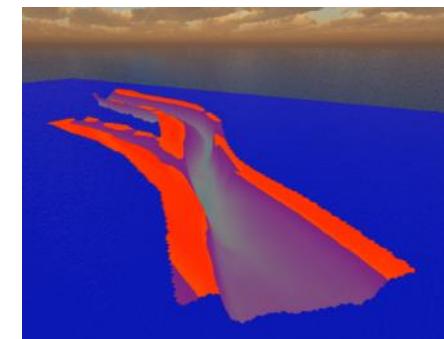
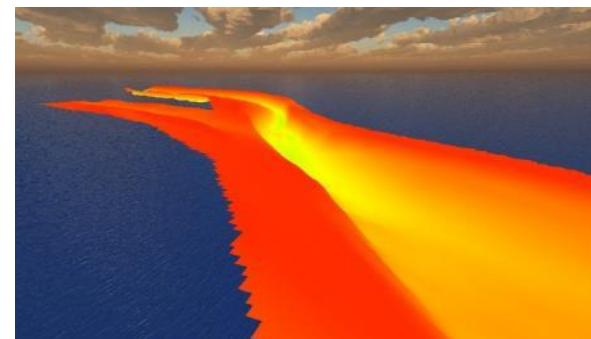
Results



- ▶ Projecting data on cross-section lines; surveyed data are projected on crosslines as a preparation for creating 3d model of riverbed.



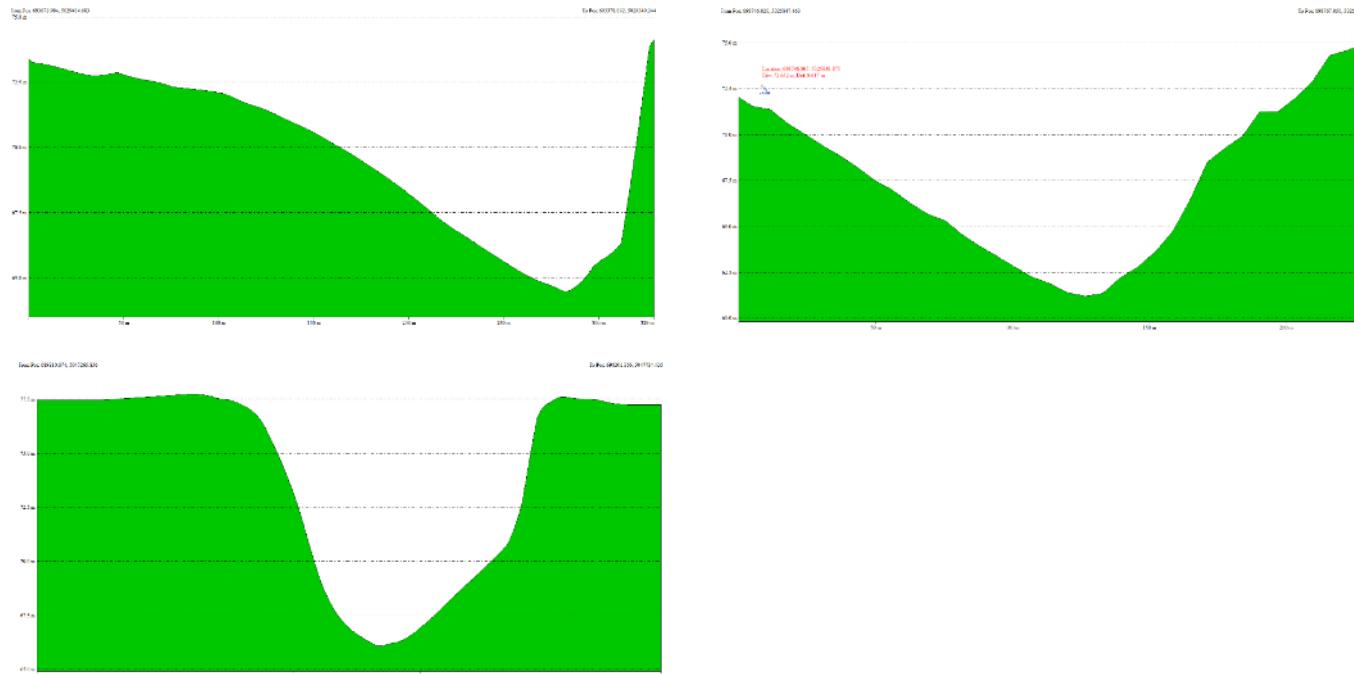
- ▶ 3D model; After cleaning and projecting, 3D model of terrain of riverbed was created.



Results



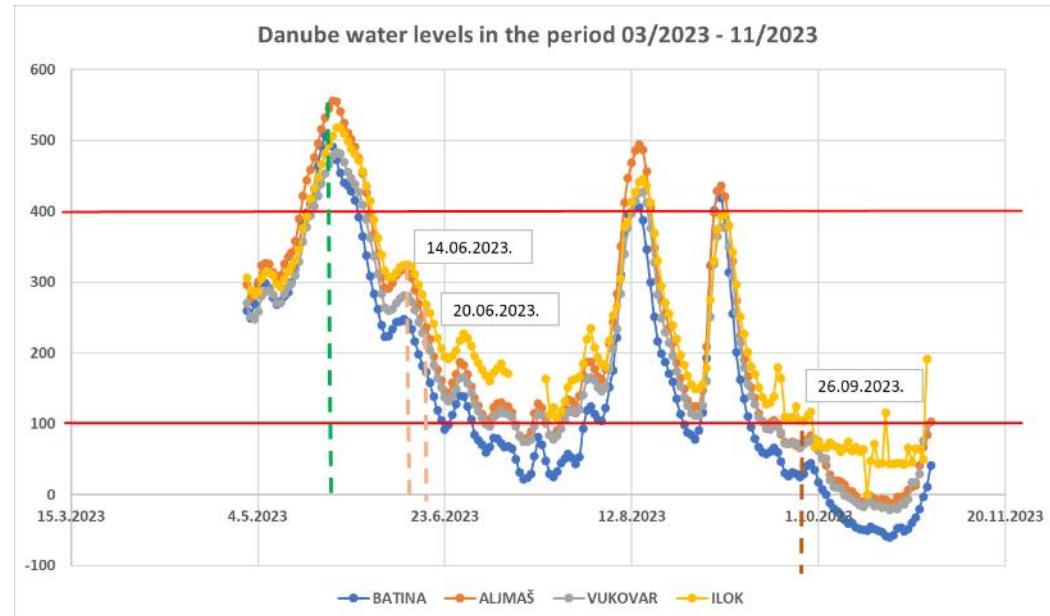
- Projections; results are delivered as a textual file in 3 projections:
 - HTRS96/TM (HVRS71),
 - HDKS (GK) 6 zone (HVRSTRST) and
 - UTM 34 (N) (HVRSTRST)



1.3 Monitoring and analysis of flow, velocity and sediment transport

► Monitoring and analysis of flow, velocity and sediment transport

- 3 sets of measurement campaign (lower, medium and higher water levels) on 3 locations
- Locations: Batina/Vukovar/Ilok for flow and velocity measurements; Batina/Drava confluence/Ilok for sediment transport



Monitoring and analysis of flow, velocity and sediment transport



Monitoring and analysis of flow, velocity and sediment transport

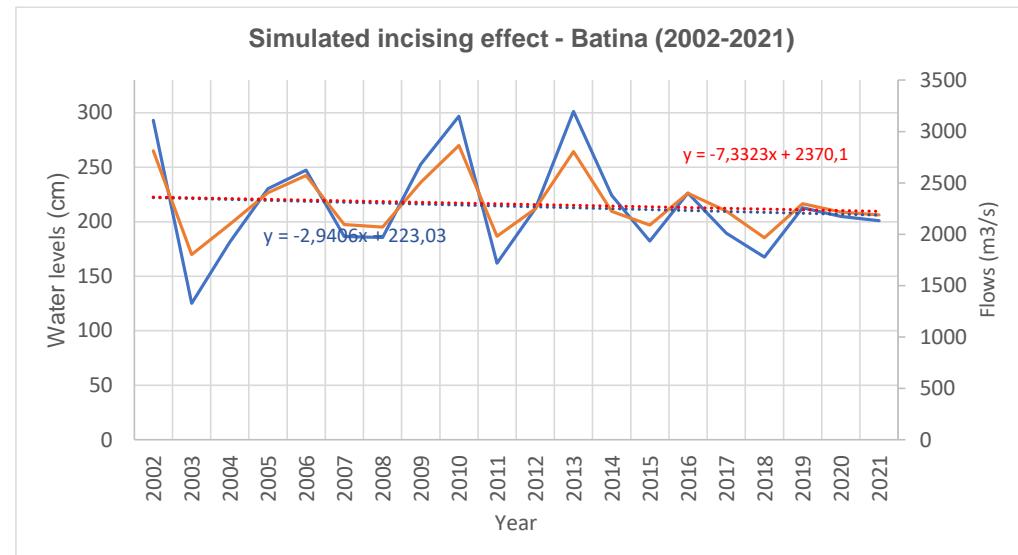
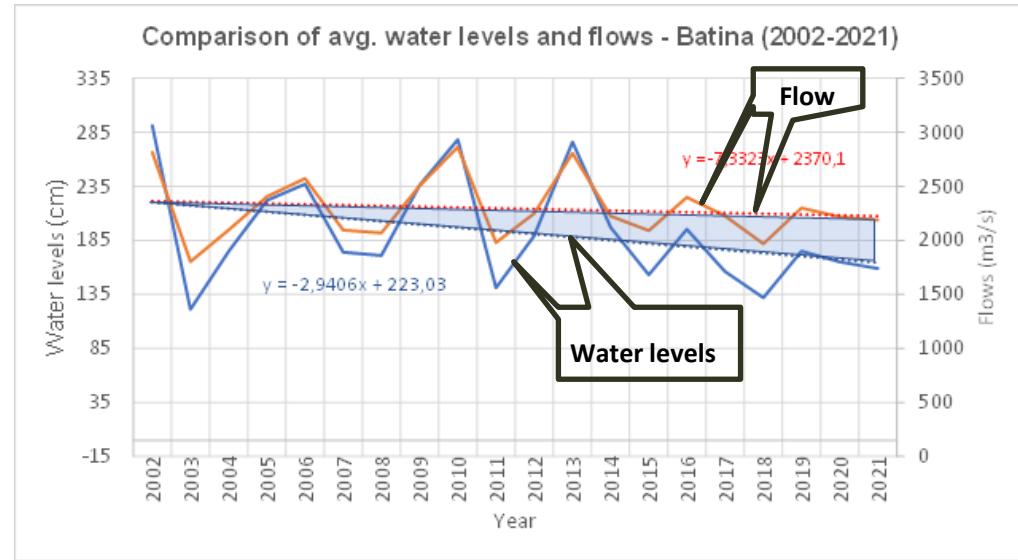


Element / Location	Measuring unit	Batina/Bezdan	The confluence of Drava	Vukovar	Ilok
The position of the upstream profile	rkkm	rkkm 1429+000	1383+000	1332+000	1302+000
		rkkm 142+5000	1381+600	1325+000	1300+000
Measured velocities					
		0,91-1,02		0,99-1,18	1,17-1,05
		0,72-0,72		0,88-0,91	1,01-0,85
		0,66-0,67		0,76-0,67	0,82-0,88
		~ 1,5		~ 2,0	~ 1,5
Measured flows					
		3.862-3.916	4.009-5.373	5.439-5.082	5389-5301
		1.833-1.839	1.963-2.797	3.484-3.112	3559-3232
		1.367-1.393	1.348-1.863	1.736-1.691	1956-1876
Transport of bedload sediment					
		5,9-9,5	10,5-5,1		7,8-18,0
		12,6-3,6	8,5-5,0		11,3-15,0
		14,3-3,0	5,0-3,4		7,9-9,5
Transport of suspended sediment					
		128-130	135-189		198-184
m01 (high water level)	kg/s				
m02 (medium water level)	kg/s	55	61-90		118-109
m03 (low water level)	kg/s	43,-44	42-63		62-63
Granulometric curve		D50 ~ 0,3 mm	D50 ~ 0,25 mm		D50 ~ 0,2 mm

Monitoring and analysis of flow, velocity and sediment transport



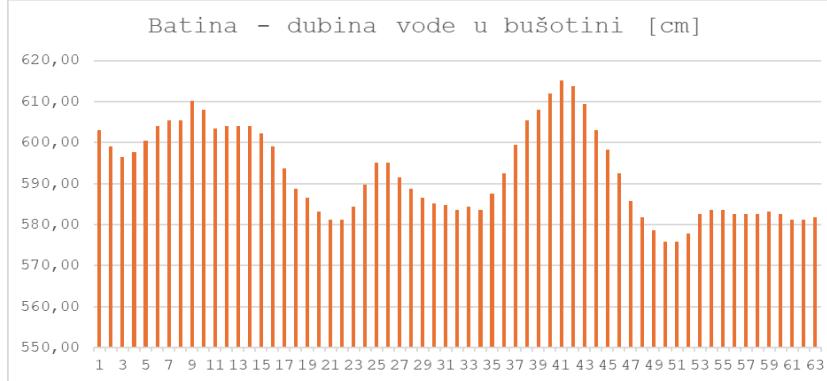
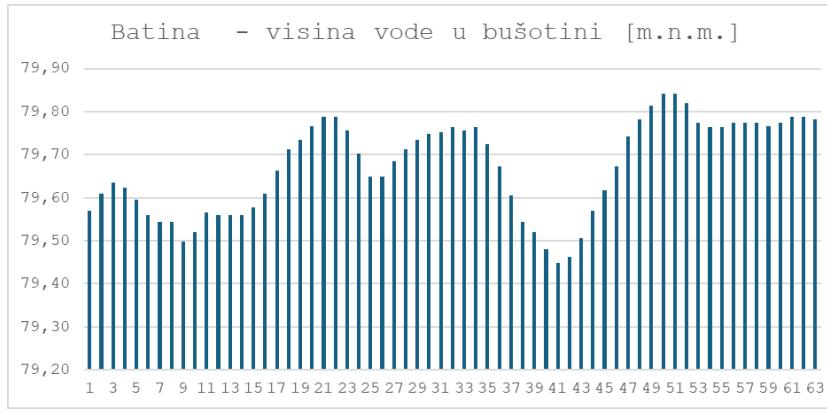
- ▶ Hydrological analysis undertaken prior to measurement campaign
- ▶ Comparison of water levels and flow data in analyzed timeline
 - Batina WM example
- ▶ General decline in values, sharper decline for water levels – incising effect
- ▶ Simulation of incising effect – **2,1 cm/ann** for Batina WM station



1.4 Piezometer installation

Piezometer installation

- Piezometer installation adjacent to Danube (<100 m), 15m of depth for continuous monitoring of water levels and temperature
- Locations: Batina, Aljmaš and Ilok
- Goals: continuous data which shall enable correlation for any future hydrographic surveying and measurements
- measurement equipment installed



2.1 Fish fauna inventory

- ▶ The electrofishing (day and night) portion of the field work was conducted between July and October 2023.
- ▶ 17 critical sections of the river from Batina to Ilok on Croatian side + Serbian protected areas
- ▶ Depending on the length of each critical section, one to four transects of 500 m were sampled
- ▶ In total:
 - 43 transects of daytime electrofishing
 - 13 transects of nighttime electrofishing
 - 5 transects of electrofishing on Serbian side

Fish sampling locations



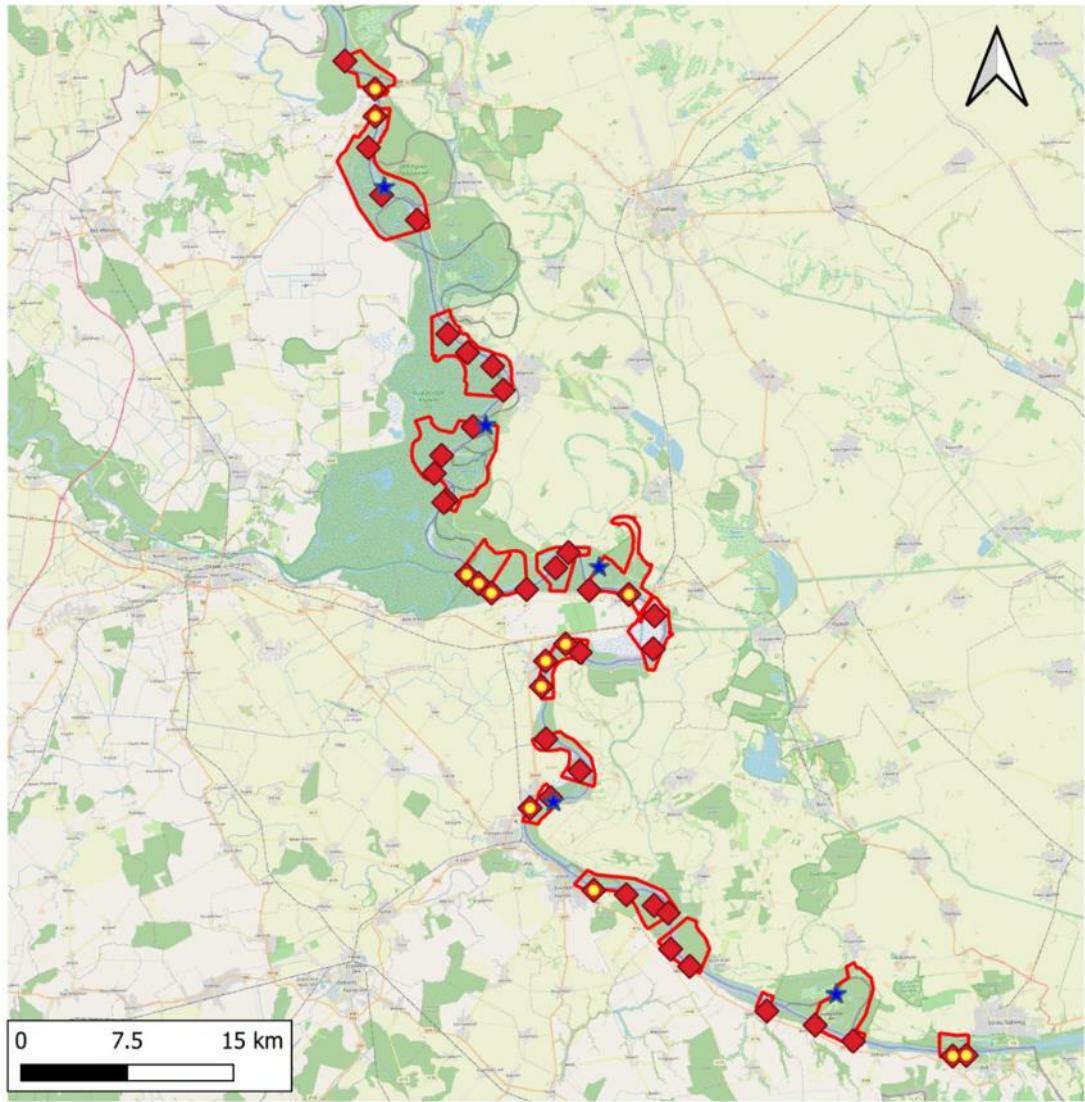
Red diamonds indicate electrofishing transects during the day,

Red diamonds with yellow dot indicate electro fishing transects during the night,

Blue stars indicate electro fishing transects on Serbian side,

Blue stars indicate electro fishing transects on Serbian side.

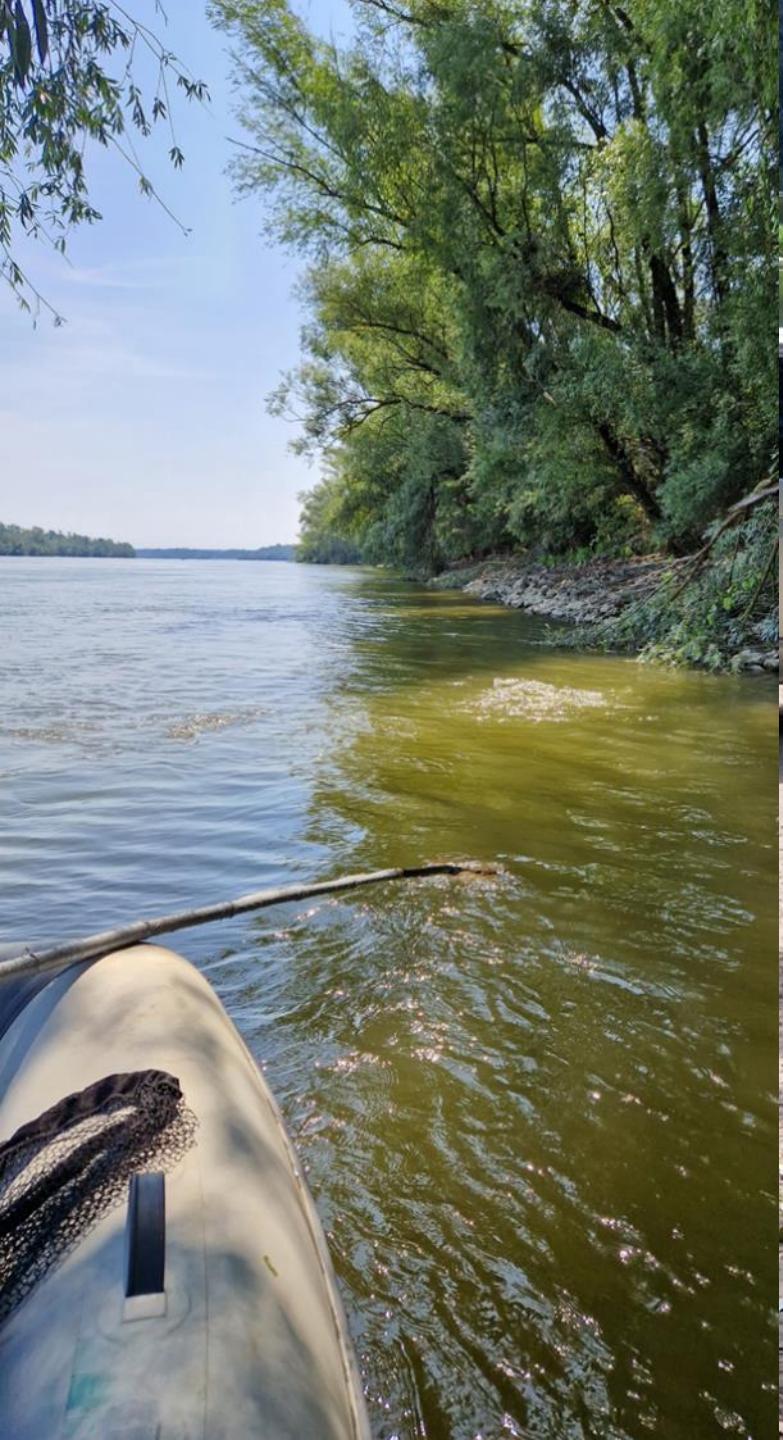
1. Batina
2. Siga
3. Apatin
4. Židovski rukavac
5. Ušće Drave
6. Aljmaš
7. Staklar
8. Erdut
9. Bogojevo
10. Dalj
11. Borovo I
12. Borovo II
13. Vukovar
14. Sotin
15. Opatovac
16. Mohovo
17. Ilok



Field work



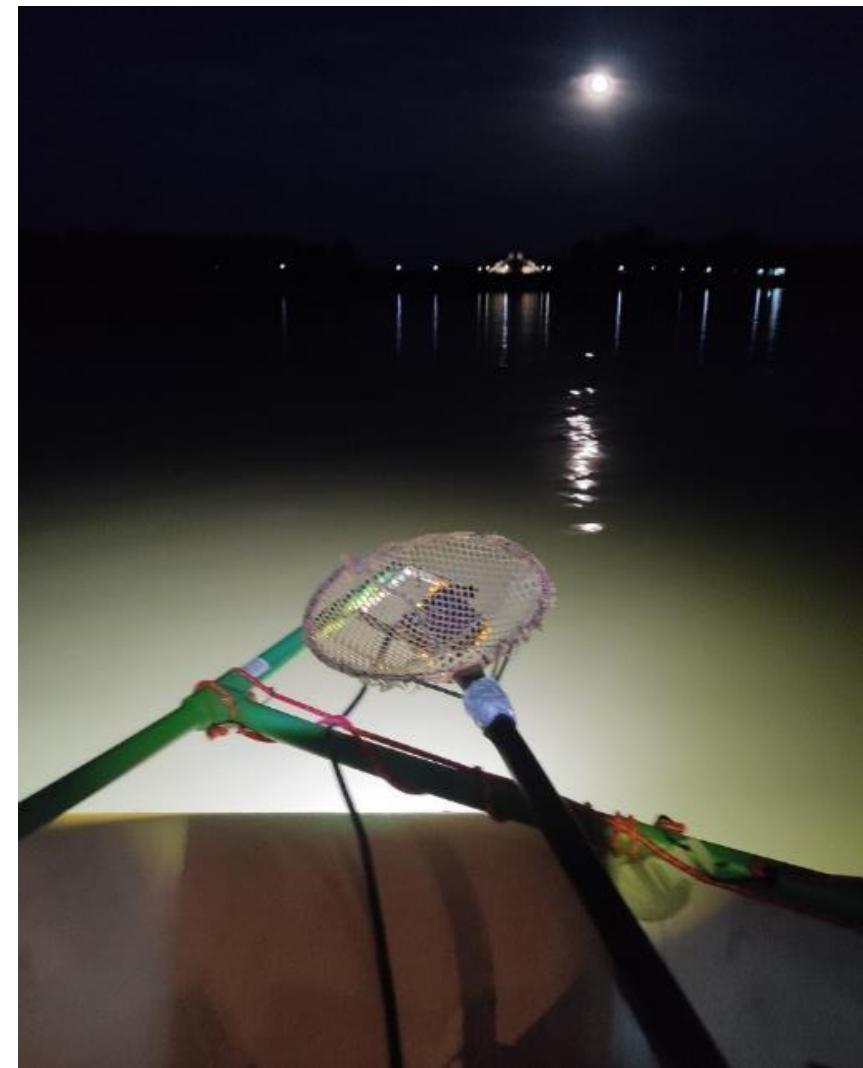
Electrofishing during the day (July 2023)







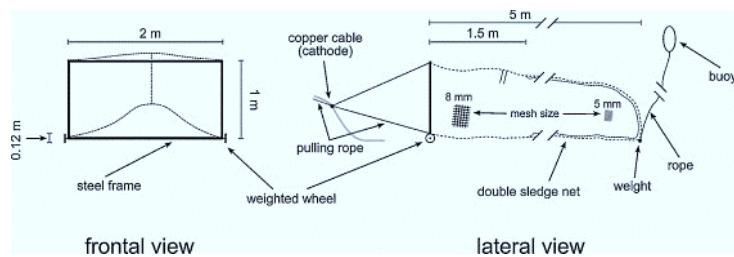
Electrofishing during the night (September/October 2023)



Sampling with electrified benthic frame trawl (electrified dredge)

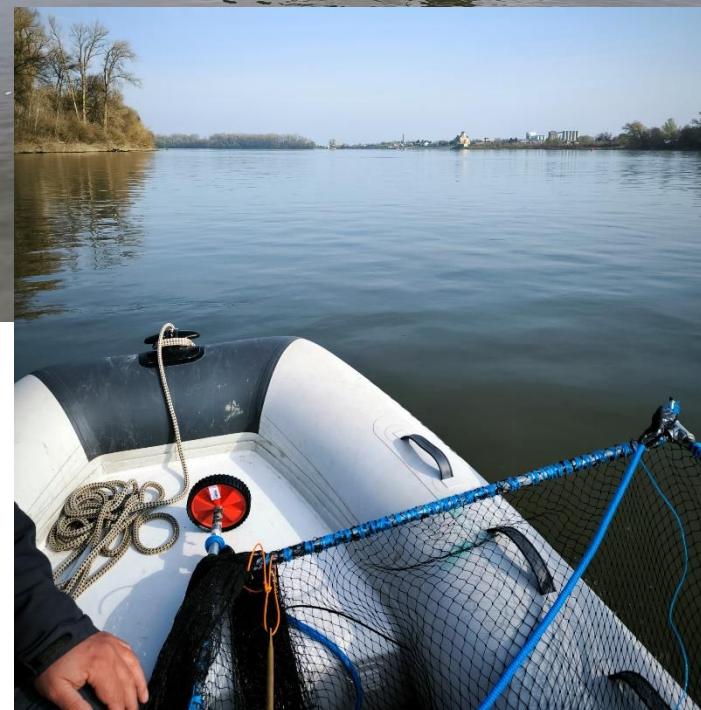


- ▶ Sampling with electrified dredge was conducted in March 2024.
- ▶ 17 critical sections of the river from Batina to Ilok on Croatian side
- ▶ Length of transects was 500 meters minimum



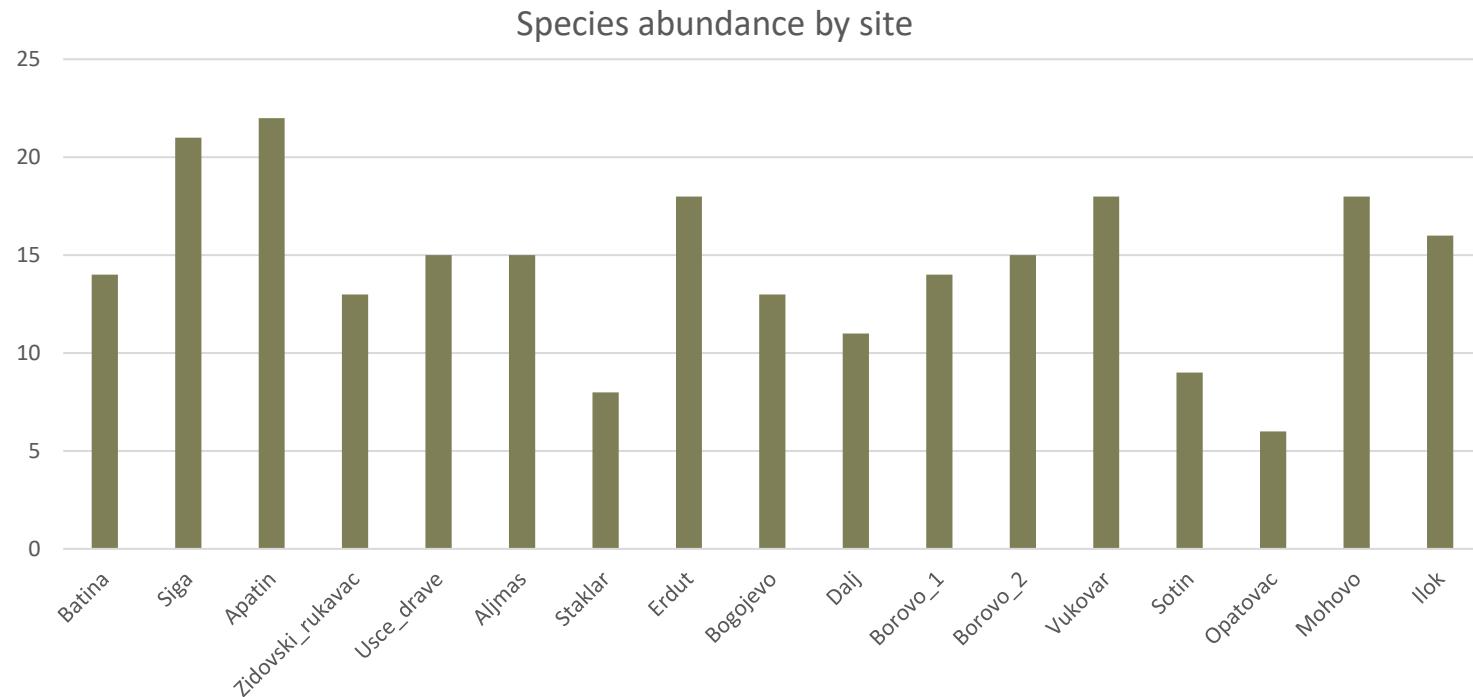
Bammer, V., György, A., Pehlivanov, L., Schabuss, M., Szaloky, Z. i
Zornig, H. (2015): Fish. U: Joint Danube Survey 3, A
Comprehensive Analysis of Danube Water Quality. ICPDR.

Sampling with electrified benthic frame trawl (electrified dredge)



Results

- ▶ 39 species caught including electrofishing during day and night and sampling with electrified dredge.
- ▶ More than 3000 individuals sampled and identified
- ▶ Cyprinidae family is most abundant and present on all 17 critical sections

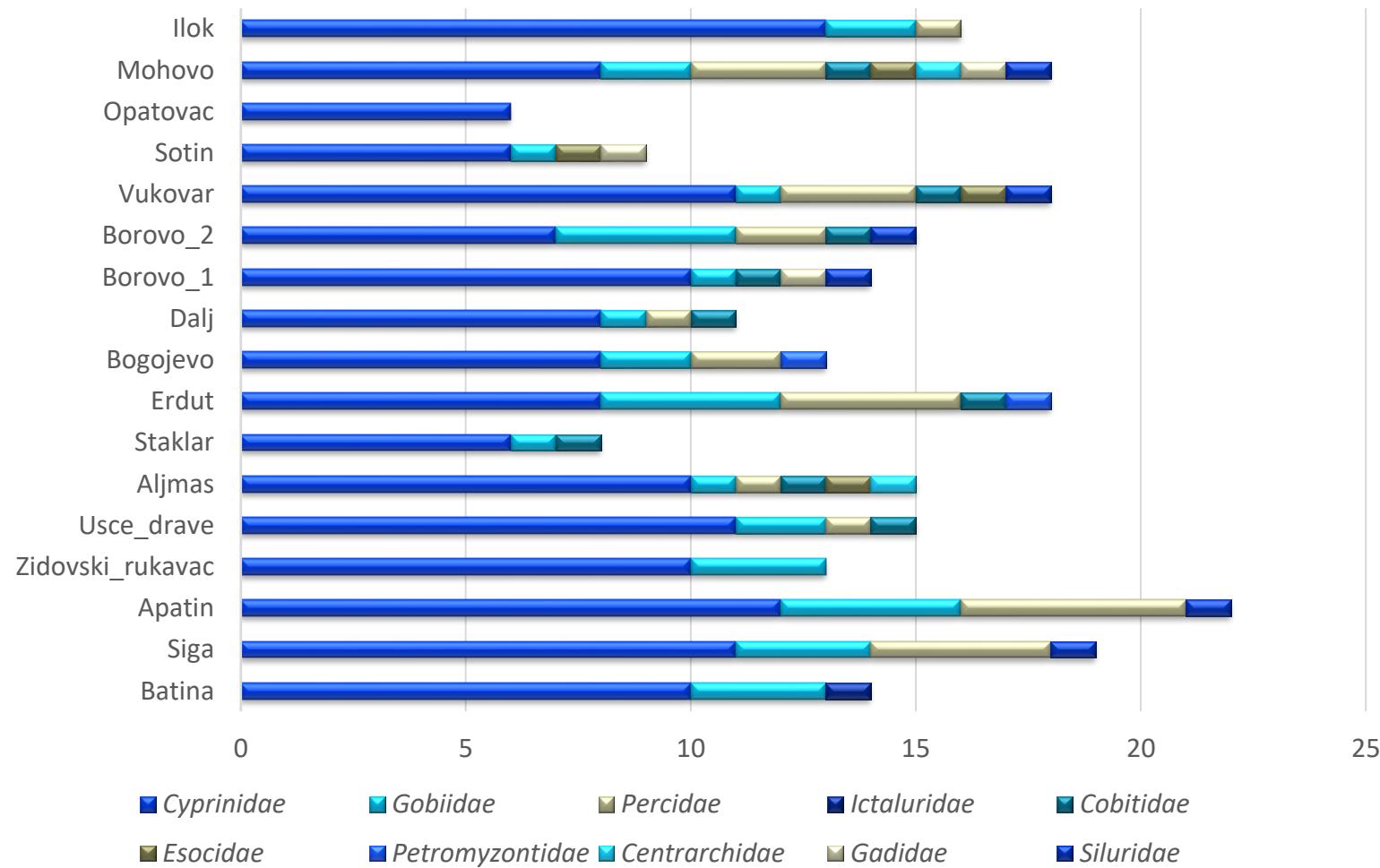


- List of all species sampled by electrofishing during day and night and sampling with electrified dredge.

Family	Species
Cyprinidae	<i>Abramis brama</i>
Cyprinidae	<i>Alburnus alburnus</i>
Cyprinidae	<i>Alburnus sava</i>
Cyprinidae	<i>Aspius aspius</i>
Cyprinidae	<i>Barbus barbus</i>
Cyprinidae	<i>Blicca bjoerkna</i>
Cyprinidae	<i>Carassius gibelio</i>
Cyprinidae	<i>Chondrostoma nasus</i>
Cyprinidae	<i>Ctenopharyngodon idella</i>
Cyprinidae	<i>Cyprinus carpio</i>
Cyprinidae	<i>Gobio obtusirostris</i>
Cyprinidae	<i>Hypophthalmichthys molitrix</i>
Cyprinidae	<i>Leuciscus idus</i>
Cyprinidae	<i>Pseudorasbora parva</i>
Cyprinidae	<i>Rhodeus amarus</i>
Cyprinidae	<i>Rutilus rutilus</i>
Cyprinidae	<i>Rutilus virgo</i>
Cyprinidae	<i>Squalius cephalus</i>
Gobiidae	<i>Babka gymnotrachelus</i>
Gobiidae	<i>Neogobius fluviatilis</i>
Gobiidae	<i>Neogobius melanostomus</i>
Gobiidae	<i>Ponticola kessleri</i>
Gobiidae	<i>Proterorhinus semilunaris</i>
Percidae	<i>Gymnocephalus baloni</i>
Percidae	<i>Gymnocephalus cernua</i>
Percidae	<i>Gymnocephalus schraetser</i>
Percidae	<i>Perca fluviatilis</i>
Percidae	<i>Sander lucioperca</i>
Percidae	<i>Zingel zingel</i>
Ictaluridae	<i>Ameiurus melas</i>
Cobitidae	<i>Cobitis elongata</i>
Cobitidae	<i>Cobitis elongatoides</i>
Esocidae	<i>Esox lucius</i>
Petromyzontidae	<i>Eudontomyzon vladaykovi</i>
Centrarchidae	<i>Lepomis gibbosus</i>
Centrarchidae	<i>Micropterus salmonides</i>
Gadidae	<i>Lota lota</i>
Siluridae	<i>Silurus glanis</i>

Results

Number of fish families on critical sections

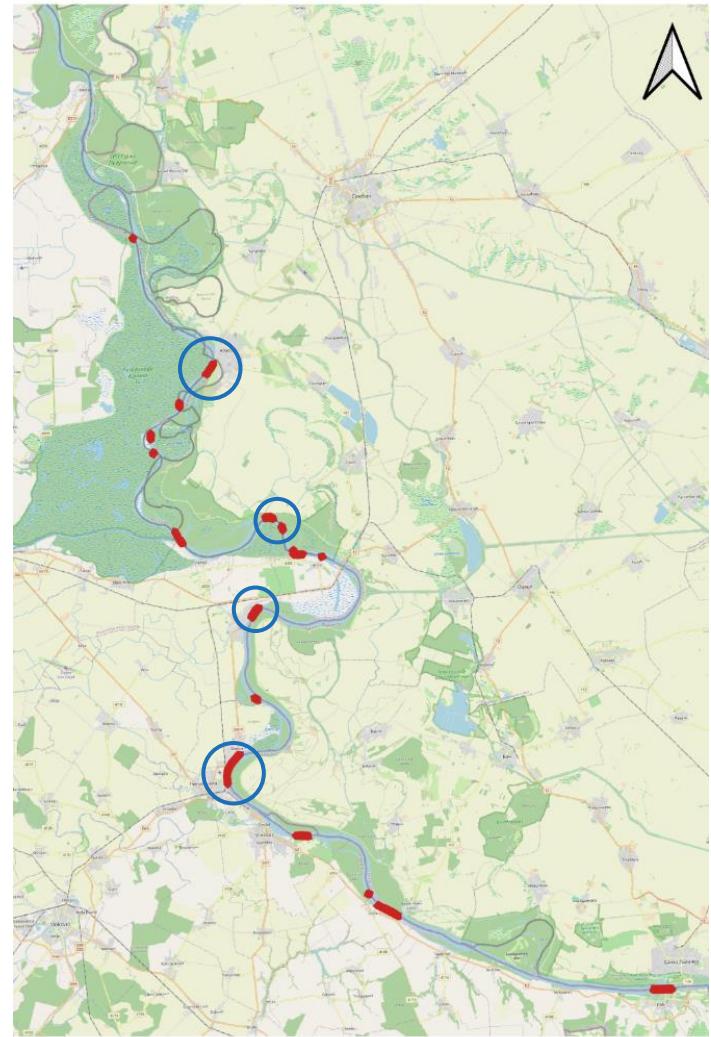


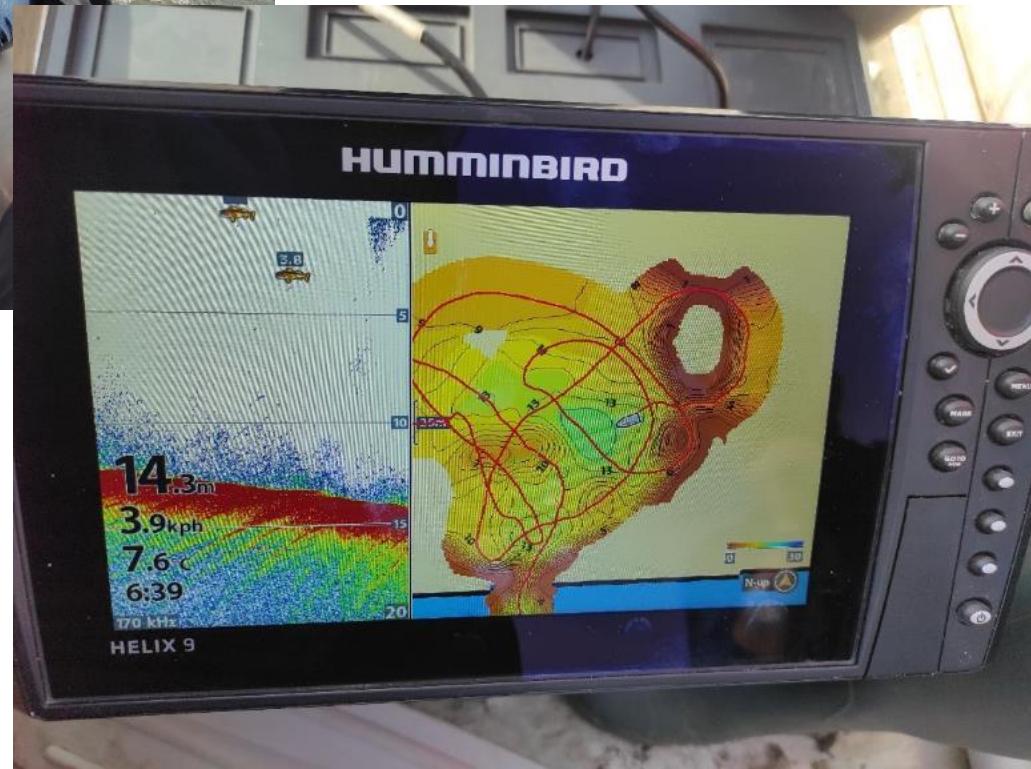
Monitoring of winter habitats



- ▶ Conducted in February 2024. with Humminbird Helix 9 sonar

- ▶ Three sources of information for selecting suitable wintering sites:
 - 3D model of terrain of riverbed
 - Data from local fisherman
 - Scientific papers and historical data





2.2 Habitat inventory

► Objectives

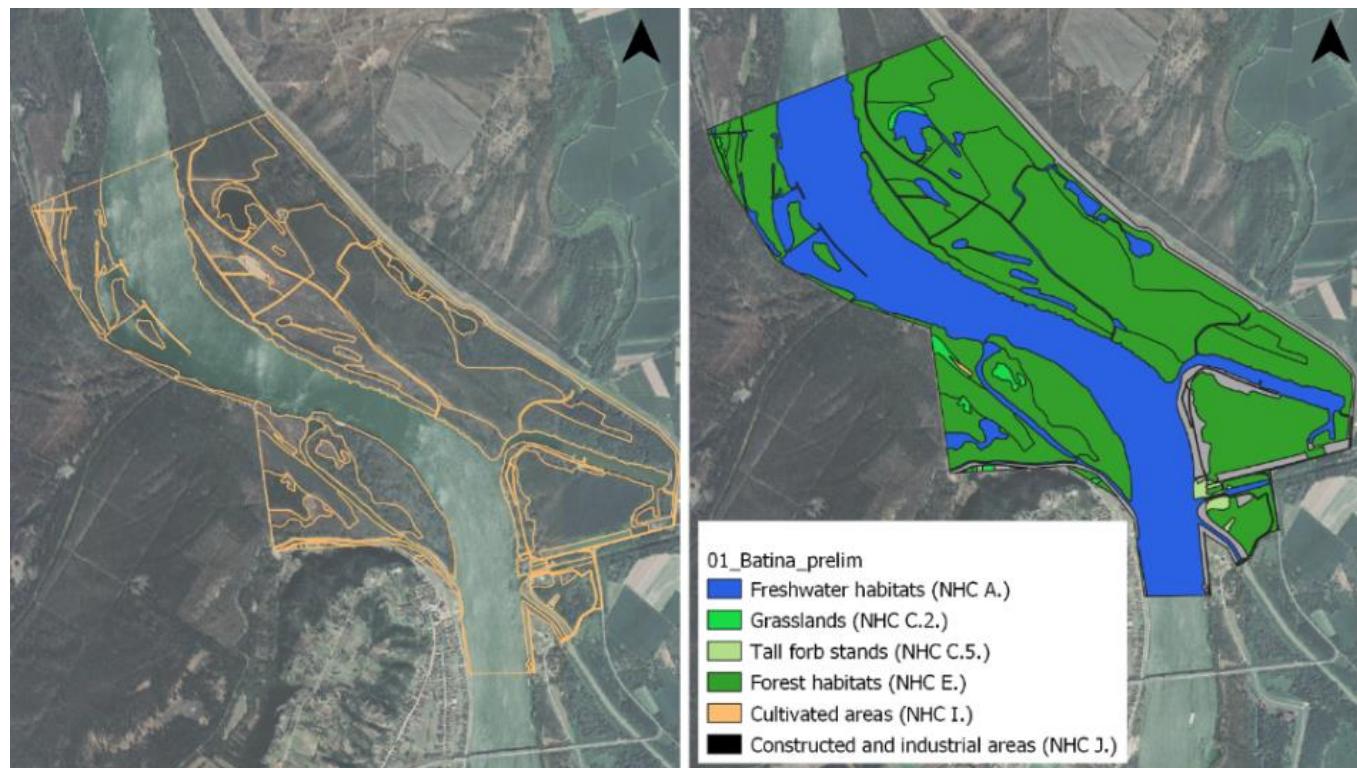
- 17 critical sections on joint Croatian-Serbian sector of the Danube River
- Mapping of target habitat types of the critical sections in the Danube floodplain
- Final habitat map (prepared in scale 1:5.000) should be integrated into GIS database,
- Data on target habitat distribution presented as part of the Biodiversity Catalogue



Methods

- ▶ Field survey - focusing on mapping of 5 target habitat types
 - 1. **Forest habitat type – riparian forests periodically inundated by the annual rise of the river** – 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
 - 2. **Two habitat type occurring on standing water bodies**
 - **Amphibious short annual vegetation, pioneer of land interface zones of standing water bodies** with nutrient poor soils, and periodic drying– 3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or Isoeto-Nanojuncetea
 - **Lakes and ponds with free-floating surface communities** or, in deep, open waters, with large pondweeds – 3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*
 - 3. **Habitat type occurring along the shallow muddy banks of the Danube**, with annual pioneer nitrophilous vegetation – 3270 Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention* p.p. vegetation
 - 4. **Habitat type belonging to alluvial type of meadows with natural flooding regime** – 6440 Alluvial meadows of river valleys of the *Cnidion dubii*

- ▶ Baseline data gathered:
 - ▶ existing **habitat maps**
 - ▶ available data on other **habitat and vegetation surveys** conducted in the Danube floodplain
 - ▶ data on **forest vegetation** in the project area (collected from the national forest management companies)
- ▶ Preliminary map is (the basis for field survey) is prepared – expert visual interpretation of ortophoto imagery, existing baseline data
- ▶ Field survey has been completed by the end of vegetation season 2023 on both sides of the Danube River

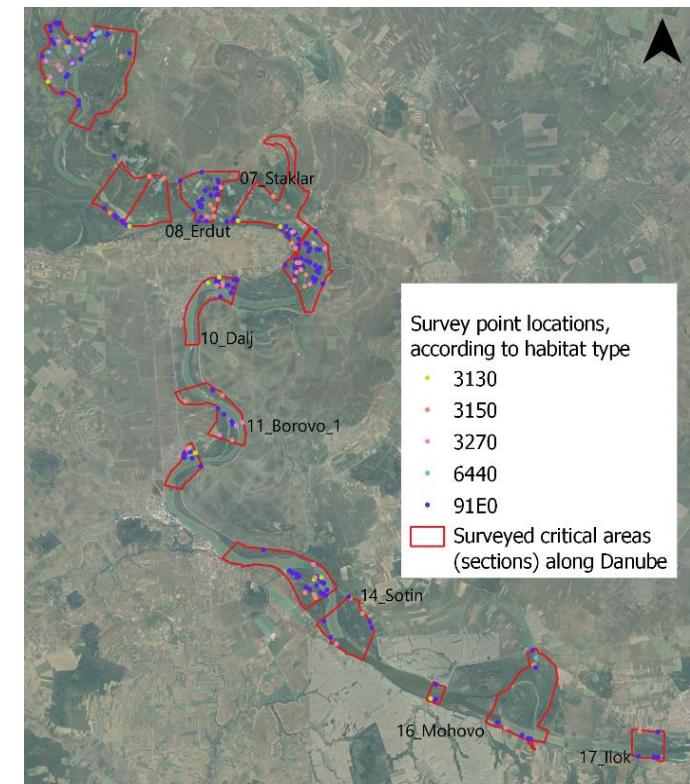
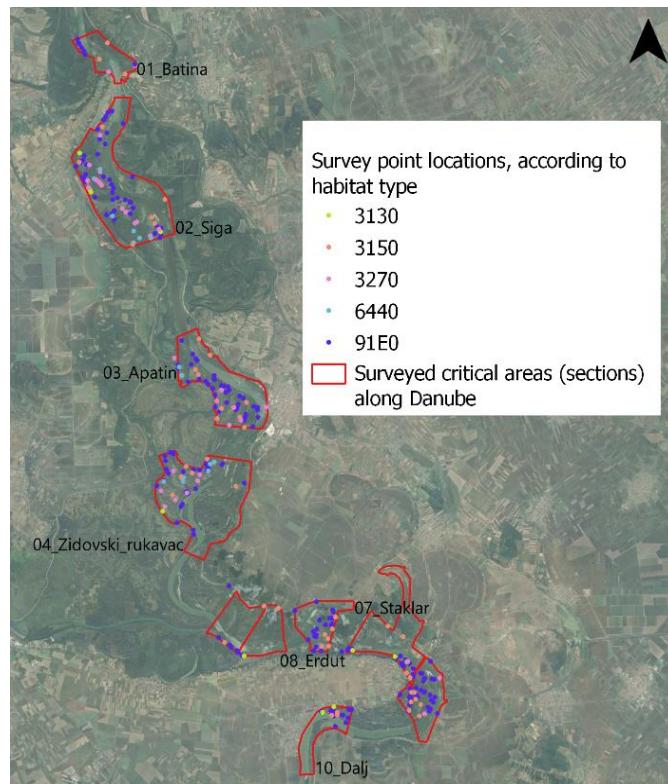


Habitat sampling locations on the Danube



1. Batina
2. Siga
3. Apatin
4. Židovski rukavac
5. Ušće Drave
6. Aljmaš
7. Staklar
8. Erdut
9. Bogojevo
10. Dalj
11. Borovo I
12. Borovo II
13. Vukovar
14. Sotin
15. Opatovac
16. Mohovo
17. Ilok

In total – almost 400 sampling locations for habitat mapping
More than 230 plant species recorded



Occurrence of surveyed habitat types along critical sections of the Danube



Natura 2000 HT	Batina	Siga	Apatin	Zidovski rukavac	Ušće_Drave	Aljmaš	Staklar	Erdut	Bogojevо	Dalj	Borovo_1	Borovo_2	Vukovar	Sotin	Opatovac	Mohovo	Ilok
91E0*	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
3130	x	x		x		x		x		x		x	x		x		
3150	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
3270	x	x	x	x		x		x	x		x	x		x		x	
6440																	



91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)



- ▶ Habitat type 91E0 sampled at 244 locations
- ▶ Recorded at 185 locations

Natura 2000 habitat type	91E0 Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (Alno-Padion, Alnion incanae, Salicion albae) / 91E0 Aluvijalne šume (Alno-Padion, Alnion incanae, Salicion albae)
Vegetation type or community	Alliance Salicion albae Soó 1951 Alliance Populion albae Br.-Bl. ex Tchou 1949, sveza Salicion albae Soó 1951 Alliance Alnion incanae Pawłowski et al. 1928 Alliances Alnion incanae Pawłowski et al. 1928 & Alnion glutinosae Malcuit 1929
Status (EU legislation)	Annex I. HD
Status (national legislation)	listed as rare and endangered habitat type (Annex III, Ordinance - RC OG 027/2021)



Occurrence of observed plant species important for the habitat type 91E0



Species name	Batina	Siga	Apatin	Zidovski rukavac	Usce_Drave	Alijmas	Staklar	Erdut	Bogojevо	Dalj	Borovo_1	Borovo_2	Vukovar	Sotin	Opatovac	Mahovo	Ilok
Trees and shrubs																	
<i>Fraxinus angustifolia</i>	x	x	x	x	x		x		x	x			x	x	x	x	x
<i>Populus alba</i>		x	x	x	x		x	x	x	x	x	x	x	x			x
<i>Populus nigra</i>	x	x	x	x	x		x	x	x	x	x		x	x		x	x
<i>Prunus padus</i>	x	x	x					x	x				x				
<i>Salix alba</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Salix x fragilis</i>		x												x			
<i>Humulus lupulus</i>	x						x	x	x	x		x					x
<i>Rubus caesius</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Viburnum opulus</i>		x								x	x	x					
Herbs																	
<i>Agrostis stolonifera</i>	x	x					x	x			x	x	x	x		x	x
<i>Carex brizoides</i>	x	x	x	x			x	x	x	x			x				x
<i>Carex elata</i>	x	x	x		x		x	x	x	x	x	x	x		x		
<i>Carex elongata</i>		x	x	x		x			x								
<i>Carex remota</i>		x	x	x			x										
<i>Carex riparia</i>	x	x	x	x		x	x	x	x	x	x	x	x	x			
<i>Galium palustre</i>	x	x	x	x	x	x		x	x	x			x		x		
<i>Iris pseudacorus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Leucojum aestivum</i>					x									x			
<i>Lycopus europaeus</i>	x	x						x			x		x	x	x		
<i>Lysimachia nummularia</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Lysimachia vulgaris</i>						x											
<i>Lythrum salicaria</i>		x	x	x		x	x		x		x	x					
<i>Mentha aquatica</i>					x												
<i>Polygonum hydropiper</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Ranunculus repens</i>				x	x	x	x		x			x	x			x	x
<i>Rumex sanguineus</i>	x	x	x	x	x	x				x		x					
<i>Solanum dulcamara</i>	x	x	x	x				x	x			x	x	x			
<i>Stachys palustris</i>	x	x	x					x	x	x	x	x	x	x		x	x
<i>Urtica dioica</i>	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x

3130 Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea



- ▶ Habitat type 3130 observed on all sampled locations (20)



Occurrence of observed plant species important for the habitat type 3130

Species name	Batina	Siga	Apatin	Zidovski rukavac	Usce_Drave	Alijas	Staklar	Erdut	Bogojovo	Daij	Borovo_1	Borovo_2	Vukovar	Sotin	Opatovac	Mohovo	Ilok
<i>Lindernia dubia</i>	x	x		x		x		x		x			x				
<i>Eleocharis acicularis</i>				x													
<i>Cyperus fuscus</i>	x	x						x		x	x		x		x		x
<i>Cyperus michelianus</i>	x	x	x	x		x		x		x	x		x		x		x
<i>Lythrum portula</i>	x	x		x				x						x			
<i>Marsilea quadrifolia</i>												x					

3150 Natural eutrophic lakes with Magnopotamion or Hydrocharition



- ▶ 62 locations sampled
- ▶ Habitat type 3150 recorded on 55 locations

Species name	Batina	Siga	Apatin	Zidovski rukavac	Usce_Drave	Ajimas	Staklar	Erdut	Bogojovo	Daij	Borovo_1	Borovo_2	Vukovar	Sotin	Opatovac	Mohovo	Ilok
<i>Lemna spp</i>	x	x	x	x	x		x	x	x	x	x		x			x	
<i>Spirodela polyrhiza</i>	x	x	x	x	x		x	x	x	x	x		x	x		x	
<i>Utricularia vulgaris</i>			x						x								
<i>Azolla filiculoides</i>		x	x				x	x		x				x			
<i>Potamogeton lucens</i>									x	x							
<i>Salvinia natans</i>	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	

Occurrence of observed plant species important for the habitat type 3150



3270 Rivers with muddy banks with *Chenopodium rubri* p.p. and *Bidention* p.p. vegetation



- Habitat type 3270 sampled on 41 locations – recorded at 27 sampling locations

Species name	Batina	Siga	Apatin	Zidovski rukavac	Usce_Drave	Alijmas	Staklar	Erdut	Bogojovo	Dajl	Borovo_1	Borovo_2	Vukovar	Sotin	Opatovac	Mohovo	Ilok
<i>Chenopodium rubrum</i>	x							x		x	x		x		x		
<i>Bidens frondosa</i>	x	x	x	x		x		x			x		x				
<i>Bidens tripartitus</i>	x	x	x	x	x	x			x	x	x		x	x	x	x	x
<i>Polygonum lapathifolium</i>	x	x	x					x			x				x		
<i>Polygonum hydropiper</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Potentilla supina</i>		x	x														
<i>Xanthium sp.</i>	x	x	x					x			x	x			x		

Occurrence of observed plant species important for **the habitat type 3270**



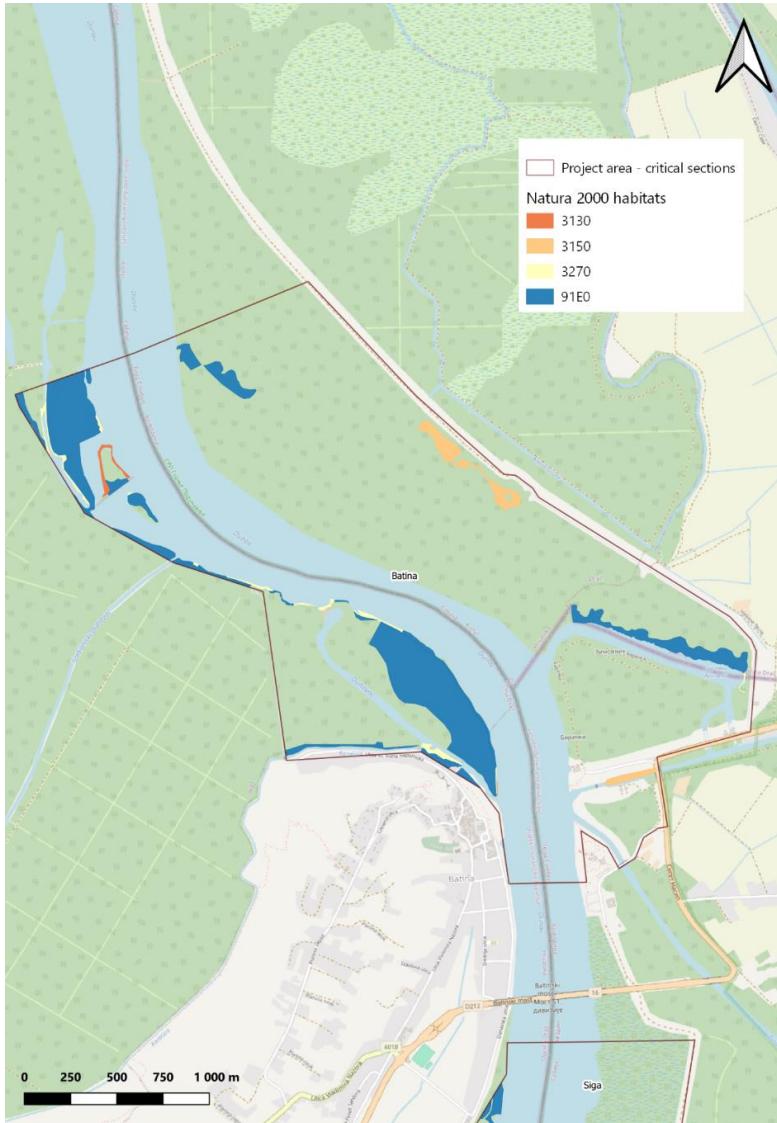
6440 Alluvial meadows of river valleys of the *Cnidion dubii*



- ▶ Habitat type sampled on 16 locations with potential (assumed) distribution
- ▶ Only 2 sampling locations – elements of the habitat type present, but no typical or indicator species recorded



Final habitat map



- ▶ Catalogue of Biodiversiy – separate map of Natura 2000 habitats for each critical section

Plant species

- ▶ 233 of plant species recorded
- ▶ 14 strictly protected in Croatia
- ▶ Several endangered (one CR, one EN, three are sensitive – VU)

Important plant species recorded within 3130 habitat type

► *Marsilea quadrifolia*, water clover

Status (global or EU)

European Red List - NT

Status (HR)

strictly protected species, endangered (EN)

Protection (EU Directives,
Conventions)

Annex I (BC), Annex II (HD), Annex IV HD

Target species for Natura
2000 site HR2000394
Kopački rit

Recorded on one section –
Borovo 2

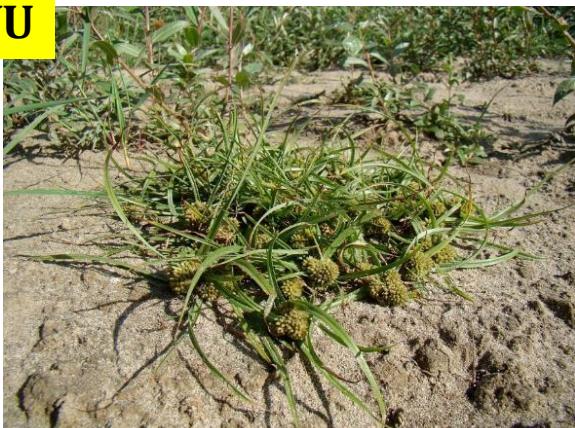


EN

Important plant species recorded within 3130 habitat type



VU



VU

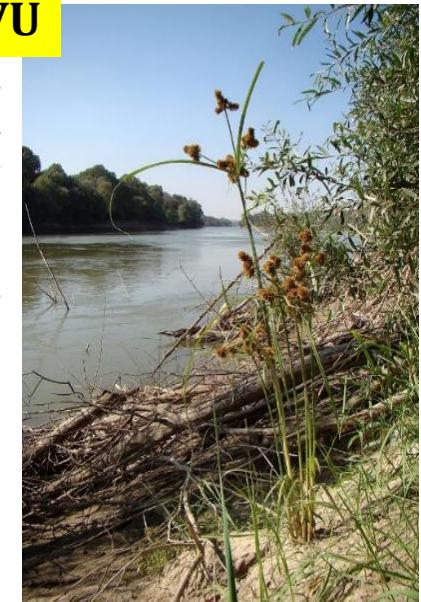
Cyperus michelianus

(source: Юрий Данилевский - Own work, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=69652660>)

VU

Cyperus glomeratus

(source: Юрий Данилевский - Own work,
 CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=69653667>)



Cyperus fuscus

(source: Bernd Sauerwein - Own work, CC BY 3.0,
<https://commons.wikimedia.org/w/index.php?curid=9087198>)



VU

Lythrum portula

(source: Christian Fischer, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=2240196>)

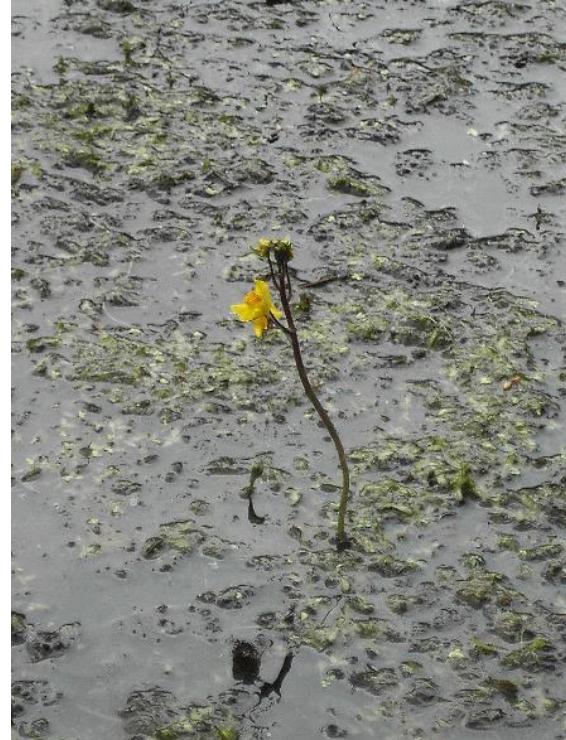
Important plant species recorded within 3150 habitat type



NT

Salvinia natans

small free-floating fern that grows on the surface of nutrient-rich, stagnant water or water with little runoff



Utricularia vulgaris

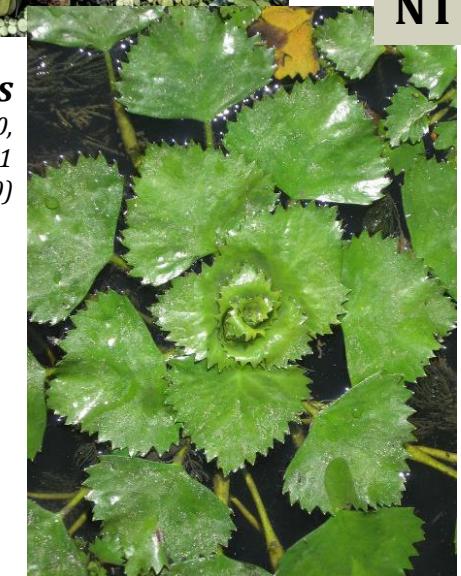
(source: Hans Hillewaert, CC BY-SA 3.0,
<https://commons.wikimedia.org/w/index.php?curid=1179422>)



NT

Utricularia vulgaris

grows in sunny places, in deep
stagnant or slow-flowing
waters, shallow, dark tannin-
rich swamps



NT

Trapa natans

(source: Elena Dyatlova~ukwiki - Own work, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=49121140>)

Important plant species recorded within 3270 habitat type



CR

Polygonum arenarium

(source: Igor Balashov -
<https://www.inaturalist.org/photos/149241462>, CC BY 4.0,
<https://commons.wikimedia.org/w/index.php?curid=122361842>)

CR

Scirpus mucronatus

(source: Wibowo Djatmiko (Wie146)
- Own work, CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=116133176>)



NT

Poa palustris

(source: By Matt Lavin from Bozeman, Montana, USA - *Poa palustris* Uploaded by Tim1357, CC BY-SA 2.0,
<https://commons.wikimedia.org/w/index.php?curid=22754288>)

Important plant species recorded within 91E0 habitat type



Carex riparia



Equisetum hyemale



Within this habitat type – 2 other strictly protected species recorded
– *Iris pseudacorus* (left), *Epipactis helleborine* (right)



Invasive alien plant species

- ▶ 25 recorded within the project area



Amorpha fruticosa



Solidago gigantea

Species name	1	2	3	4	5	6	7	8	
3130 type								x	
<i>Amaranthus blitoides</i>									x
<i>Xanthium strumarium</i>	x		x						
3270 type									
<i>Ambrosia artemisiifolia</i>	x	x	x						
<i>Bidens frondosa</i>	x	x	x	x	x		x		x
<i>Conyza canadensis</i>		x	x					x	x
<i>Datura stramonium</i>		x						x	
<i>Juncus tenuis</i>								x	
<i>Panicum dichotomiflorum</i>	x					x			
Other									
<i>Amaranthus retroflexus</i>	x								
<i>Phytolacca americana</i>	x	x				x	x	x	x
<i>Panicum capillare</i>								x	
<i>Broussonetia papyrifera</i>								x	
<i>Abutilon theophrasti</i>	x								
91E0 type									
<i>Acer negundo</i>	x	x	x	x	x	x	x	x	x
<i>Ailanthus altissima</i>									x
<i>Robinia pseudoacacia</i>						x	x		
<i>Amorpha fruticosa</i>	x	x	x	x		x	x	x	x
<i>Asclepias syriaca</i>		x				x	x	x	x
<i>Solidago gigantea</i>	x	x	x	x	x	x	x	x	x
<i>Solidago canadensis</i>			x					x	
<i>Impatiens parviflora</i>		x	x					x	
<i>Impatiens glandulifera</i>			x						
<i>Erigeron annuus</i>	x	x	x	x	x	x	x	x	x
<i>Echinocystis lobata</i>	x	x	x	x	x	x	x	x	x
<i>Galinsoga parviflora</i>			x						



Acer negundo

2.3 Bird fauna inventory

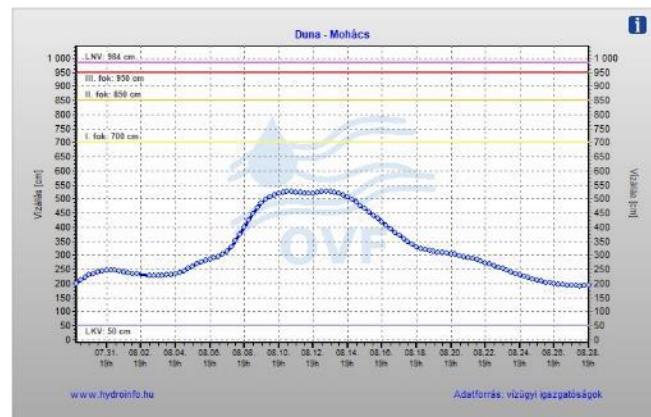
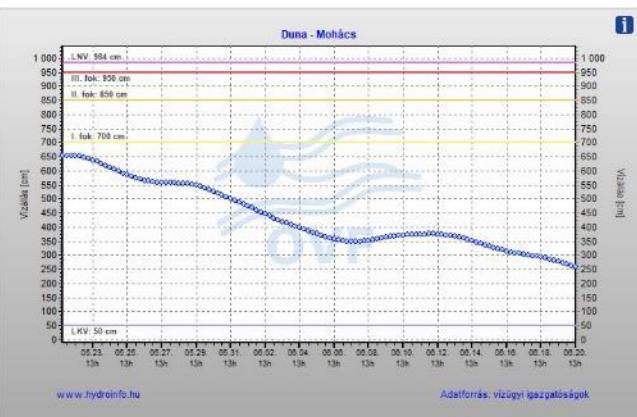
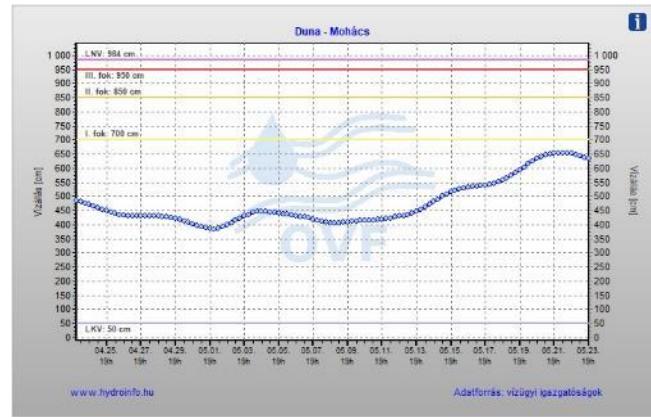
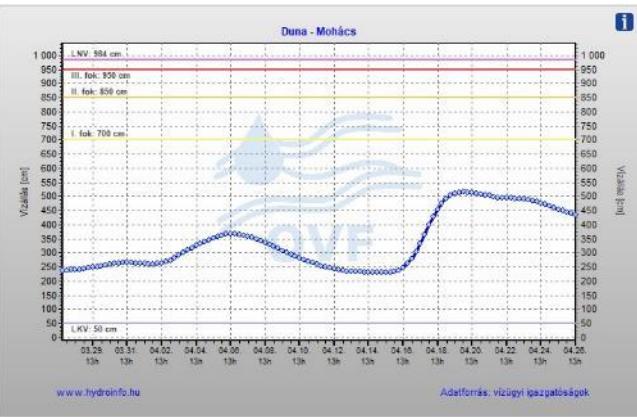


- ▶ All planned activities carried out
 - ▶ Breeding birds of Danube islands and sand bars (May-July)
 - ▶ Breeding birds of Danube steep banks (May-July)
 - ▶ Wetlands birds in Danube floodplain (17 sub-sites)
 - colonial waterbirds (April-July)
 - marshland breeding birds (April-July)
 - raptors (February-July)
 - ▶ Migratory birds along the Danube – (March-May; September-November)
 - ▶ Wintering birds along the Danube – December-February
2022/2023



Bird fauna inventory

- ▶ Breeding season characterised with high water levels
 - Mid-April to early June
 - Mid-August (9.-17.08.)



Results of bird fauna inventory

- ▶ 245 bird species recorded along the Danube River in the Joint Croatian-Serbian sector (main river course + active floodplain)
- ▶ 122 breeding species
 - 32 breeding residents
 - 90 migratory breeders
- ▶ 61 passage species (spring and fall migration)
 - Area used for feeding and resting during migration
- ▶ 25 primarily wintering species
- ▶ 37 rare visitors – uncommon visitors



White-tailed eagle breeding population size (pairs) along the Danube



Critical sector	Rkm	within critical sector	active floodplain	former floodplain	potential pairs	Total pairs
1 Batina	1433-1424	1	1	3	1	6
2 Siga	1424-1412	2	1	2	4	9
3 Apatin	1412-1399	3	14	1	1	19
4 Židovski dunavac	1399-1389	10	20	1	4	35
5 Ušće Drave	1389-1382	9	18	0	4	31
6 Aljmaš	1382-1378	2	0	0	1	3
7 Staklara	1378-1370	1	2	0	1	4
8 Erdut	1370-1366	4	0	0	0	4
9 Bogojevo	1366-1360	1	0	0	1	2
10 Dalj	1360-1351	0	1	0	0	1
11 Borovo 1	1351-1340	2	0	0	0	2
12 Borovo 2	1340-1334	0	0	0	0	0
13 Vukovar	1334-1322	1	1	0	0	2
14 Sotin	1322-1319	0	0	0	0	0
15 Opatovac	1319-1313	0	1	0	0	1
16 Mohovo	1313-1307	2	2	0	0	4
17 Ilok	1307-1296	0	0	0	0	0
Total		38	61	7	17	123

Take-home message: larger active floodplain supports higher number of breeding pairs



Black kite potential breeding population size (pairs) along the Danube



Critical sector	Rkm	within critical sector	active floodplain	former floodplain	Total
1 Batina	1433-1424	1	0	2	3
2 Siga	1424-1412	0	0	2	2
3 Apatin	1412-1399	2	1	2	5
4 Židovski dunavac	1399-1389	3	0	0	3
5 Ušće Drave	1389-1382	3	0	0	3
6 Aljmaš	1382-1378	0	1	0	1
7 Staklara	1378-1370	1	0	0	1
8 Erdut	1370-1366	1	0	0	1
9 Bogojevo	1366-1360	1	0	0	1
10 Dalj	1360-1351	2	1	0	3
11 Borovo 1	1351-1340	1	2	0	3
12 Borovo 2	1340-1334	0	1	0	1
13 Vukovar	1334-1322	1	1	0	2
14 Sotin	1322-1319	0	0	0	0
15 Opatovac	1319-1313	0	1	0	1
16 Mohovo	1313-1307	0	0	0	0
17 Ilok	1307-1296	0	1	0	1
Total		16	9	6	31

Take-home message: old alluvial forests near wet meadows critical for protection of this species



Sand Martin colonies and breeding pairs along the Danube



Critical sector	Rkm	Active colonies	Former nesting sites	Estimated breeding pairs	Total nesting sites
1 Batina	1433-1424	0	1	0	1
2 Siga	1424-1412	0	1	0	1
3 Apatin	1412-1399	0	4	0	4
4 Židovski dunavac	1399-1389	0	0	0	0
5 Ušće Drave	1389-1382	0	1	0	1
6 Aljmaš	1382-1378	0	0	0	0
7 Staklara	1378-1370	0	1	0	1
8 Erdut	1370-1366	0	2	0	2
9 Bogojevo	1366-1360	1	1	20-30	2
10 Dalj	1360-1351	0	1	0	1
11 Borovo 1	1351-1340	1 (+1)	4	15-20	5 + (1)
12 Borovo 2	1340-1334	0	0	0	0
13 Vukovar	1334-1322	1	2	3-6	3
14 Sotin	1322-1319	0	0	0	0
15 Opatovac	1319-1313	0	0	0	0
16 Mohovo	1313-1307	1	1	180-200	2
17 Ilok	1307-1296	(1)	0	6-10	(1)
Total		4 + (2)	19	224-266	23 + (2)

Take-home message: remaining steep banks critical for survival of this species in the area



Kingfisher potential breeding territories along the Danube



Critical sector	Rkm	Within critical site	Active floodplain	Total breeding territories
1 Batina	1433-1424	6	2	8
2 Siga	1424-1412	6	9	15
3 Apatin	1412-1399	18	1	19
4 Židovski dunavac	1399-1389	8	1	9
5 Ušće Drave	1389-1382	8	0	8
6 Aljmaš	1382-1378	1	0	1
7 Staklara	1378-1370	5	4	9
8 Erdut	1370-1366	7	0	7
9 Bogojevo	1366-1360	1	2	3
10 Dalj	1360-1351	2	0	2
11 Borovo 1	1351-1340	7	6	13
12 Borovo 2	1340-1334	1	1	2
13 Vukovar	1334-1322	9	0	9
14 Sotin	1322-1319	3	0	3
15 Opatovac	1319-1313	0	0	0
16 Mohovo	1313-1307	4	0	4
17 Ilok	1307-1296	2	1	3
Total		88	27	115

Take-home message: freely meandering river sections and remaining steep banks critical for survival of this species in the area



Little-ringed Plover potential breeding territories along the Danube



Critical sector	Rkm	Within critical site	Active floodplain	Total breeding territories
1 Batina	1433-1424	0	0	0
2 Siga	1424-1412	1	1	2
3 Apatin	1412-1399	0	0	0
4 Židovski dunavac	1399-1389	1	0	1
5 Ušće Drave	1389-1382	0	0	0
6 Aljmaš	1382-1378	0	0	0
7 Staklara	1378-1370	2	0	2
8 Erdut	1370-1366	0	0	0
9 Bogojevo	1366-1360	0	0	0
10 Dalj	1360-1351	1	0	1
11 Borovo 1	1351-1340	1	0	1
12 Borovo 2	1340-1334	0	0	0
13 Vukovar	1334-1322	0	0	0
14 Sotin	1322-1319	0	1	1
15 Opatovac	1319-1313	0	0	0
16 Mohovo	1313-1307	0	0	0
17 Ilok	1307-1296	0	0	0
Total		6	2	8

Take-home message: very few remaining sand bars/islands vital for the survival and conservation of this species along the joint HR/SR section

Colonial waterbirds - Results



- ▶ 16 heron/cormorant colonies located along the Croatian-Serbian joint section of the Danube
- ▶ Only one (Sakadas lake) situated in the active floodplain (Great cormorant/Grey heron)
- ▶ 2 breeding species of cormorants (*Phalacrocorax carbo*, *Microcarbo pygmeus*)
- ▶ 7 breeding species of herons (*Ardea cinerea*, *A. alba*, *A. purpurea*, *Egretta garzetta*, *Ardeola ralloides*, *Nycticorax nycticorax*, *Bubulcus ibis*)
- ▶ Birds from the colonies forage in the floodplains up to 10 km from the colonies
- ▶ **Take-home message: navigation projects must not cause river bed deepening or disconnection between river and its floodplain**

2.4 River benthos type inventory

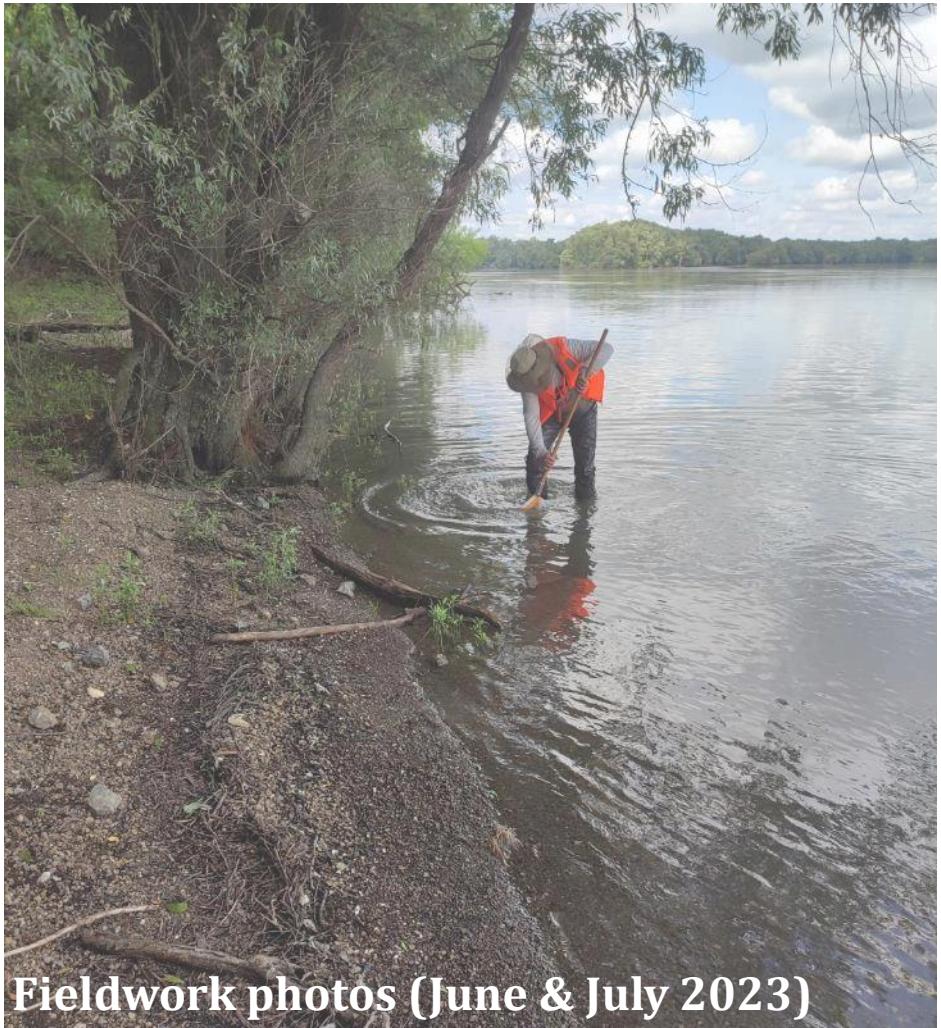


► Objectives

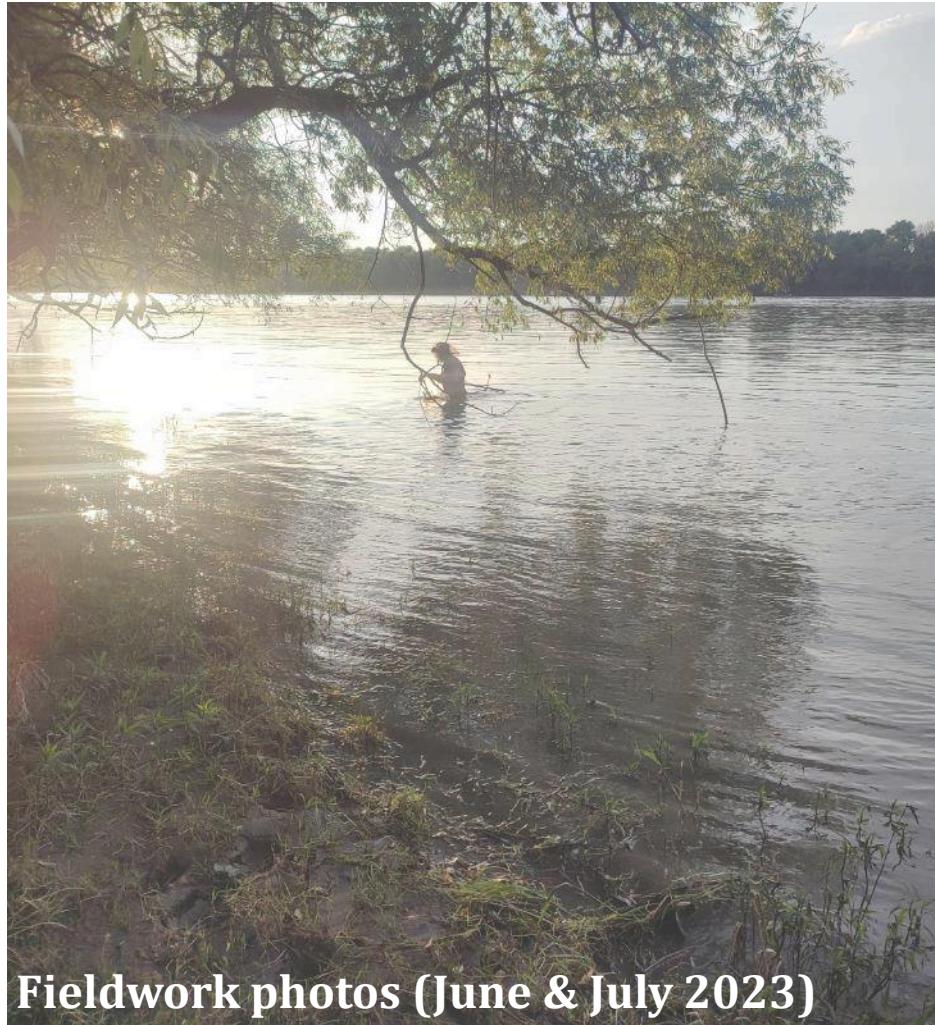
1. 17 critical sections on joint Croatian-Serbian part of Danube
2. Survey river macroinvertebrate community structure in the critical sections of Danube river
3. Integration of data into GIS database and presentation of macrozoobenthic communities within the Biodiversity Catalogue

Methods

- ▶ Field survey – sampling methodology is following the national (HR) Methodology of sampling, laboratory analyzes and determining the ecological quality ratio for biological quality element
- ▶ Field work has been carried completely on all 17 critical sections during summer 2023
 - June 2023 (7 upstream sections, from Batina to Aljmaš)
 - End of July 2023 (downstream sections, from Erdut to Ilok)



Fieldwork photos (June & July 2023)

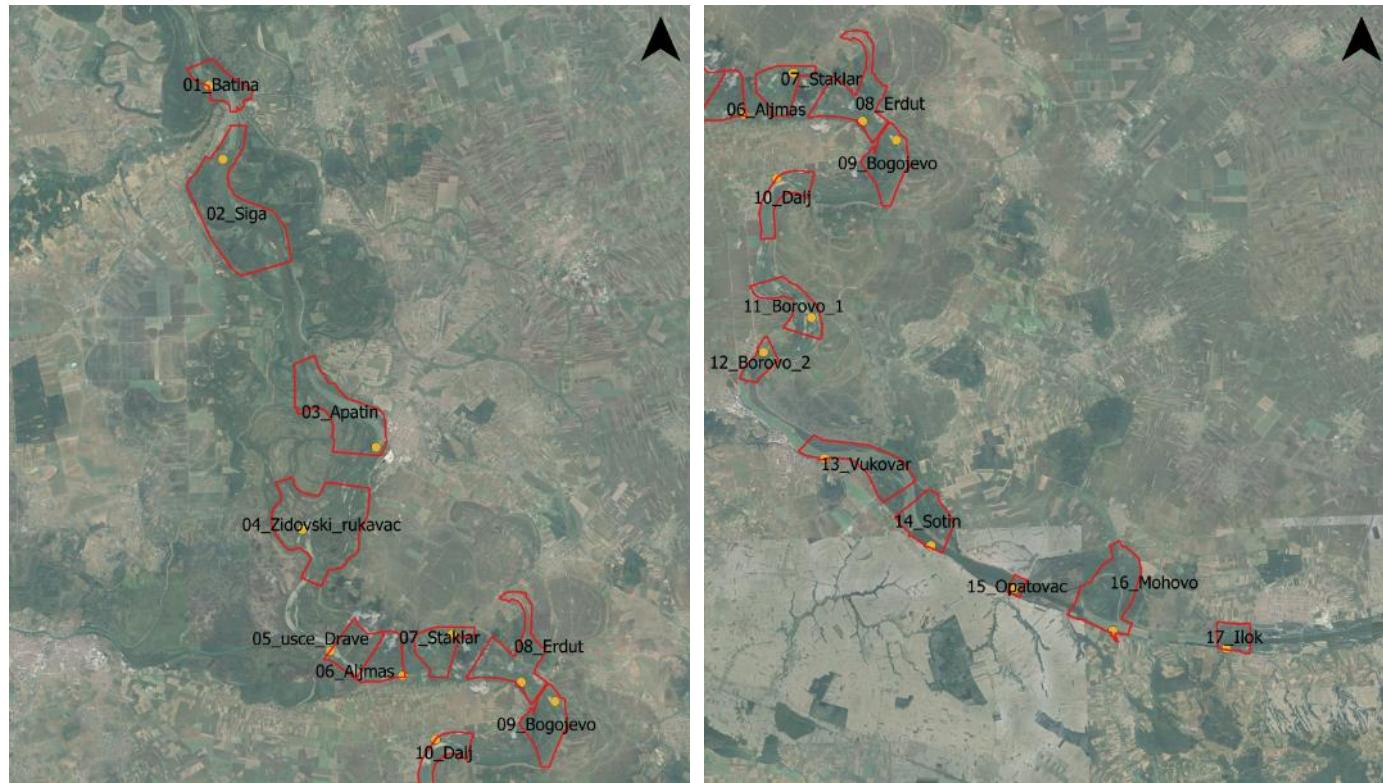


Fieldwork photos (June & July 2023)



Habitat sampling locations on the Danube

1. Batina
2. Siga
3. Apatin
4. Židovski rukavac
5. Ušće Drave
6. Aljmaš
7. Staklar
8. Erdut
9. Bogojevo
10. Dalj
11. Borovo I
12. Borovo II
13. Vukovar
14. Sotin
15. Opatovac
16. Mohovo
17. Ilok





01_Batina



02_Siga



03_Apatin



04_Židovski_rukavac



05_Ušće_Drave



06_Aljmaš

07_Staklar



08_Erdut



12_Borovo_2



14_Sotin



13_Vukovar



16_Mohovo



15_Opatovac

17_Ilok



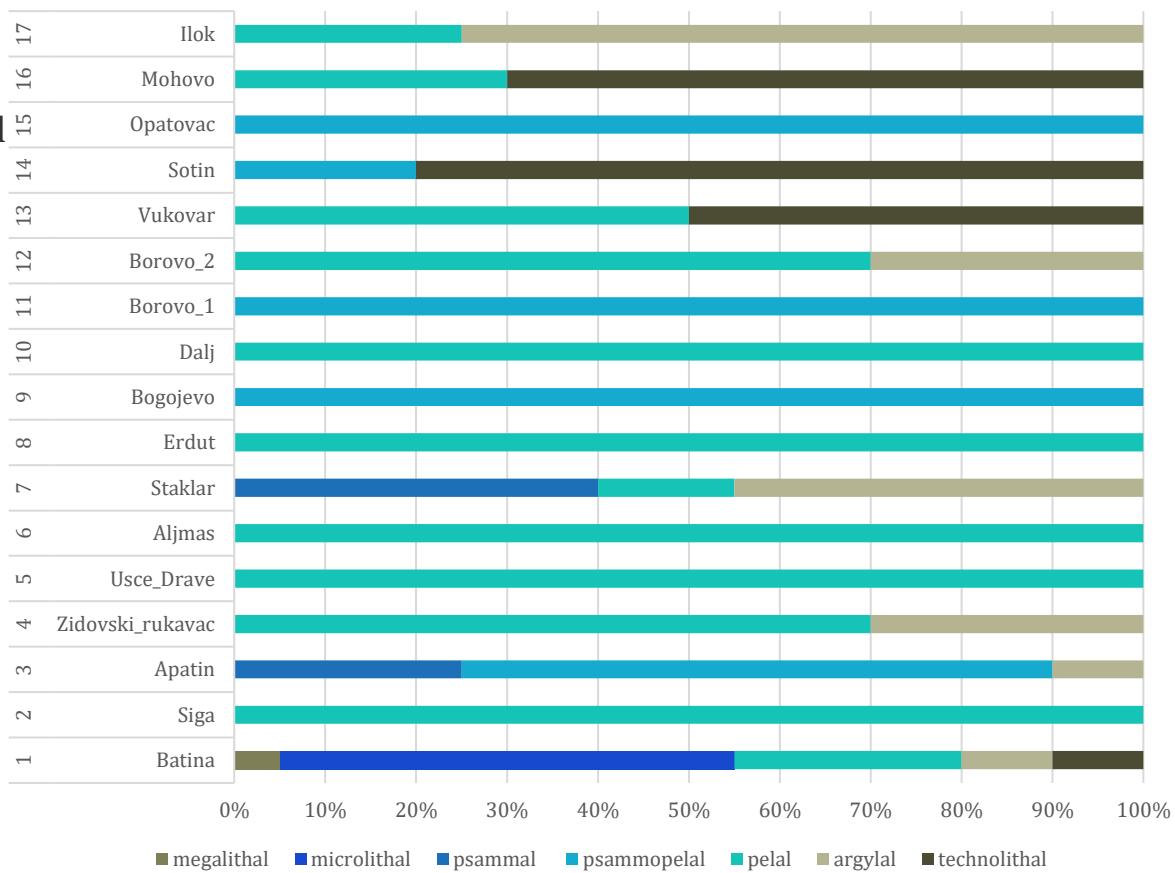
Habitat sampling locations on the Danube

- ▶ During sampling, all relevant data were gathered according to the protocol (water levels, water temperature of the Danube, data on physical and chemical parameters gathered (oxygen, pH, conductivity), photo documentation)
- ▶ Samples (according to the protocol) have been stored and shipped for further laboratory analysis.
- ▶ At 14 locations, samples were taken on the right bank of the Danube, while at the remaining critical sections, sampled transects were selected in the central part of the watercourse (river islands).

Habitat sampling locations on the Danube

Proportion of the benthic habitats i.e. sampled natural substrate type.

- ▶ 9 locations pelal (particles <6 µm) dominated the sample
- ▶ 5 locations psammopelal prevailed in the sample
- ▶ 1 location microlithal (2-6 cm, i.e. medium and coarse pebbles up to the size of a hand) dominated
- ▶ 2 locations argylal (<6 µm, inorganic silt and clay) dominated in the sample



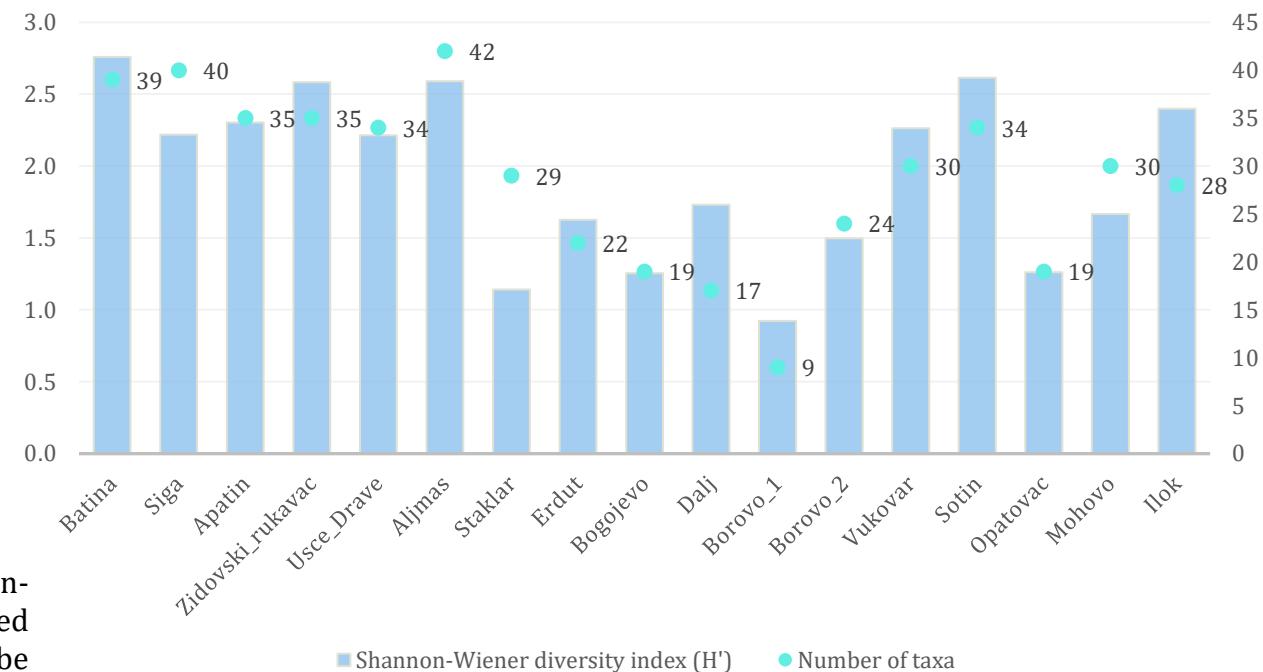
Laboratory processing and analysis



- ▶ Laboratory processing of samples include isolation of animal from the samples, and later determination of taxa.
- ▶ Determination of animals was done to the lowest possible taxa level, but at least to obligatory taxa level according to prescribed methodology
- ▶ Indicators (indices) and modules for the assessment of the ecological status based on macrozoobenthos used for the type of watercourse were calculated.

Results

- ▶ In total almost 17 500 animal specimens have been isolated and determined in 17 samples, in total 92 taxa recorded
- ▶ Number of taxa observed at each sampling section (transect) varied between 9 (section Borovo 1) and 42 (section Aljmaš).
- ▶ The most frequent observed species is a Ponto-Caspian alien gastropod species *Lithoglyphus naticoides* (88,2% of samples).
- ▶ The highest taxa richness was observed within crustaceans and molluscs (Bivalvia and Gastropoda)



Results

- ▶ Indicators (indices) and modules for the assessment of the ecological status based on macrozoobenthos used for the type of watercourse to which the Danube River belongs (HR-R_5D; Lowland very large streams-Danube, 5D) are as follows:
 1. Saprobitry module:
 - 1.1. Croatian saprobic index (SIHR)
 - 1.2. Extended biotic index (PBI) (IBE Aqem)
 2. General degradation module:
 - 2.1. Shannon-Wiener diversity index (H)
 - 2.2. Proportion of taxa that prefer gravel, littoral and sandy substrate type Akal+Lit+Psa (ALP%) ([%]) Type Aka+Lit+Psa (scored taxa = 100%)
 - 2.3. Index of Biocoenotic Region (IBR)

Results

- The ecological quality ratios calculated on the basis of indices values are then used to calculate the ecological quality ratio of the saprobitry module and the general degradation module for the sampled type of watercourse

Index	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Shannon-Wiener diversity index (H')	2,8	2,2	2,3	2,6	2,2	2,6	1,1	1,6	1,3	1,7	0,9	1,5	2,3	2,6	1,3	1,7	2,4
Extended biotic index (PBI)	6,6	7,4	6,0	5,6	6,0	7,6	5,6	5,4	2,4	3,4	2,0	5,0	5,0	6,0	5,0	6,0	5,4
Proportion of taxa that prefer gravel, littoral and sandy substrate type (ALP%)	56,8	40,7	50,4	61,6	50,3	48,2	35,6	36,5	43,1	30,0	24,9	35,5	59,0	74,4	49,5	51,3	40,7
Index of Biocoenotic Region (IBR)	7,1	7,0	7,2	7,2	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,1	7,4	7,1	7,4	7,2
Croatian saprobic index	2,2	2,2	2,3	2,2	2,2	2,3	2,2	2,4	2,2	2,8	2,2	2,5	2,8	2,6	2,3	2,5	2,8
Ecological quality ratio –saprobitry module	0,69	0,72	0,62	0,63	0,66	0,71	0,64	0,57	0,49	0,38	0,48	0,53	0,46	0,55	0,58	0,58	0,48
Ecological quality ratio –general degradation module	0,77	0,63	0,68	0,77	0,68	0,71	0,49	0,55	0,54	0,53	0,41	0,53	0,72	0,83	0,57	0,60	0,64

Overall assessment of ecological status **according to macrozoobenthos** – upstream sections have generally good status, from Staklar and downstream to Ilok generally moderate

- Results indicate that several alien species, belonging to different benthic taxa groups have widespread distribution in joint Croatian-Serbian sector of the Danube

Occurrence of alien species in benthic macroinvertebrate communities

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
<i>Corbicula fluminea</i>								x	x				x	x	x	x	x
<i>Dreissena polymorpha</i>								x				x	x				
<i>Sinanodonta woodiana</i>												x					
<i>Orconectes limosus</i>																x	
<i>Corophium curvispinum</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Corophium robustum</i>	x	x	x	x	x			x	x			x	x	x	x	x	x
<i>Dikerogammarus villosus</i>	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x
<i>Dikerogammarus haemobaphes</i>	x							x				x					
<i>Dikerogammarus bispinosus</i>	x		x	x			x					x	x				
<i>Echinogammarus ischnuuus</i>														x			
<i>Obesogammarus obesus</i>	x	x	x				x	x				x	x	x	x	x	x
<i>Jaera istri</i>	x	x	x	x	x	x	x	x	x			x	x	x	x	x	x
<i>Hemimysis anomala</i>			x	x		x	x					x					x
<i>Limnomysis benedeni</i>	x	x	x	x	x	x	x	x				x	x	x	x	x	x
<i>Lithoglyphus naticoides</i>	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Potamopyrgus antipodarum</i>												x	x				
<i>Hypania invalida</i>	x	x	x	x	x		x					x	x	x	x	x	x

Dikerogammarus villosus „killer shrimp”



(Source: NOAA Great Lakes Environmental Research Laboratory, 2004, Creative Commons License)

Polychaete *Hypania invalida*



(Source: Alexander Koenig, Zoologisches Forschungsmuseum, 2018, Creative Commons License)

Eight alien species have been confirmed in more than 50% of sampled sections, and are dominating in abundance in relation to autochthonous species



Isopod crayfish *Jaera istri*

(Source: Alexander Koenig, Zoologisches Forschungsmuseum, 2017, Creative Commons License)



**Amphipod crustacean
*Corophium curvispinum***

(Source: Naturalis - Zoology and Geology catalogues - https://biportal.naturalis.nl/multimedia/RMNH.5012316_1/scientificName=Chelicorophium+curvispinum&logicalOperator=AND&from=0, CC0)



Gastropod *Lithoglyphus naticoides*

(Source: Jan Steger - <http://www.animalbase.uni-goettingen.de/zoo/web/servlet/AnimalBase/home/picture?id=6617>)

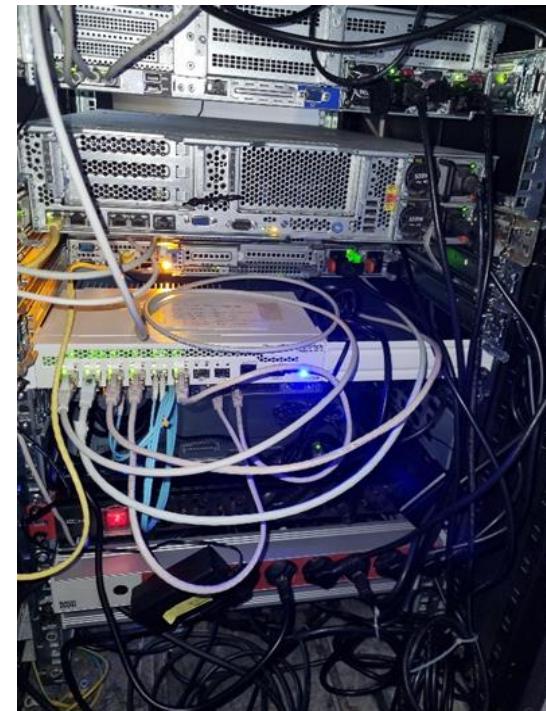
3. ESTABLISHMENT OF A GEOINFORMATION SYSTEM (GIS)

► Activities within the scope of the project:

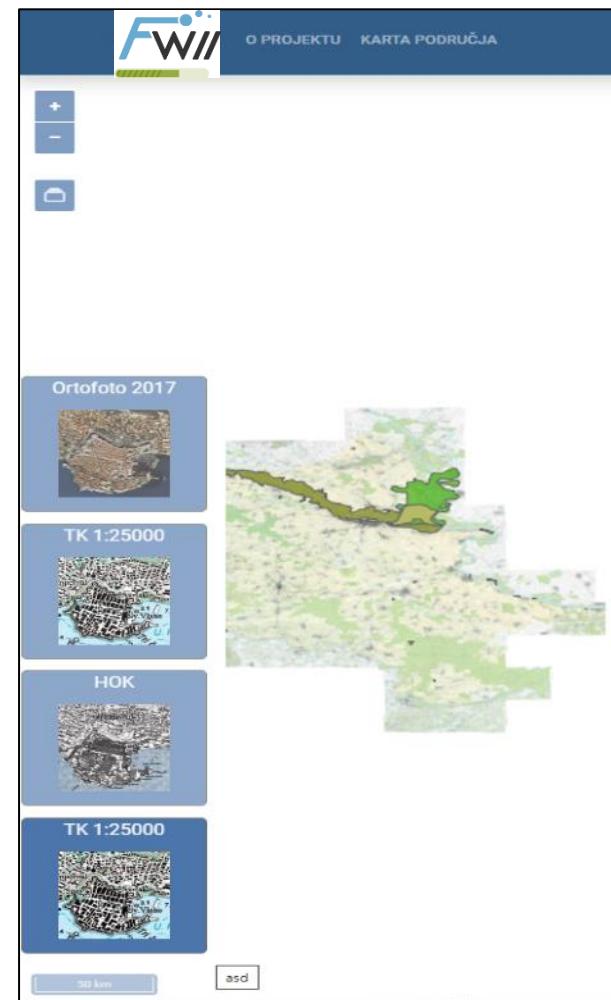
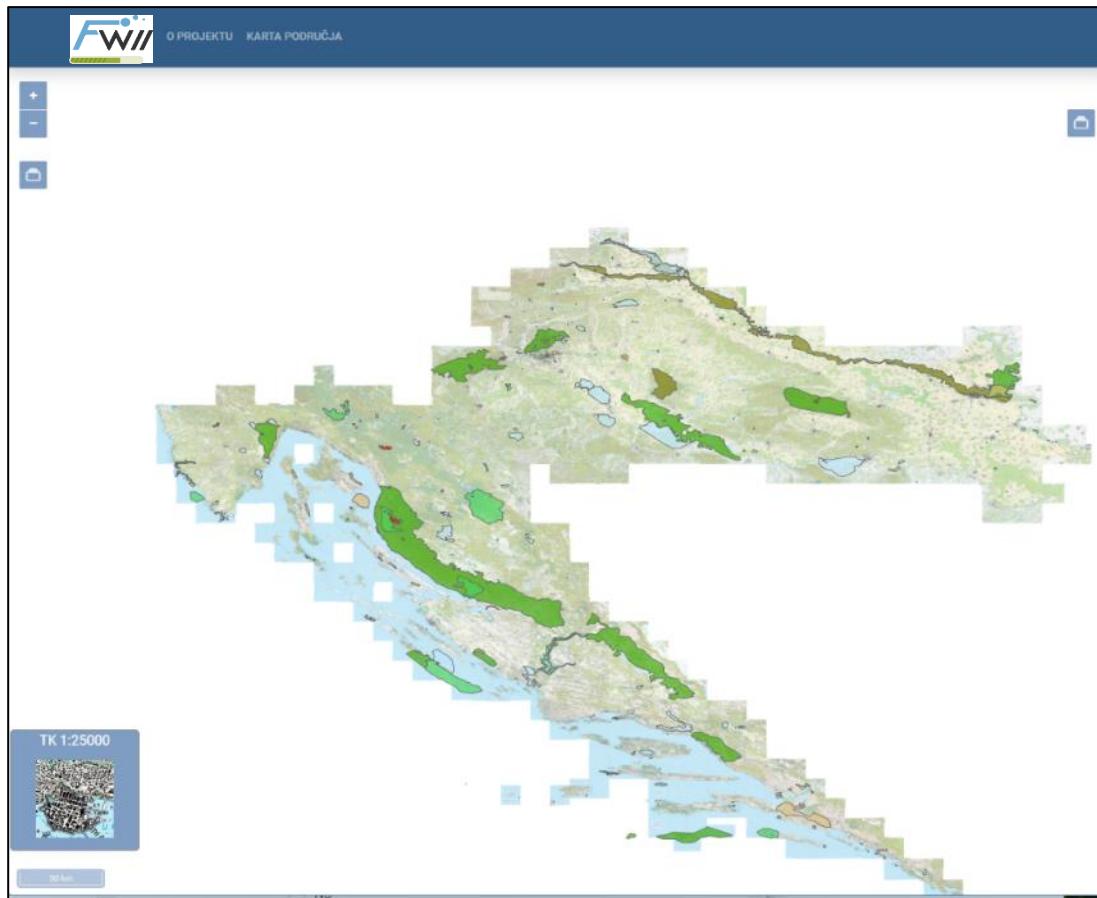
- Set-up and configuring of a server +
- Implementation of a WebGIS system (user requirement analysis, application development and implementation) +/-
- Collection of monitoring data, systematization and GIS database establishment +/-

Set-up and configuring of a server

- ▶ The server is set-up and configured at the MMPI location
 - Technical characteristics of server
 - local server - at least 5 TB of disk space (upgradable)
 - interface requirements - at least 128 GB of RAM
 - min 2xIntel Xeon processors
- ▶ Access is tested and enabled



Implementation of a WebGIS system (user requirement analysis, application development and implementation)



Implementation of a WebGIS system (user requirement analysis, application development and implementation)



The screenshot displays a web-based content management system (CMS) interface for a WebGIS application. On the left, a sidebar titled "Content" shows a tree structure of site pages:

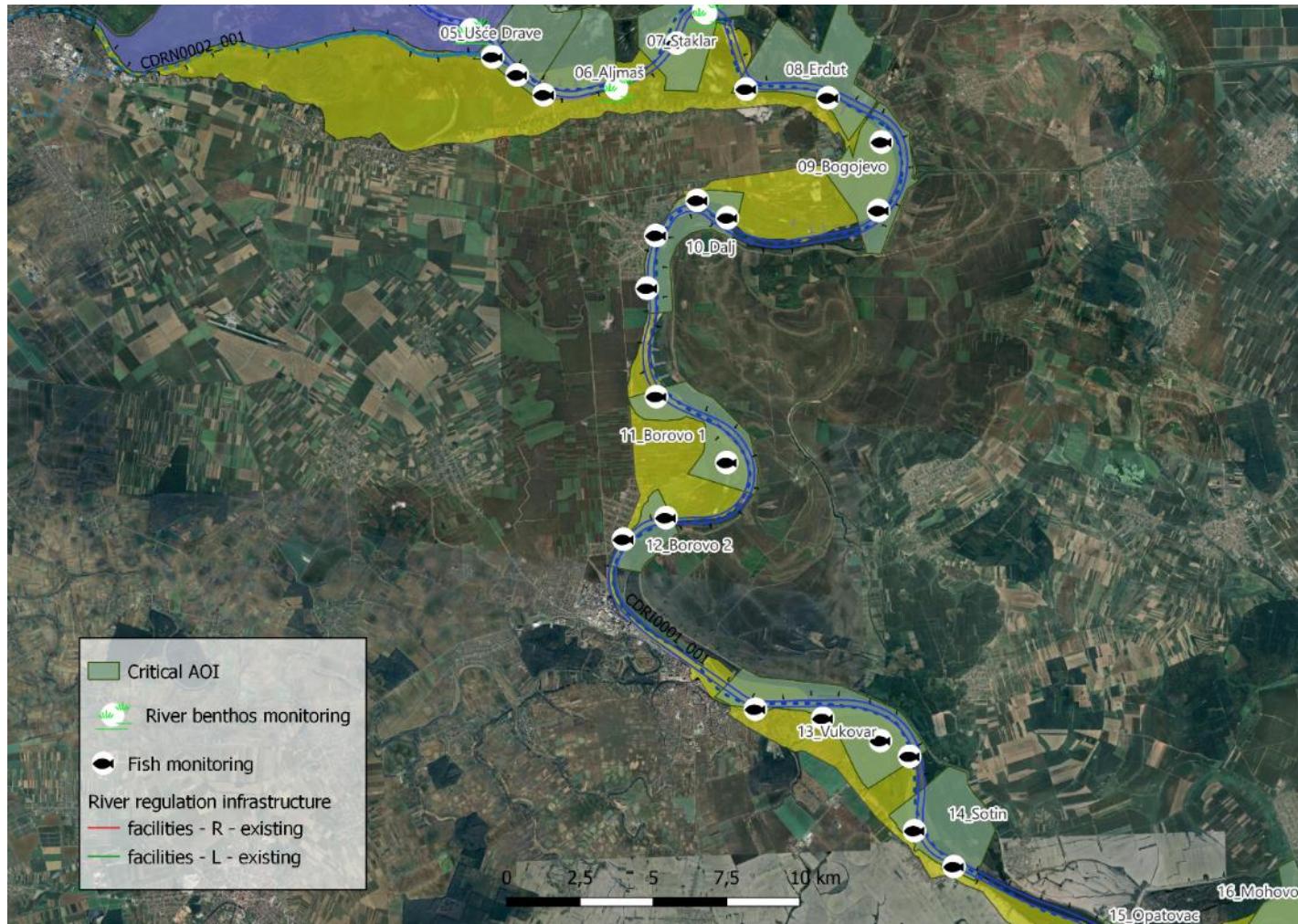
- Home Page
- O projektu
- Karta područja
 - Ortofoto 2017
 - Tk25000
 - HOK
 - Natura 2000 - Zaštićemo podru...
 - Natura 2000 - Direktiva o ptica...
 - Natura 2000 - Direktiva o stani...
- Recycle Bin

The "Karta područja" node is currently selected, highlighted with a blue border. To the right, a "Create" dialog box is open under the heading "Create an item under Karta područja". This dialog shows a "Layer" option selected. Below it, the main content area shows the creation of a new layer named "Tk25000". The form fields include:

- Title:** TK 1:25000
- Layer Type:** Base layer Thematic layer
- Icon:** Base layer icon (with a thumbnail image of a map)
- WMS URL:** <https://geoportal.dgu.hr/services/tk/wms>
- Layers:** TK25
- Group Name:** Podloge
- Visible:** Yes No

At the bottom of the interface, there are navigation links: "Home Page / Karta područja / Tk25000", and buttons for "Save and preview", "Save", and "Save and publish".

Collection of monitoring data, systematization and GIS database establishment



Final steps



- ▶ Implementation of a local WebGIS system
- ▶ Collection of monitoring data, systematization and GIS database establishment
- ▶ User manuals development, system administrator's usage instructions, system management and control manual, and documentation for user training



Co-financed by the Connecting Europe Facility of the European Union



Thank you for your kind attention



Republika Hrvatska
**MINISTARSTVO MORA,
PROMETA I INFRASTRUKTURE**

Danijel Đuđar
T +385 32 445 051
W <https://mmpi.gov.hr>
www.vodnipaylovi.hr



Oikon Ltd. – Institute of Applied Ecology
Trg senjskih uskoka 1-2
HR – 10020 Zagreb
T +385 1 5507 100
F +385 1 5507 101
E oikon@oikon.hr
W www.oikon.hr



Hidroing Ltd.
Tadije Smičiklasa 1
HR - 31000 Osijek
T +385 31 25 11 00
F +385 31 25 11 06
E hidroing@hidroing-os.hr
W www.hidroing-os.hr



Vodoprivredno-projektni biro, p.l.c.
Ulica grada Vukovara 271/III
HR - 10000 Zagreb
T +385 1 5630 400
F +385 1 5630 401
E vpb@vpb.hr
W <https://www.vpb.hr>