ARUP

Public Water Management Company Srbijavode

European Bank for Reconstruction and Development

Environmental and Social Impact Assessment, Climate Change Assessment and Technical Assessment for Pambukovica Dam in Serbia

Biodiversity Impact Assessment

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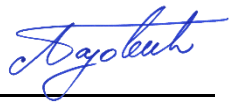
		Signature			
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Abbreviations

Abbreviation	Definition
AQEM	Austrian/German Rapid Bioassessment Method
ASPT	Average Score Per Taxon
BBF	Biodiversity Baseline Framework
BC	Birds Directive
BNG	Biodiversity Net Gain
BN	Bern Convention
BMWP	Biological Monitoring Working Party
BTO	British Trust for Ornithology
CES	Candidate Emerald Site
CHA	Critical Habitat Assessment
CH	Critical Habitat
CR	Critically Endangered
DAFOR	Dominant, Abundant, Frequent, Occasional, Rare
DD	Data Deficient
EAAA	Ecologically Appropriate Area of Analysis
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EIA	Environmental Impact Assessment
EN	Endangered
EOO	Extent of Occurrence
EP	Environmental Protection
ESIA	Environmental and Social Impact Assessment
EU	European Union
EUNIS	European Nature Information System
FL	Flora and Fauna
FL	Fork Length
GN	Guidance Note
HD	Habitats Directive
HMP	Habitat Management Plan

Abbreviation	Definition
IBA	Important Bird and Biodiversity Areas
IFC	International Finance Corporation
INNS	Invasive Non-Native Species
IUCN	International Union for Conservation of Nature
LC	Least Concern
LIFE	Lotic-invertebrate Index for Flow Evaluation
LR	Lower Risk
MAFWM	Ministry of Agriculture, Forestry and Water Management
NT	Near Threatened
NTAXA	Number of Taxa
PCR	Polymerase Chain Reaction
PBF	Priority Biodiversity Features
PFB	Priority Forested Biodiversity
PR	Performance Requirement
RS	Republic of Serbia
SP	Strictly Protected
SPAs	Special Protection Areas
TSM	Thick Shelled Mussel
VU	Vulnerable
WEMMP	Water and Environmental Management and Monitoring Plan
WMD	Water Management Directorate

1. Introduction

1.1 Background

The European Bank for Reconstruction and Development (the "EBRD") is considering providing finance to the Republic of Serbia (the "Borrower", or the "Client"), represented by the Ministry of Finance to enable construction of a water resources reservoir near Pambukovica, Serbia. The Project will be implemented by the Public Water Management Company Srbijavode ("Srbijavode"), the national body responsible for water management, including water use and protection from pollution. Srbijavode is also responsible for management of risks associated with water bodies (such as flood risk) and the Project would increase flood downstream through water retention in the reservoir. Srbijavode operates under the Water Management Directorate (WMD), which in turn is an administrative authority of the Ministry of Agriculture, Forestry and Water Management (MAFWM). The Loan is expected to finance the construction of a new impoundment dam and reservoir infrastructure at Pambukovica including associated works such as upstream sediment traps and road realignment (vertical realignment over the reservoir).

A Serbian Environmental Impact Assessment (EIA) study was prepared by the Energoprojekt - Hidroinženjering on behalf of Srbijavode and was subject to an Environmental and Social Gap Analysis, which indicated that a full Environmental and Social Impact Assessment (ESIA) in accordance with EBRD's Environmental and Social Performance Requirements[1] was required. The assessment of biodiversity impacts, aligned with Performance Requirements 6[2] (PR6) and supported by an adequate biodiversity baseline, was identified as a significant gap in the gap analysis report and was subsequently conducted by ARUP in 2023.

Second year biodiversity surveys were undertaken in 2024 to address potential data gaps caused by heavy rains and high-water levels in the previous year. These surveys were conducted to ensure the ESIA report aligns with EBRD Guidance Note 6[3] (GN6).

1.2 Purpose of this Chapter

1.2.1 Objectives

The objective of this chapter is to describe the baseline biodiversity of the Study Area, value this biodiversity according the EBRD standards (PR6) and carry out a Biodiversity Impact Assessment, considering proposed construction and operations phase mitigation. The specific objectives are as follows:

- Describe the methods used and present the results of biodiversity surveys undertaken in the Study Area in 2023 and 2024 (Section 4 and Section 5).
- Undertake a Critical Habitat (and Priority Biodiversity Features) Assessment in accordance with EBRD GN6 (Section 0).
- Evaluate biodiversity impacts associated with the construction and operation of the proposed Project, in alignment with Serbian legislation and international standards, including EBRD PR6 (Section 8.1).
- Identify and assess adverse and beneficial impacts on species, habitats, and ecological processes, ensuring that all relevant biodiversity considerations are addressed (Section 8.2).
- Develop and recommend mitigation measures to avoid, minimize, or offset identified impacts, meeting the requirements of Serbian law and EBRD PR6 (Section 8.3).

[1] EBRD (2019) Environmental and Social Policy (v. April 2019)

[2] EBRD (2019) Environmental and Social Policy – Performance Requirement 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources (v. April 2019)

[3] EBRD (2020) Guidance Note for Performance Requirement 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.

- Ensure compliance with EBRD standards and Serbian legislation, integrating findings into actionable strategies to achieve No Net Loss and Net Gain, where required.

1.3 Legal and Policy Framework

The EBRD is committed to ensuring that projects are structured to meet EU environmental principles, practices and substantive standards, where these can be applied at the project level, regardless of their geographic location. From a PR6 perspective, this includes for example the European Union's EIA, Habitats and Birds Directives. When host country regulations differ from EU substantive environmental standards, projects will be required to meet whichever is more stringent.

1.3.1 National legislation

The main national legal framework, which is considered in this biodiversity chapter is listed below:

- Law on Environmental Protection ("Official Gazette of the RS", no. 135/2004, 36/2009, 36/2009 - other laws, 72/2009 - other laws, 43/2011 - US decision, 14/2016, 76/2018, 95 /2018 - other law and 95/2018 - other law)
- Law on Environmental Impact Assessment ("Official Gazette of RS", no. 135/2004 and 36/2009)
- Law on Strategic Environmental Impact Assessment ("Official Gazette of RS", no. 135/2004 and 88/2010)
- Decree on Establishing the List of Projects Subject to Impact Assessment and the List of Projects that May Require Environmental Impact Assessment ("Official Gazette of RS" no 114/08)
- The Law on Nature Conservation ("Official Gazette of RS", no. 36/2009, 88/2010, 91/2010 - amended, 14/2016, 95/2018 - other laws and 71/2021)
- Law on Agricultural Land ("Official Gazette of RS", no. 62/2006, 65/2008 - other laws, 41/2009, 112/2015, 80/2017 and 95/2018 - other laws).
- Rulebook on Proclamation and Protection of Strictly Protected and Protected Wild Species of Plants, Animals, and Fungi ("Official Gazette of RS", no. 5/2010, 47/2011, 32/2016, and 98/2016).[4]

1.3.2 International guidelines and regulations

In addition to adhering to the laws of Serbia, as previously noted, this project falls under Category A according to EBRD, IFC, and EPs guidelines:

- EBRD Environmental and Social Policy (2019), which includes a set of PRs. The EBRD PRs also refer to other international best practice guidelines;
- IFC Performance Standards on Environmental and Social Sustainability (2012);
- EPs (EP4, 2020),
- IFC General Environmental, Health and Safety Guidelines (2007),
- Bird Directive (Directive 2009/147/EC), formerly Directive 79/409/EEC. The Birds Directive obliges EU Member States to designate Special Protection Areas (SPAs) for species in need of special protection

[4] There is no national guidance covering the implications / requirements for 'Protected' and 'Strictly Protected' species. The decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian] describes the difference 'SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia). There is no particular legal requirements defined for either group.

and to regulate hunting and trade of bird species, ensuring the preservation of natural populations of wild bird species within the EU;

- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979). The Bern Convention imposes legal obligations on the Parties to protect habitats and breeding grounds for strictly protected species, including all European bat species, and includes recommendations to minimize the adverse effects of power lines on birds.

Red Book Data

In addition to adhering to national and international laws and guidelines, this project considers several critical sources of data concerning threatened species and biodiversity. These include:

- IUCN Global List of Threatened Species at Global Level (2019). The Red List distinguishes nine categories based on estimates of population decline, extinction risk, and species rarity. Species categorized as Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) are considered threatened. The list highlights the need for more data for some species (Data Deficient, DD) and replaces the Lower Risk (LR) category with Near Threatened (NT),
- IUCN Red List of Threatened Species in Europe (2019). This list applies the same criteria as the global list but focuses on European species, assessing their population decline, extinction risk, and rarity,
- Red Book of Flora of Serbia 1 – Extinct and Critically Endangered Taxa (1999). This publication assesses 171 plant taxa in Serbia, with detailed information on their population conditions, locations, significance, decline causes, and protective measures. It highlights four extinct taxa, 46 taxa no longer in Serbia, and 121 species facing severe threats,
- Red Book of Diurnal Butterflies of Serbia – Lepidoptera: Hesperioidea and Papilionoidea (2003). This book analyzes 57 butterfly species in Serbia, using international IUCN classification. It identifies one extinct species, 22 endangered, 24 vulnerable, 7 rare, and 3 not endangered species,
- Red Book of Fauna I – Amphibians (2015). This book assesses the status of 10 amphibian species in Serbia, representing 47% of the country's amphibian fauna. It provides detailed information on the species, their habitats, threat assessments, endangering factors, and protective measures;
- Red Book of Fauna II – Reptiles (2015). This publication presents the status of 16 reptile species in Serbia, including turtles, lizards, and snakes, accounting for approximately 75% of the total recorded reptile species. It offers comprehensive information on the species, their habitats, threats, and protective measures,
- Red Book of Fauna of Serbia III – Birds (2018). This book provides an overview of endangered breeding and non-breeding bird populations in Serbia, assessing 352 taxa. It identifies 14 regionally extinct, 15 critically endangered, 22 endangered or vulnerable breeding species, and assesses non-breeding populations for extinction risk,
- Red Book of Fauna IV – Orthopterans (2018). This publication overviews 45 endangered Orthoptera taxa in Serbia, including one regionally extinct species, 4 critically endangered, 3 endangered, 27 vulnerable, and 10 nearly endangered species.

1.4 Ecological Context of Site Location

Areas designated for the construction of a dam reservoir and irrigation system are situated within a complex and multifaceted landscape that comprises rural, agricultural and natural elements. The majority of the terrain is dedicated to arable land, where intensive annual crop agriculture prevails, catering to the region's agricultural needs. Scattered throughout the area are patches of natural forests. Additionally, there are narrower sections where natural vegetation has been modified to accommodate human activities. Invasive / non-native species have taken root at similar sites. The River Ub meanders across the landscape, with a varying degree of modification and natural features. Along its course, numerous road crossings facilitate human movement and connectivity. Some of its tributaries are known to be ephemeral, active only during seasonal rains or sudden flash floods.

In this diverse landscape, an array of species groups has been documented, demonstrating the ecological richness of the area. Field surveys and subsequent biodiversity assessments have revealed the presence of various species, including amphibians, birds, fishes, molluscs, and other aquatic invertebrates. In terrestrial habitats, a wide range of invertebrate species and mammals have been recorded. Among the notable findings are several species of amphibians, which thrive in the seasonal water bodies formed by the river's tributaries during periods of rainfall. Bat diversity is high, and avian diversity is particularly prominent, with the region serving as a habitat for numerous resident and migratory bird species. The riverine ecosystem supports a variety of fish species and freshwater molluscs, contributing to the overall aquatic biodiversity. However, it's important to note that alongside these native species, certain invasive / non-native species have established within the area which will need further consideration and mitigation efforts.

There are no Legally Protected or Internationally Recognized Areas of Biodiversity Value areas (as defined by EBRD) in the vicinity of the proposed Project area. The closest legally protected areas to the Project site are the Obedska Bara (Swamp) Nature Reserve / Candidate Emerald Site (CES), located 19 km away, and the Klisura Reke Gradac (Gradac River Gorge) CES, located 18 km away. Further information is provided in section 3.1.

2. Methodology

The initial phase of the Biodiversity Impact Assessment involved a thorough review of project documentation, including the Serbian EIA study and the Environmental, Social Gap Analysis report and Biodiversity Baseline conducted in 2023 and 2024.

These documents provided background information about the Project and its setting. Additional data and information were gathered on the species and habitats within the Biodiversity Study Area (see Section 2.1) through available literature reviews. These reviews included sources such as the International Union for Conservation of Nature (IUCN) database, relevant scientific literature, reports under the Ramsar Convention, the EU Habitat Directive, and other credible sources.

The primary focus was to identify biodiversity components relevant to the Project site and its surroundings. This encompassed a wide range of flora, fauna, ecosystems, and habitats existing within the Biodiversity Study Area. Stakeholder engagement was taken into account, and consultations were held with environmental agencies and experts to gather their knowledge and insights regarding the species and habitats present in the Biodiversity Study Area.

Further detail on the specific methodologies employed for each species group or habitat is provided in the relevant sub-sections in Sections 4 and 5. However, the overarching objectives of the surveys were to gather information about the habitat and species present within the Biodiversity Study Area. This enabled a Critical Habitat (and Priority Biodiversity Features) Assessment (see Chapter 0) to be produced to value the habitats and species present according to EBRD PR6, in advance of undertaking the Biodiversity Impact Assessment (Chapter 8) which encompasses relevant avoidance, migration, and compensation.

2.1 Definition of the Biodiversity Study Area

The Biodiversity Study Area () was defined as the dam footprint (including the estimated construction area) and the area of the reservoir when full, plus a 100m buffer. In addition, a survey buffer was applied to the following key construction areas:

- 100 m for the E21 highway watercourse crossing of the River Ub that will need to be raised above the reservoir level as part of the Project,
- 50 m for a seven sediment trap dams that have been planned to be constructed in the upstream catchment to mitigate arrival of sediment into the reservoir,
- 100 m for the irrigation area.
- The study area was further refined compared to the one defined and used in the biodiversity baseline study, incorporating newly obtained data from the hydrological model of the water surface line at the dam crest elevation.

Freshwater ecology survey sites extend beyond the core Biodiversity Study Area (both upstream and downstream on the proposed reservoir extent) (Figure 2). The locations of aquatic ecology survey sites are outlined in Section 5.

In addition to Biodiversity Study Area, information on habitats within the downstream Irrigation Area () was also collected to inform further assessment. The Irrigation Area consists of the land area downstream of the reservoir, where a network of pipes and/or water channels would be constructed to transfer water stored in the reservoir to the wider catchment for irrigation during operation.

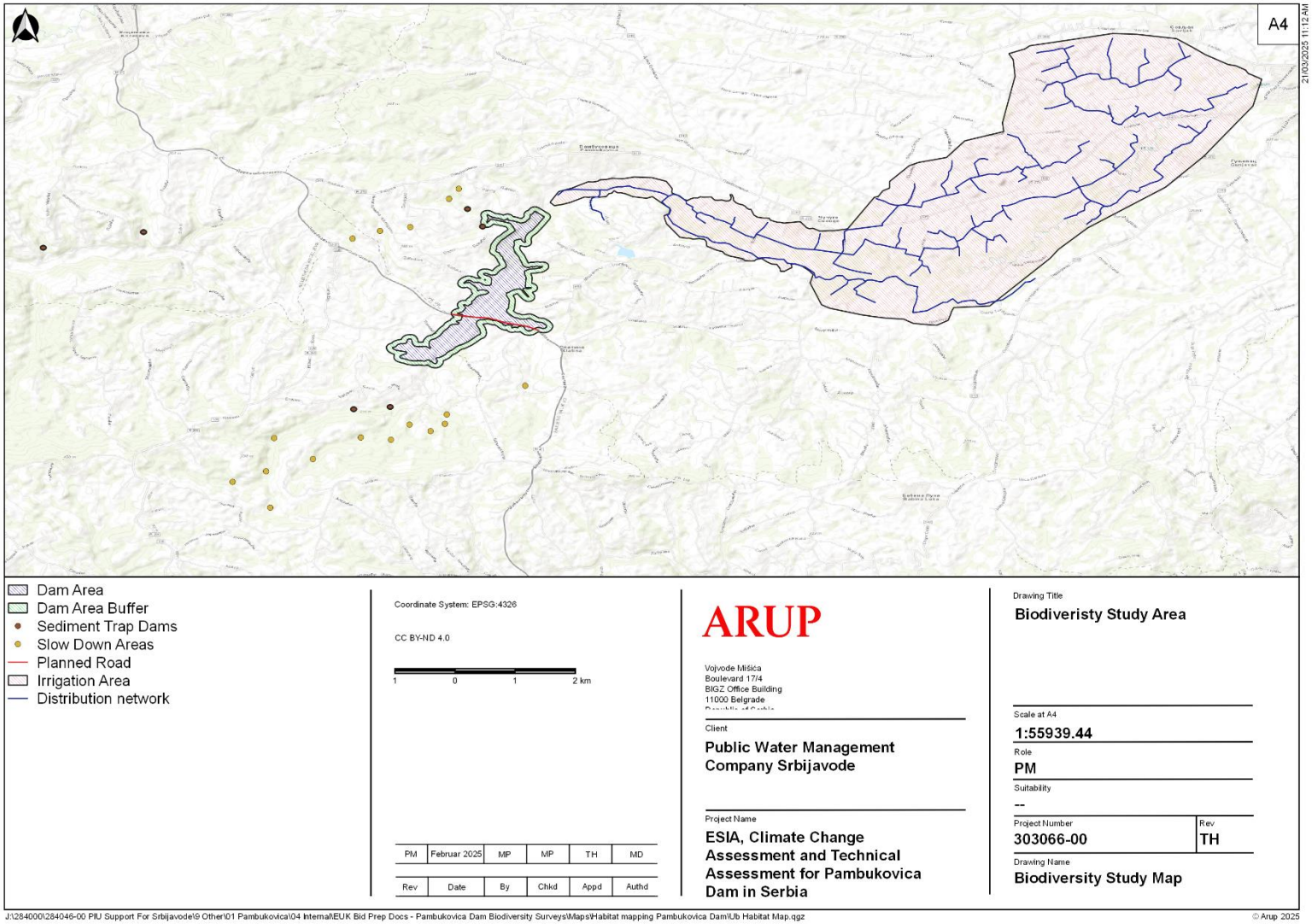


Figure 1 - Biodiversity study area

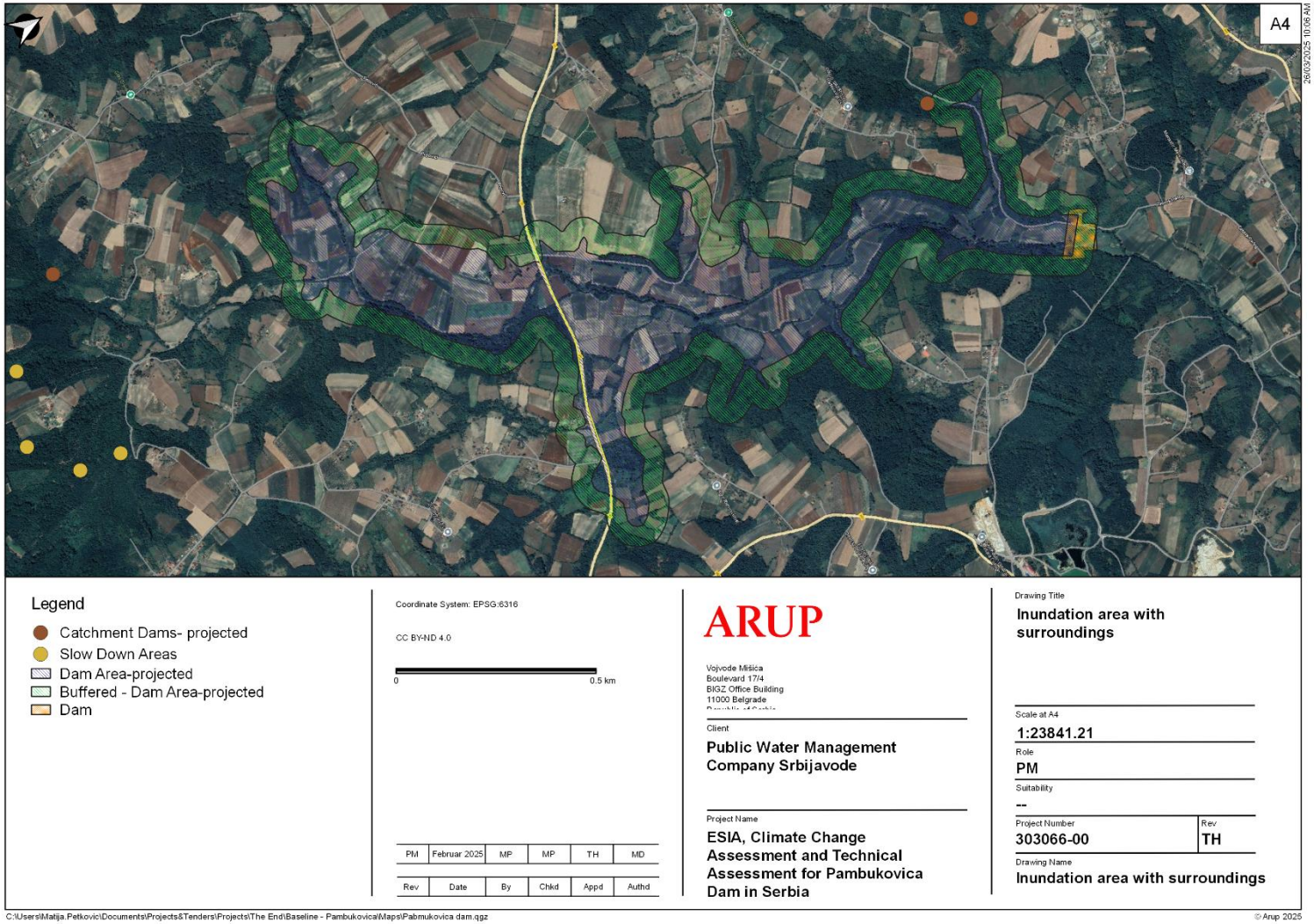


Figure 2 - Inundation area with surrounding

2.2 Desk Study

2.2.1 Protected Areas

A desk study search of Legally Protected or Internationally Recognized Areas of Biodiversity Value areas in proximity to Biodiversity Study Area was undertaken. This included but was not limited to Emerald sites (including candidate sites), Ramsar sites, Key Biodiversity Areas (including Important Bird Areas, Important Plant Areas and Alliance for Zero Extinction Sites) and National Parks.

2.2.2 IUCN Screening and Literature Review

A desk study search was conducted using the IUCN website to identify the potential for CR, EN, VU species within a 20 km buffer of Biodiversity Study Area. This initial screening step aims to highlight which CR, EN, VU may potentially be present within the project area. However, it should be noted that species identified as part of this desk-based and high-level screening may not be present in the project area and likely presence should be informed by survey.

In addition to the IUCN Screening, a thorough review of scientific articles related to the biodiversity of the broader region was undertaken.

The existing Serbian national red books of flora[5], day butterflies[6], amphibians[7], reptiles[8], birds[9] were also reviewed to highlight species of national / regional significance, or endangered species that could be present in within the Project area.

2.2.3 Stakeholder Engagement During Data Collection

Stakeholder engagement was undertaken with the aim of identifying and consulting with the relevant parties who have an interest or influence on the project area, and to collect their views and opinions on the potential environmental and social impacts of the Project. The stakeholder engagement process consisted of their identification and mapping: Desk review of the available information and data sources was performed to identify the main stakeholders in the project area, such as local authorities, communities, associations, and groups. The stakeholders were categorized according to their level of interest and influence on the project, and their potential concerns and expectations were assessed.

During the surveys, several key stakeholders were engaged to gather information relevant to the project site. The hunting association "Tamnava" from Koceljevo, which manages the nearby "Vlašić" hunting ground, was consulted to gain insights into local hunting activities and species management. Additionally, representatives of the "Kolubara" fishing area, including local recreational fishers, were interviewed to capture their observations on aquatic habitats and species in the region. A local farmer also provided valuable historical information about a former commercial fishpond near the River Ub, now converted to arable land, sharing recollections of past aquatic biodiversity, including crayfish and salmonid fish.

Representatives of river users and rangers were present during the aquatic survey and electrofishing. Communication was conducted to gather information on both the current and historical status and use of the Ub River.

[5] Red Book of Flora of Serbia, Ministry of Environmental Protection of the Republic of Serbia, Faculty of Biology, University of Belgrade, Institute for Nature Conservation of the Republic of Serbia, Belgrade, 1999.

[6] P. Jaksic, Red Book of Day Butterflies of Serbia, Institute for Nature Conservation of Serbia, 2003.

[7] M. Kalezić, L. Tomović and D. Georg, Red Book of Fauna of Serbia I - Reptiles, Belgrade: Institute for Nature Conservation of Serbia, 2013.

[8] L. Tomović, M. Kalezić and G. Džukić, The Red Book of Fauna of Serbia II – Reptiles, Belgrade: Institute for Nature Conservation of Serbia, 2015.

[9] D. Radišić, V. Voislav, S. Puzović and A. Vujić, Red Book of Fauna of Serbia III – BIRDS, Belgrade: Institute for Nature Conservation of Serbia, 2018.

Survey methods were designed in collaboration with expert stakeholders, and the interpretation of findings was carried out by specialists associated with the University of Belgrade and the Environmental Protection Agency (MoEP).

2.3 Site surveys

Following the initial site visit in May 2023, during which survey locations, transects, and the number of required visits were determined, species-specific surveys were carried out according to the schedule shown in Figure 3. Based on the findings from 2023, a second year of surveys was conducted in 2024 (Figure 4) to further inform the baseline assessment.

In 2023, surveys were conducted for habitats, plants, fungi, birds, bats, reptiles, riparian and other mammals, amphibians, and terrestrial invertebrates. For aquatic receptors, assessments included electrofishing, eDNA sampling, physical searches for thick-shelled river mussels (TSM), and macrophyte and aquatic macroinvertebrate surveys.

The 2024 surveys built upon findings from 2023. Electrofishing, macrophyte, and aquatic invertebrate surveys were repeated to validate previous results and capture seasonal and spatial variations. Specific TSM surveys were undertaken in 2024 to build on the initial 2023 assessment, that was limited to eDNA and physical searches. The objective of these survey was gather information on population attributes, including density, age structure, and recruitment. Bat surveys were also extended to build on data recorded in 2023 and determine how and in what extent bats use the project site; this involved the use of static bat detectors.

The detailed methods and results for each ecological receptor are presented in Section 4 to Section 5. The survey schedule was adjusted in collaboration with local biodiversity specialists to accommodate adverse weather conditions at the start of the proposed survey window

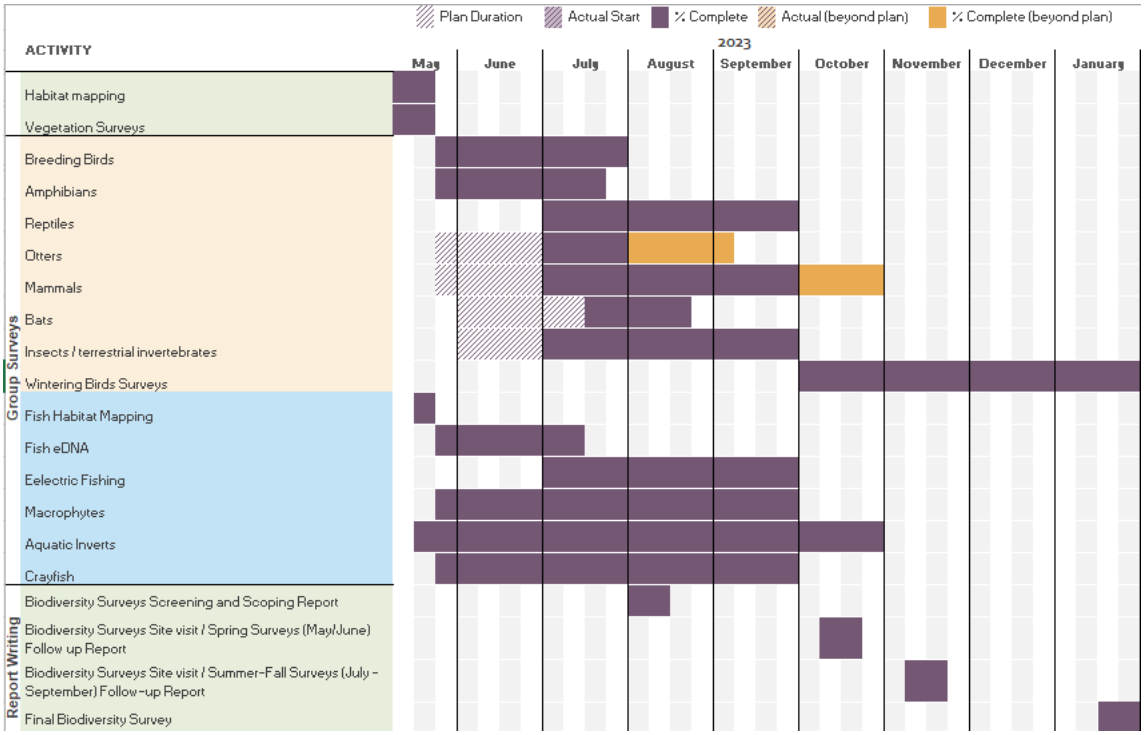


Figure 3 - Survey schedule and progress 2023

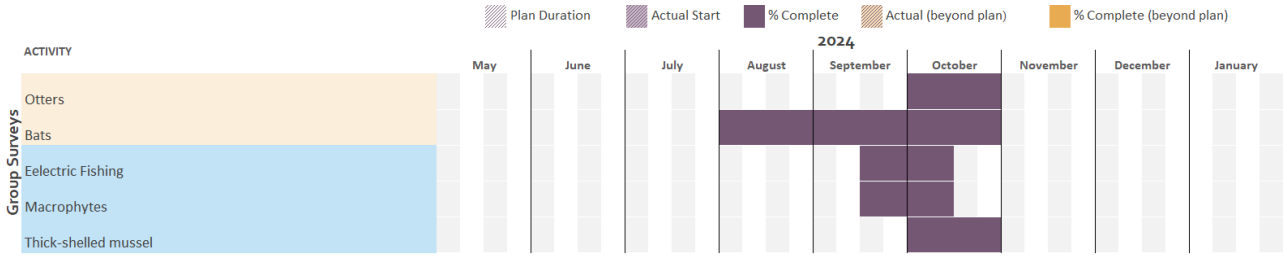


Figure 4 - Survey schedule and progress 2024

2.4 Data Analysis, Screening and Critical Habitat Assessment

A key objective of the baseline surveys and desk study literature review was to gather biodiversity information to help identify PBF and/or CH as defined by EBRD. Based on information gathered during the biodiversity baseline, a Critical Habitat Assessment (CHA) is undertaken to identify areas of high biodiversity value, which would be sensitive to the Pambukovica Dam Project. The purpose of this step is to determine if any features in the study area qualify as PBF or CH), following EBRD's definitions/criteria. These features will require attention during the Biodiversity Impact Assessment and mitigation planning, which will form a key part of Project's ESIA. Note, that as per guidance, this is an assessment of the context in which the development is proposed and therefore does not consider specific impacts at this stage of analysis. It supplements the definition of the ecological baseline and answers the basic question, "*how important is the study area for conservation and what PR6 requirements will apply*?".

For a planned development with the potential to generate significant negative impacts on a PFB or CH, a mitigation plan will be required that achieves *no net loss* or a *net gain* of those features in the Project area and its zone of influence. Detailed methodology is presented in Section 0.

2.5 Limitations

Ecological surveys are limited by factors which affect the presence of plants and animals such as the time of year, migration patterns and behaviour. Therefore, the absence of evidence of any particular species should not be taken as conclusive proof that the species is not present or that it will not be present in the future. However, professional judgement allows for the likely presence of these species to be predicted with sufficient certainty to not significantly limit the validity of these findings.

Any grid references provided within this report are approximate (obtained through handheld GPS devices) and are to be used as a guide only.

The 2023 baseline biodiversity study primarily focused on the inundation area of the project. The objective of the second-year freshwater ecology surveys was to provide supplementary data to support the project's hydrological impact assessment. These surveys were conducted at selected sites along the Ub River, both upstream and downstream of the current survey area, to ensure a comprehensive understanding of the potential ecological impacts. The survey schedule (Figure 3) was adjusted to accommodate adverse weather conditions, including the major flooding in Central Serbia, which occurred which occurred at the end of May 2023 and gradually subsided into early June 2023.

3. Desk Study Results

3.1 Legally Protected and Internationally Recognized Areas of Biodiversity Value

There are no Legally Protected or Internationally Recognized Areas of Biodiversity Value areas (as defined by EBRD) in the vicinity of the proposed Project area. The closest legally protected areas to the Project site are the Obedska Bara (Swamp) Nature Reserve and Candidate Emerald Site (CES), located 19 km away, and the Klisura reke Gradac (Gradac River Gorge) CES, located 18 km away.

3.1.1 Obedska Bara CES (RS0000003) and IBA – 19km north

Obedska Bara is positioned in the alluvial plane of the Sava river (46-95 river km) in southern Srem, Vojvodina Province. It is largest alluvial area in whole Serbia (around 12000 ha) and it represents an authentic mosaic of forest, meadows, swamp and pond habitats. More than 30 aquatic, forest and meadow plant communities have been described. Along the borders of IBA more than 20 settlements are situated and two inside of IBA (Kupinovo and Obrež) which belongs to six municipalities (Surčin, Obrenovac, Vladimirci, Šabac, Ruma and Pećinci). This site qualifies as a Key Biodiversity Area of international significance because it meets one or more previously established criteria and thresholds for identifying sites of biodiversity importance (including Important Bird and Biodiversity Areas, Alliance for Zero Extinction sites, and Key Biodiversity Areas).

The site was identified as important in 2019 because it was regularly supporting significant populations of the species listed below, meeting ('triggering') IBA criteria (**Error! Reference source not found.**).

Table 1 - Bird populations meeting IBA criteria ('trigger species') - Obedska Bara

Scientific name	Common name	Red List Category	Population estimate at site	IBA criteria met
Ciconia nigra	Black Stork	LC	6-9 breeding pairs	B2a, C6
Plegadis falcinellus	Glossy Ibis	LC	4-10 breeding pairs	C6
Nycticorax nycticorax	Black-crowned Night-heron	LC	400-500 breeding pairs	B1b, B3a, C2, C6
Egretta garzetta	Little Egret	LC	170-180 breeding pairs	C6
Microcarbo pygmaeus	Pygmy Cormorant	LC	100-150 breeding pairs	B2a, B3a, C2, C6
Clanga pomarina	Lesser Spotted Eagle	LC	3-4 breeding pairs	B2a, C6
Milvus migrans	Black Kite	LC	5-7 breeding pairs	C6
Leiopicus medius	Middle Spotted Woodpecker	LC	300-360 breeding pairs	B2a, C6
Oriolus oriolus	Eurasian Golden Oriole	LC	1,500-2,000 breeding pairs	B2a

B1b: Species with an unfavourable conservation status in the region
B2a: Species with a favourable conservation status but concentrated in the region
B3a: Regionally important congregations – biogeographical populations
C2. Concentrations of a species threatened at the European Union level
C6. Species threatened at the European Union level
IUCN Least Concern (LC)

3.1.2 Klisura Reke Gradac CES (RS0000054) and Valjevske mountains IBA– 18km south-west

The Gradac river gorge, with its source tributaries has the special characteristics and the degree of preservation. It lies south of Valjevo and influent in the Kolubara river, of which it is a right tributary. The river gorge is the habitat of a number of rare plant and animal species. In the river brook trout, chub, barbel can be found. The biggest attraction of Gradac river are undoubtedly the otters. The gorge of the river has

more than 70 karst caves. The Degurić cave is, according to the latest research, the longest and in the region of the Valjevo karst. In the caves, traces of palaeolithic, and middle ages ancient times have been discovered.

The gorge is part of a larger IBA, located in the far west of the country near the Drina River and the state border with Bosnia and Herzegovina. It spans over 60 km between the cities of Valjevo and Bajina Bašta, encompassing a diverse mountainous region. Key features of the area include mountains such as Maljen, Povlen, Medvednik, Jablanik, Bobija, and Sokolina, as well as gorges carved by rivers like Trešnjica, Gradac, and others. The IBA is predominantly covered by deciduous forests, interspersed with numerous streams, meadows, and pastures, creating a rich and varied landscape.

The site was identified as important in 2019 because it was regularly supporting significant populations of the species listed below, meeting ('triggering') IBA criteria (**Error! Reference source not found.**).

Table 2 - Bird populations meeting IBA criteria ('trigger species') - Valjevske mountains

Scientific name	Common name	Red List	Season (year/s of estimate)	Size in pairs	IBA criteria
Strix aluco	Tawny Owl	LC	resident (2016–2019)	200–300	B2a
Pernis apivorus	European Honey-buzzard	LC	breeding (2008–2013)	20–25	B2a, C6
Gyps fulvus	Griffon Vulture	LC	resident (2017)	20–25	C6
Aquila chrysaetos	Golden Eagle	LC	resident (2017–2019)	7–8	C6
Picus canus	Grey-faced Woodpecker	LC	resident (2016–2019)	100–200	C6
Picus viridis	Eurasian Green Woodpecker	LC	resident (2017–2019)	240–370	B2a
Leiopicus medius	Middle Spotted Woodpecker	LC	resident (2016–2019)	850–1,300	B2a, C6
Sylvia atricapilla	Eurasian Blackcap	LC	breeding (2016–2019)	40,000–60,000	B2a
Turdus philomelos	Song Thrush	LC	breeding (2016–2019)	5,000–6,500	B2a
Turdus merula	Eurasian Blackbird	LC	breeding (2016–2019)	10,500–14,000	B2a
Erithacus rubecula	European Robin	LC	resident (2016–2019)	15,000–20,000	B2a

B2a: Species with a favourable conservation status but concentrated in the region

C6. Species threatened at the European Union level

IUCN Least Concern (LC)

The proximity of protected areas is illustrated in Figure 5.

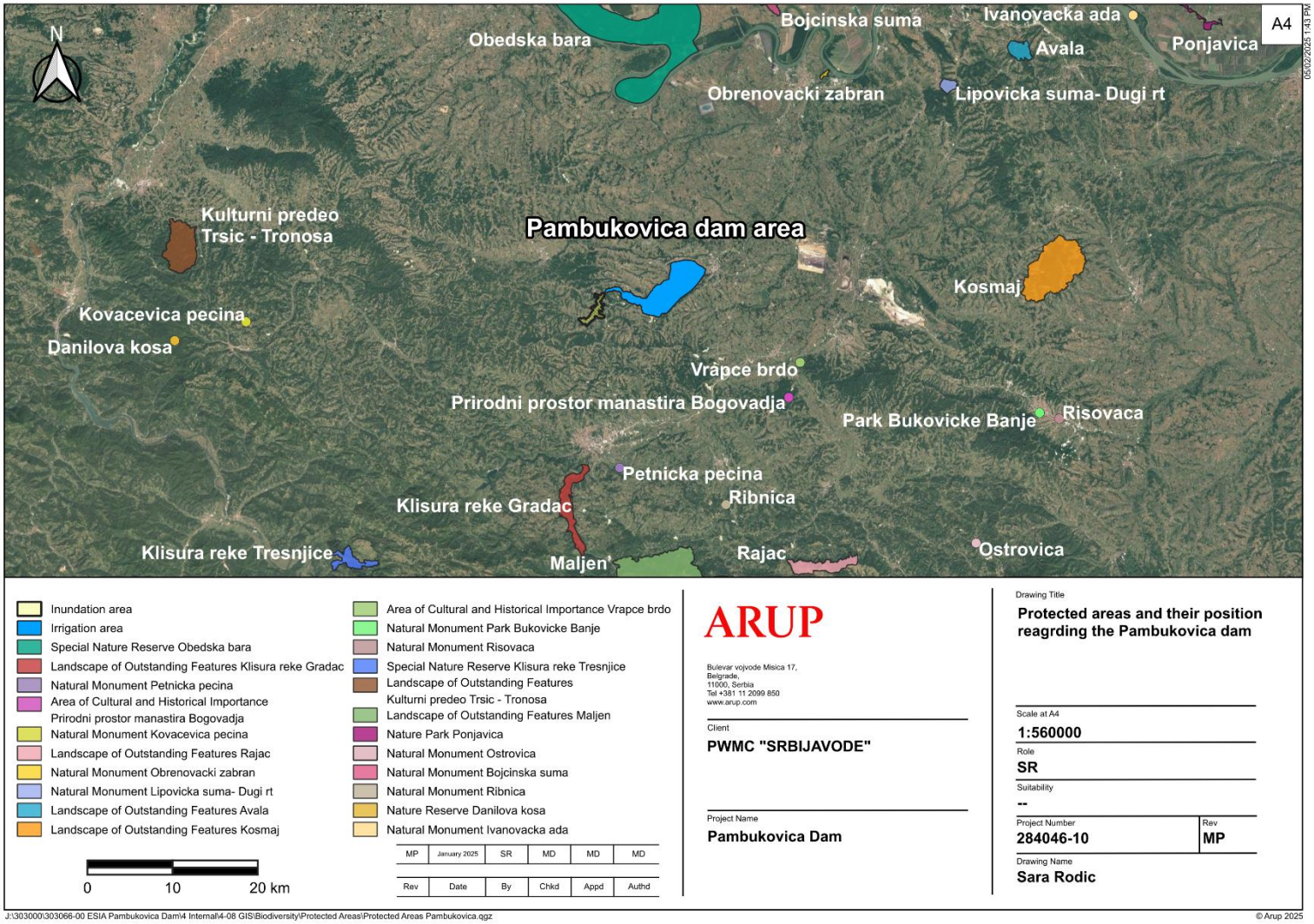


Figure 5 - Protected areas and their position regarding the Pambukovica dam

3.2 IUCN Screening Results

A preliminary IUCN screening indicated the potential presence of 33 '*threatened species'* as defined by EBRD criteria (EBRD GN6), i.e. species defined as CR, EN or VU according to IUCN within a 20 km buffer of the Biodiversity Study Area (**Error! Reference source not found.**). It should be noted that during s urveys, the presence of only one species identified during the IUCN screening was confirmed breeding, European turtle dove *Streptopelia turtur* (Figure 6). This species holds a VU status according to IUCN classification and is listed in Annex II of Serbian legislation under the decree on the proclamation and protection of strictly Protected and Protected wild species of plants, animals, and fungi. Regardless of whether a species is classified as 'protected' or 'strictly protected', under national law all such species identified in the project area must be appropriately safeguarded through impact avoidance, mitigation, and monitoring measures.

Table 3 - Endangered species, classified according to IUCN categories, detected in the initial screening of the location.

No	Binomial name	Common name / Family	IUCN Global	IUCN Europe	Habitats and species directive	Serbian legislation
Arthropods						
1.	*Ampedus quadrisignatus*	Click beetle	EN	EN		
2.	*Anisarthron barbipes*	Long-horned Beetle	VU	VU		
3.	*Astacus astacus*	Noble Crayfish	VU		V	SP
4.	*Cheilosia loewi*	True Fly	EN	EN		
5.	*Pedostrangalia revestita*	Long-horned Beetle	VU	VU		
6.	*Plagigeyeria gladilini*	Freshwater Snails	VU	VU		
7.	*Pseudanodonta complanata*	Depressed River Mussel	VU	NT		
8.	*Ropalopus ungaricus*	Long-horned Beetle	EN	EN		
9.	*Theodoxus transversalis*	Striped Nerite	EN	EN	SP	
10.	*Zeuneriana amplipennis*	Danube Wide-winged Bush-cricket	EN	EN		P
Fish						
11.	*Acipenser ruthenus*	Sterlet	EN	VU		P
12.	*Anguilla anguilla*	European Eel	CR	CR		SP
13.	*Cyprinus carpio*	Eurasian Carp	VU			P
14.	*Huso huso*	Beluga	CR	CR		SP
Amphibians						
15.	*Triturus macedonicus*	Macedonian Crested Newt	VU	VU		
Fungi						
16.	*Baeospora myriadophylla*	Agaric Fungi	VU			
17.	*Bovista paludosa*	Fen Puffball	VU			

No	Binomial name	Common name / Family	IUCN Global	IUCN Europe	Habitats and species directive	Serbian legislation
18.	*Buchwaldoboletus lignicola*	Wood Bolete	VU			
19.	*Hapalopilus croceus*	Orange Polypore	VU			SP
20.	*Hygrocybe ovina*	Blushing Waxcap	VU			
21.	*Picipes rhizophilus*	Polypore	VU			
22.	*Pluteus fenzlii*	Agaric Fungi	VU			
23.	*Tricholoma acerbum*	Agaric Fungi	VU			
Mammals						
24.	*Miniopterus schreibersii*	Schreiber's Bent-winged Bat	VU	VU	II	SP
25.	*Mustela lutreola*	European Mink	CR		II	
26.	*Myotis capaccinii*	Long-fingered Mat	VU	VU	II	SP
Birds						
27.	*Anser erythropus*	Lesser White-fronted Goose	VU	VU		SP
28.	*Aquila heliaca*	Eastern Imperial Eagle	VU	LC		SP
29.	*Clanga clanga*	Greater Spotted Eagle	VU	VU		SP
30.	*Falco vespertinus*	Red-footed Falcon	VU	VU		SP
31.	*Streptopelia turtur*	European Turtle-dove	VU	VU		P
Moss						
32.	*Gymnobarbula bicolor*		VU	VU		

IUCN Vulnerable (VU), Least Concern (LC) or Endangered (EN)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

Figure 6 - *Streptopelia turtur* by Andrej Chudy CC BY 2.0.

3.3 Other desk study results

The closest reference area for this review was the artificial fishpond Dokmir, located 5km from the Pambukovica Dam. An ornithological survey was conducted in this area between 1997 and 2003[10]. During surveys, particular attention was paid to the 147 bird species documented in this study. Based on the species list from this study, the bird surveys were designed not only to detect the listed species but also to account for all potentially present species. **Error! Reference source not found.** provides a list of the mentioned s pecies along with expert remarks on their presence or absence at the project site. It is worth noting that Dokmir Pond has now dried up, and the former lake ecosystem has been replaced by agricultural land. As a result, bird species abundance has decreased.

The list of recorded taxa, distribution, and relative abundance of freshwater mussels in the River Tisa[11], with the closest sampled location approximately 90 km from the Pambukovica Dam, indicated the potential presence of six species (**Error! Reference source not found.**). Special attention was given to these species d uring the aquatic surveys.

Table 4 - Freshwater Mussel Species in the Serbian Stretch of the Tisa River

Scientific name	Common name	Note	IUCN Europe/Global	EU Protection Status	Serbian Status	Habitat Preference
Unio pictorum	Painter's Mussel	Native	NT /LC	Not listed	Not listed	Slow-flowing rivers, lakes
Unio tumidus	Swollen River Mussel	Native	NT/LC	Not listed	Not listed	Slow-moving and stagnant waters
Sinanodonta woodiana	Chinese Pond mussel *INNS*	Invasive	NA/LC	Not listed	Not listed	Lakes, ponds, slow rivers

[10] M. Raković and M. Novaković, "Avifauna of Dokmir fishpond," Faunisticke studije, Ciconia 12, no. 12, pp. 121-129, 2003.

[11] J. Tomović, V. Simić, B. Tubić, K. Zorić, M. Kračun, M. Vanja and P. Momir, "Freshwater Mussels of the Serbian Stretch of the Tisa River," Water Research and Management, vol. 4, no. 1, pp. 35-40, 2013.

Scientific name	Common name	Note	IUCN Europe/Global	EU Protection Status	Serbian Status	Habitat Preference
Pseudanodonta complanata	Depressed River Mussel	Native	EN /EN	Not listed	Not listed	Slow-flowing rivers, canals
Unio crassus	Thick-shelled River Mussel	Native	EN /EN	Annex II, IV (Habitats Directive)	SP	Clean, oxygen-rich rivers
Anodonta cygnea	Swan Mussel	Native	VU /LC	Not listed	Not listed	Lakes, ponds, slow rivers

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia

IUCN Not applicable (NA), Least Concern (LC), Near threatened (NT), Vulnerable (VU), Endangered (EN)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

INNS – Invasive / non-native Species in Serbia

4. Biodiversity Site Surveys: Terrestrial

4.1 Habitats, Plants and Fungi

4.1.1 Survey Methodology

Habitat Mapping, Plant and Fungi Surveys were conducted from June to October 2023. The use of GIS in the field ensured accurate mapping of the boundaries of habitat types, as presented in the habitat map. The mapping (Figure 7, **Error! Reference source not found.**) covered the proposed Pambukovica Dam reservoir area, with an additional buffer area of 100 meters. In addition, terrestrial mapping of the catchment sediment traps (**Error! Reference source not found.**) was undertaken within a 50-meter buffer applied.

Habitat types were classified according to the Interpretation Manual of European Union Habitats (EUNIS) methodology and screened against EU Habitats Directive Annex I habitat types. Vegetation units with their associated data were used to identify and describe the habitat composition and structure. The itineraries for plant and fungi transects were not pre-defined; instead, data were collected during all surveys.

The DAFOR scale was used to determine notable plant species relative abundance in the area:

- 51-100%: dominant
- 31-50%: abundant
- 16-30%: frequent
- 6-15%: occasional
- 1-5%: rare, and
- 0%: not present species.

Other details about the sampled vegetation were recorded to assist with the habitat classification according to EUNIS (and EU Habitats Directive Annex 1) type descriptions including details about: altitude, aspect, soil depth and superficial geology.

Details about the condition of habitat types surveyed were recorded on the basis of whether they were:

- In good condition and comprising viable plant populations of largely native (Serbian) origin (and therefore considered to be Natural Habitat);
- Suffering from moderate disturbance or interference but still comprising largely populations of native (Serbian) plant species and therefore of significant biodiversity value (and therefore considered as Natural Habitat); or,
- In poor condition (i.e. extensively managed or altered from the natural state by human activity) and comprising a large proportion of species of invasive / non-native origin (and therefore considered as Modified Habitat).

The fungi survey was undertaken simultaneously with habitat mapping and plant surveys (May – August 2023). Particular attention was paid to confirm the possible occurrence of the '*threatened'* fungi species, as defined by EBRD (**Error! Reference source not found.**) and an assessment of the potential for habitats w ithin the site to support these species was made. Threatened species are those listed as VU on the IUCN Red List (and as such potential BBF tiggers), listed on Annex II or IV of Habitats Directive and/or subject to provisions of Serbian legislation, whose extent of occurrence (EOO) may include project area. Potential suitable habitats for listed species were recorded and described. List of fungi taxa whose EOO includes project area is given (**Error! Reference source not found.**).

Table 5 - List of fungi taxa whose published EOO includes project area

Scientific name	Common name	IUCN Status
Hapalopilus croceus	Orange Polypore	VU
Baeospora myriadophylla		VU

Scientific name	Common name	IUCN Status
Tricholoma acerbum		VU
Buchwaldoboletus lignicola	Wood Bolete	VU
Hygrocybe ovina	Blushing Waxcap	VU
Pluteus fenzlii		VU
Picipes rhizophilus		VU

4.1.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria. Habitat mapping and condition assessment was used to quantify the biodiversity value of the baseline and the potential habitat losses resulting from the project and inform the requirements for offsets (see Section 8).

4.1.3 Survey Results

Habitat Mapping Results

The topography of the Biodiversity Study Area primarily consists of gently rolling hills, with arable land being the predominant land use. Natural habitats are primarily concentrated near to the location of the proposed dam, within a narrow strip of riparian corridor that is present along the majority of the River Ub and higher up in the valley close to outer boundary of the Biodiversity Study Area. The results of the habitat mapping is presented in Figure 7. Habitats recorded included a blend of broadleaf woodlands, grasslands, and scrublands, as well as more modified habitats including, arable land and land markets, low density buildings and transport networks and other hard-surfaced areas.

The condition of habitats is a factor in determining their ecological value and the level of conservation effort required to maintain or restore them. Understanding the condition of habitats allows for targeted management strategies to be developed to enhance biodiversity and ecosystem health. The conditions for each recorded habitat type are provided in **Error! Reference source not found.** and are explained below.

- Habitats in good condition exhibit a high degree of naturalness and ecosystem integrity. They are characterized by a diverse array of native plant species, stable soil and substrate conditions, and minimal signs of human disturbance. These habitats provide optimal conditions for supporting a wide range of native wildlife species and ecosystem functions.
- Habitats in moderate condition show some signs of disturbance or alteration but still maintain a significant level of biodiversity and ecological value. They may exhibit slight changes in plant species composition, minor soil disturbance, or localized human impacts. While these habitats may not be pristine, they are capable of supporting a diverse array of native species and ecosystem processes.
- Habitats in poor condition have been heavily impacted by human activities or natural disturbances, resulting in significant degradation of ecosystem health and biodiversity. These habitats may exhibit extensive soil erosion, dominance of non-native or invasive / non-native plant species, and reduced habitat quality for native wildlife. Restoration efforts may be needed to improve the condition of these habitats and restore their ecological functions.

Natural and semi-natural habitats recorded within the proposed Pambukovica dam inundation area were:

Fagetum moesiace submontanum typicum woodland (G1.69)
Quercetum frainetto-cerris woodland (G1.76811)
Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba* (G1.1)

Mesic grasslands (E2)
Sparsely wooded grasslands (E7)
Balkan riverine willow scrub (F9.123)

None of the habitats recorded conform to descriptions of those listed in Annex 1 of the EU Habitats Directive, but some are listed in Resolution 4 of the Bern Convention; Balkan riverine willow scrub, *Fagetum moesiace submontanum typicum* woodland, and *Quercetum frainetto-cerris* woodland.

Modified habitats recorded within the proposed Pambukovica dam inundation area were:

Arable land and land markets (I1)
Robinia pseudoacacia woodland (G1.C3)
Transport networks and other constructed hard-surfaced areas (J4)
Low density buildings (J2)
Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. Italica* (G5)

Woodlands

The majority of forest and woodland habitats were recorded in the vicinity of the dam and extending several kilometres upstream along the River Ub. Forest was also prevalent at higher elevation, on the outer most extent of the Biodiversity Study Area. These forests are typically characterized by a mix of *Fagus* sp. (beech), *Quercus* sp. (oak), *Alnus* sp. (alder), *Populus* sp. (poplar), *Salix* sp. (willow) and *Robinia pseudoacacia* (black locust trees). However, it is important to note that these forest stands tend to be relatively small and fragmented, containing only a moderate number of mature trees. So whilst they offer habitat for a number of species groups, the forest stands are not typically of the highest biodiversity value.

Woodlands recorded within the proposed Pambukovica dam inundation area were predominantly broadleaved deciduous woodlands found to comprise the following subtypes:

Fagetum moesiace submontanum typicum woodland (G1.69)
Quercetum frainetto-cerris woodland
Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*
Robinia pseudoacacia woodland

Grasslands

Sparce isolated grasslands are distributed throughout the Biodiversity Study Area, often surrounded by woody scrub. The prevailing meadow habitat within the site corresponds to EUNIS habitat type E2, known as mesic grasslands. Here, a lush tapestry of petite flowering plants intermingles with blackberry and rosehip bushes, creating habitat for various passerine birds, both as a nesting site and a foraging area. Grasslands recorded within the proposed Pambukovica dam inundation area were found to comprise two subtypes: mesic grasslands (CODE) and sparsely wooded grasslands (CODE).

Mesic grasslands are primarily composed of *Poaceae* and *Cyperaceae* species, with the presence of various weed species. Sparsely wooded grasslands are characterized by an abundance of grasses and graminoids, along with herbaceous plants, and occasional scattered woody species. Mosaic habitats, such as ecotones (e.g., transition areas between forest/woodland and grassland), are widespread throughout the entire area.

Arable land

Arable land is a dominant habitat type, making up 48 % of the Biodiversity Study Area; transport networks and hard-surfaced areas were also mapped. Low density buildings are presented in a small percentage and scattered over the future dam area.

Mosaic habitats, such as ecotones (i.e., boundaries between forest/woodland and grassland, for example), are widely distributed throughout the entire territory of the Pambukovica Dam area.

Aquatic and Riparian Habitats

There are two types of aquatic habitats on the site. Balkan riverine willow scrub are presented in a small percentage at the entrance to the future reservoir as well as along the E21 highway.

Riparian and gallery woodland, with dominant *Alnus glutinosa/Populus nigra/Salix alba*, are widely presented along the Ub River both upstream and downstream the future dam area.

Littoral zone of surface water bodies are represented by a land adjacent to the Ub River. Surface running waters are represented by the Ub River catchment area. More detailed classification of instream habitats (fish habitat mapping) is presented in Section 5.1. In addition to these, two further habitat C2 subtypes of ecological relevance are present within the study area. Epipotamal streams (EUNIS C2.31) occur in the upper reaches of lowland streams, including parts of the Ub River. These sections are characterized by calmer flow conditions, broader annual temperature variation, and aquatic communities that include many species typical of standing water. This habitat corresponds to the "Barbel zone" in Western European fish classifications. Also present are sparsely vegetated river gravel banks (EUNIS C3.55), which support pioneer plant communities on exposed gravel deposits (see Section 5.1.2). These dynamic habitats contribute to the structural and ecological diversity of the river corridor and play an important role in early-stage vegetation succession and habitat heterogeneity.

According to mentioned criteria, terrestrial habitat conditions of the Pambukovica Dam area are provided (**Error! Reference source not found.**). The habitats in **Error! Reference source not found.** are assessed ag ainst EBRD thresholds for CH and PBF in Chapter 0 as part of the CHA.

Table 6 - Conditions of terrestrial habitats distributed in the Pambukovica Dam area

Habitat type	EUNIS Code	Habitat category	Habitat condition	Reason
Mesic grasslands	E2	Natural	Good	Dominant plant native species
Sparsely wooded grasslands	E7	Natural	Moderate	Subdominant plant native species
Balkan riverine willow scrub	F9.123	Natural	Moderate	Subdominant plant native species
Fagetum moesiace submontanum typicum woodland	G1.69	Natural	Good	Dominant plant native species
Quercetum frainetto-cerris woodland	G1.76811	Natural	Good	Dominant plant native species
Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*	G1.1	Natural	Moderate	Subdominant plant native species
Robinia pseudoacacia woodland	G1.C3	Modified	Poor	Invasive / non-native plant species, human activity
Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. italica*	G5	Modified	Poor	Invasive / non-native plant species, human activity
Arable land and land markets	I1	Modified	Poor	Invasive / non-native plant species, human activity
Low density buildings	J2	Modified	Poor	Human activity
Transport networks and other constructed hard-surfaced areas	J4	Modified	Poor	Human activity

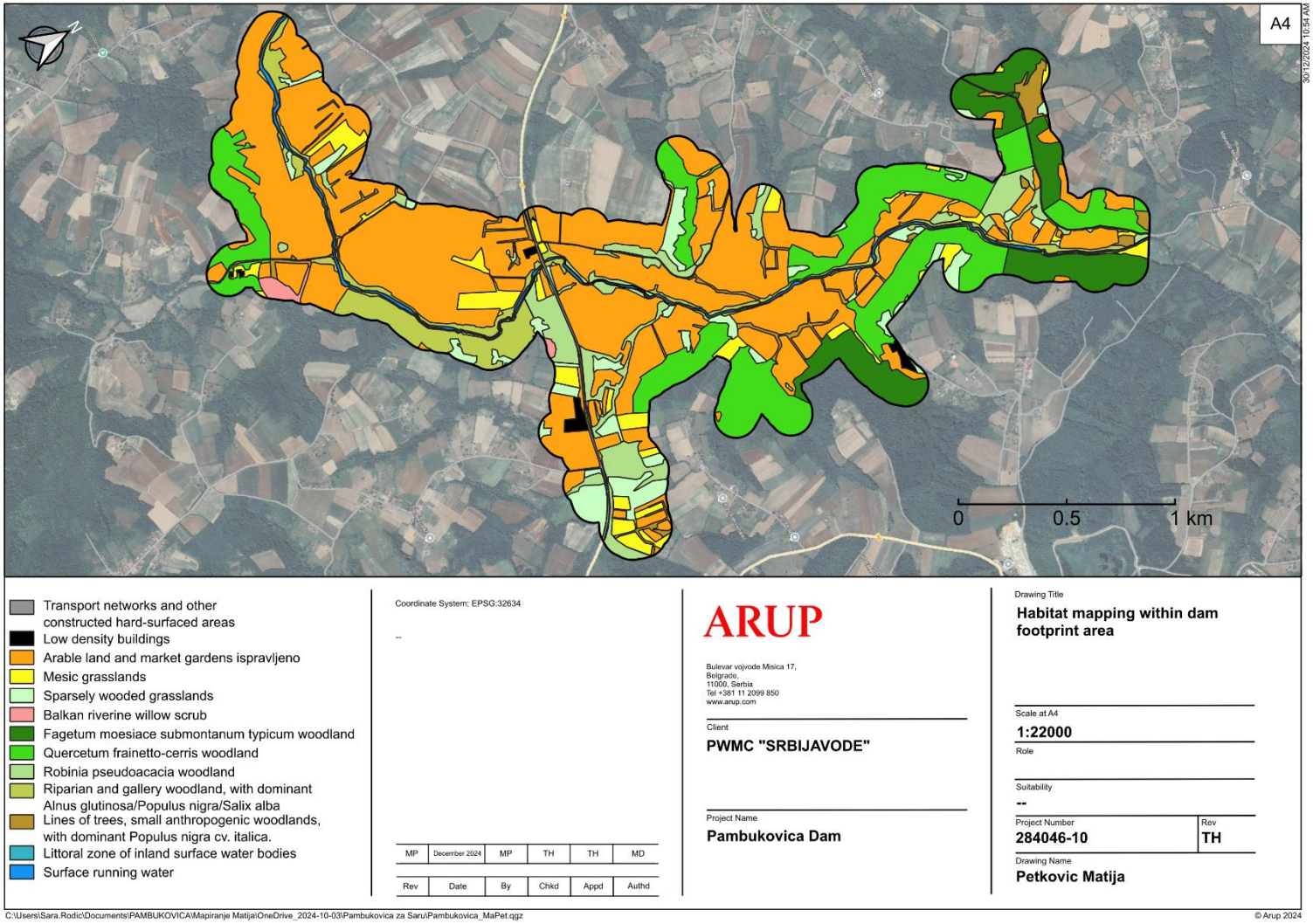


Figure 7 - Habitat map showing habitat types recorded within the Biodiversity Study Area (inundation area) with 200m survey buffer

Table 7 - Total coverage of habitat types recorded within the proposed Biodiversity Study Area with 200m buffer

Eunis Code	Habitat	Area (ha)	% of Biodiversity Study Area with 200m buffer
J4	Transport networks and other constructed hard-surfaced areas	2.94	0.75
J2	Low density buildings	1.82	0.46
I1	Arable land and market gardens	187.143	47.66
E2	Mesic grasslands	17.578	4.47
E7	Sparsely wooded grasslands	21.91	5.58
F9.123	Balkan riverine willow scrub	1.86	0.47
G1.69	*Fagetum moesiace submontanum typicum* woodland	29.16	7.42
G1.76811	*Quercetum frainetto-cerris* woodland	67.14	17.09
G1.C3	*Robinia pseudoacacia* woodland	23.99	6.10
G1.1	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*	22.68	5.77
G5	Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. italica*.	9.55	2.43
C3	Littoral zone of inland surface waterbodies	1.8	0.45
C2 C2.31 C3.55	Surface running water, comprising Epipotamal streams Sparsely vegetated river gravel banks	5.07	1.29
	Total	392.66	100

Habitat mapping of the sediment trap dam areas was undertaken within buffer of 50 metres; a summary of the habitats recorded are provided in **Error! Reference source not found.**. Also, satellite images of the s ediment trap dams is shown in **Error! Reference source not found.**.

. The construction of these upstream sediment traps is part of the broader Pambukovica dam and reservoir infrastructure project, and planned to be constructed in subsequent phases which are not currently is expected to be financed by the initial EBRD loan.

Table 8 - Habitat mapping of the sediment trap dams

Sediment trap dam	Habitat
Babinac 1	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Sparsely wooded grassland ecotone
Babinac 2	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*
Joševa 3	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Sparsely wooded grassland ecotone
Joševa 4	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Sparsely wooded grassland ecotone
Jasenovac	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Sparsely wooded grassland ecotone

Sediment trap dam	Habitat
Medvednjak	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Balkan riverine willow scrub / Mesic grassland ecotone
Oglađenovačka	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*/ Mesic grassland / Macadam ecotone

Table 9 - Satellite images of the sediment trap dams

Picture 1 - Flood barrier 1 and 2

Picture 2 - Flood barrier 3 and 4

Picture 3 - Flood barrier 5 and 6

Picture 4 - Flood barrier 7

Irrigation Area

A broad characterisation of the habitats within the irrigation area is presented in Figure 8 and **Error! Reference source not found.**; this was created from review of areal imagery and follow-up ground truthing walk over surveys. A small fraction of the land within the irrigation area is non-arable, featuring also low-density buildings and roads. The predominant land use is intensive agriculture, primarily for the cultivation of annual crops such as sunflower and wheat. Some of the arable land has been transformed into greenhouses, mainly for growing vegetables. Sparse orchards can also be found, typically consisting of plum, apple, or pear trees. A few woodlands, primarily oak or beech, are scattered sporadically in narrow strips among certain plots. The riparian area of the River Ub (in a few locations) and several plots in the southern part of the irrigation area are exceptions to this pattern. Grasslands are situated amidst larger arable plots, in between strips of forests, and on plots that have not been used for arable farming for some time. The River Ub flows through the irrigation area for a length of 18.42 km and is classified as a habitat type of C2 surface running waters (**Error! Reference source not found.** and Figure 8), comprising Epipotamal streams (C2.31) and Sparsely vegetated river gravel banks (C3.55).

Table 10 - Total coverage of broad habitat types within the irrigation area

Eunis Code	Habitat	Area (ha)	% of irrigation area
J2	Low density buildings	24.53	0.86
J4.2	Road networks	51.01	1.79
G1	Broadleaved deciduous woodland	490.80	17.26
I1	Arable land and market gardens	1800.91	63.35
E2	Mesic grasslands	475.51	16.73
	Total	2842.76	100.00

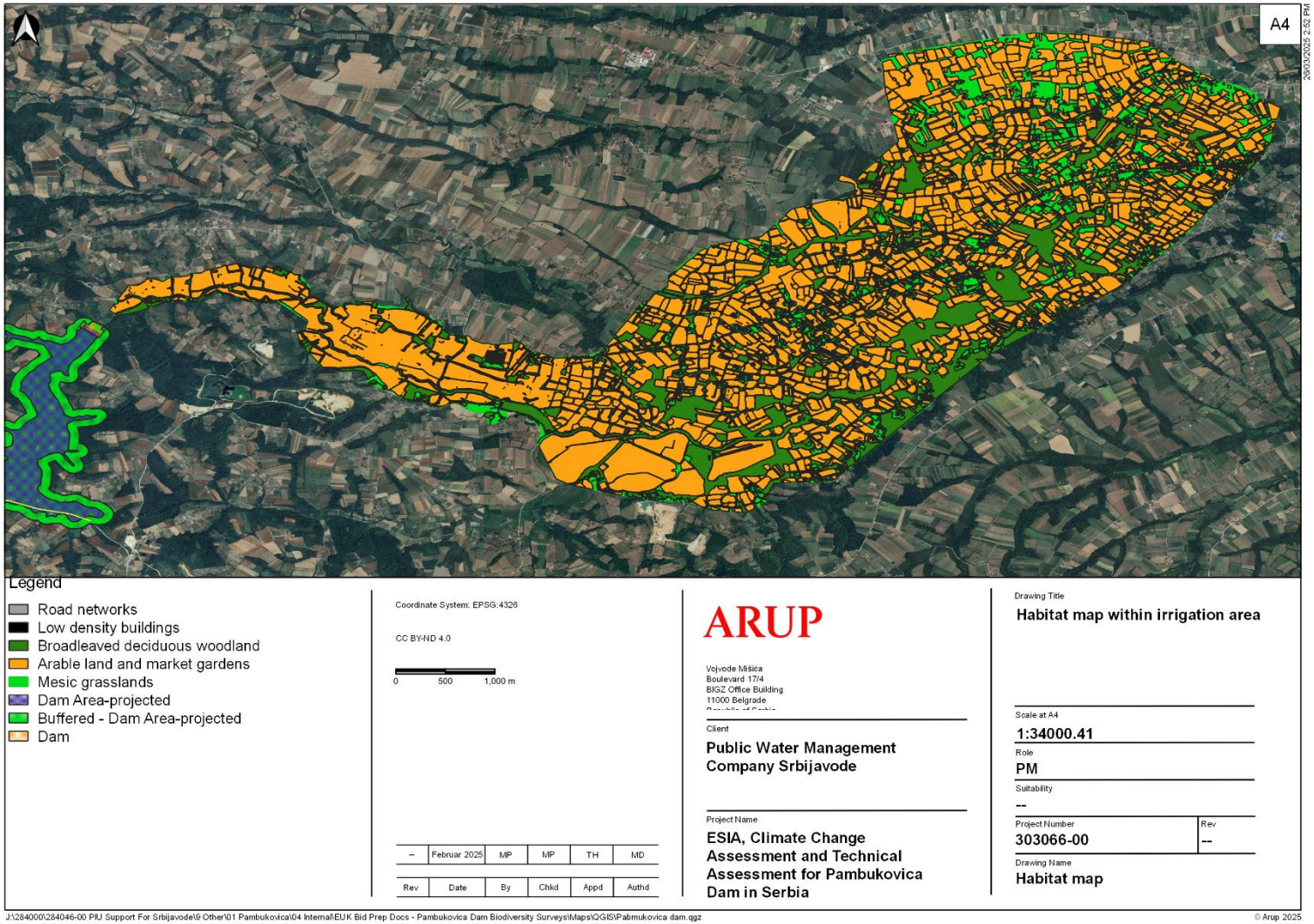


Figure 8 - Broad habitat mapping within irrigation footprint area

Plant Survey Results

The data in the **Error! Reference source not found.** indicates that no plant species listed as CR, EN, or VU o n the IUCN Red List, or those classified as CR or EN on Serbian national or regional red lists, were recorded during the surveys in the area. The presence of Invasive / non-native species such as bastard indigo *Amorpha fruticosa* and common ragweed *Ambrosia artemisiifolia* has also been observed. None of the detected species are listed in the EU Habitat and Species Directive or the Bern Convention.

Table 11 - Recorded plant species

No	Scientific name	Common name	IUCN Global	IUCN Europe	Serbian legislation	DAFOR scale /Additional notes
1.	*Achillea millefolium*	Yarrow	LC	LC		Frequent / widely distributed in mesic and sparsely wooded grassland and woodland edges
2.	*Alnus glutinosa*	Common Alder				Frequent / mainly distributed along the riparian zone of the Ub River and its tributaries
3.	*Ambrosia artemisiifolia* *	Common Ragweed				Abundant / widely distributed on arable land margins
4.	*Amorpha fruticosa* *	Bastard Indigo				Dominant / widely distributed along the riparian zone of the Ub River and its tributaries
5.	*Anthemis arvensis*	Corn Chamomile				Abundant / mainly occurred in mesic grasslands
6.	*Anthemis ruthenica*					Dominant / mainly occurred on arable land margins and in ruderal areas
7.	*Ballota nigra*	Black Horehound		LC		Abundant / mainly occurred on woodland edges and arable land margins
8.	*Chelidonium majus*	Great Celandine		LC		Frequent / mainly occurred in woodland and woodland edges
9.	*Cichorium intybus*	Chicory		LC		Frequent / mainly occurred on mesic grassland, arable land margins and in ruderal areas
10.	*Crataegus monogyna*	Common Hawthorn	LC	LC		Occasional / mainly occurred in sparsely wooded grassland and woodland margins
11.	*Cruciata laevipes*	Crosswort				Occasional / widely distributed in mesic and sparsely wooded grassland
12.	*Echium vulgare*	Echium Vulgare				Occasional/mainly occurred in mesic and sparsely wooded grassland
13.	*Euphorbia* spp.	Spurge				Frequent / woodland and woodland edges
14.	*Fagus moesiaca*	Balkan Beech				Frequent/ composing old well-preserved broadleaved deciduous woodland
15.	*Lolium perenne*	Perennial Ryegrass				Dominant / widely distributed in mesic and sparsely wooded grassland

No	Scientific name	Common name	IUCN Global	IUCN Europe	Serbian legislation	DAFOR scale /Additional notes
16.	*Malva sylvestris*	Common Mallow		LC		Abundant / mainly occurred on woodland edges, arable land margins and in ruderal areas
17.	*Mentha longifolia*	Horse Mint	LC			Frequent / mainly distributed along the riparian zone of the Ub River and its tributaries
18.	*Petasites hybridus*	Butterbur		LC		Rare / distributed in the littoral zone of the Ub River, mainly upstream the dam
19.	*Poa pratensis*	Common Meadow-grass				Dominant / widely distributed in mesic and sparsely wooded grassland
20.	*Populus nigra*	Black Poplar	DD	DD		Occasional / mainly distributed along the riparian zone of the Ub River and its tributaries
21.	*Ranunculus repens*	Creeping Buttercup				Frequent / mainly occurred in mesic. sparsely wooded grassland and woodland edges
22.	*Ranunculus* spp.*	Buttercup				Abundant / typical for grassland and woodland margins
23.	*Robinia pseudoacacia*	Black Locust				Abundant / typical for grassland and woodland margins
24.	*Rosa canina*	Dog Rose		LC	P	Frequent / typical for sparsely wooded grassland and woodland edges
25.	*Rubus spp.*					Frequent / widely distributed in grassland, woodland woodland edges
26.	*Salix alba*	White Willow				Frequent / mainly occurred along the riparian zone of the Ub River and its tributaries
27.	*Salix cinerea*	Grey Willow	LC	LC		Occasional / mainly occurred along the riparian zone of the Ub River and its tributaries
28.	*Salvia nemorosa*	Perennial Salvia				Occasional / distributed in sparsely wooded grassland, woodland edges and arable land margins
29.	*Sambucus ebulus*	Dwarf Elderberry		LC		Dominant / mainly occurred on grassland margins and in ruderal areas
30.	*Senecio* spp.	Dusty Miller				Frequent / widely distributed in mesic, sparsely wooded grassland and arable land margins

No	Scientific name	Common name	IUCN Global	IUCN Europe	Serbian legislation	DAFOR scale /Additional notes
31.	*Silene latifolia*	White Campion				Abundant / mainly occurred in mesic, sparsely wooded grassland and arable land margins
32.	*Symphytum officinale*	Comfrey		LC		Occasional/mainly occurred on arable land margins and along the riparian zone of the Ub River and its tributaries
33.	*Trifolium repens*	White Clover		LC		Dominant / widely distributed in mesic, sparsely wooded grassland and arable land margins
34.	*Urtica dioica*	Stinging Nettle	LC	LC		Dominant/mainly occurred on woodland and grassland edges, arable land margins and, ruderal areas and along the riparian zone of the Ub River and its tributaries
35.	*Verbascum* spp.	Mullein				Occasional / mainly occurred on sparsely wooded grassland, woodland edges, arable land margins and in ruderal areas

* Invasive / non-native species

IUCN Vulnerable (VU) or Least Concern (LC)

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

Fungi Survey Results

No VU fungi species listed in the initial IUCN screening (**Error! Reference source not found.**) were r ecorded during surveys as incidental findings. The surveys were conducted under suitable conditions for fungal detection, with moderate temperatures and recent rainfall in the days prior, which are generally favorable for the emergence of fruiting bodies. While no individuals were observed, these conditions support confidence in the conclusion that the target species were likely absent or present in very low abundance at the time of the survey. However, habitats potentially suitable for three of the IUCN VU fungi species (*Hapalopilus croceus*, *Baerospora myriadophylla* and *Tricholoma acerbum)* were recorded, particularly in the following habitats: *Quercetum frainetto-cerris and Fagetum moesiace submontanum typicum* woodlands.

4.1.4 Protected or Notable Species / Habitats

From this review, no plant species classified as CR, EN, or VU according to the IUCN Red List, nor species listed as CR or EN under Serbian national or regional red lists, were recorded in the project area. However, the presence of Invasive / non-native species such as *Amorpha fruticosa* (Bastard Indigo) and *Ambrosia artemisiifolia* (Common Ragweed) was noted, particularly along riparian zones. None of the plant species detected are listed under the EU Habitat and Species Directive or the Bern Convention, meaning they do not meet the criteria for protected status under these frameworks. The EOO of the recorded species (**Error! R eference source not found.**) is well above the thresholds for restricted-range classification and therefore does not trigger the relevant EBRD criteria or IUCN Criterion B tresholds.

Rosa canina (Dog Rose) is listed as a protected species under Serbian legislation, as part of the national list of "Strictly Protected" and "Protected" species. Its status necessitates careful consideration during construction activities to ensure compliance with relevant conservation regulations.

In terms of fungi, no VU fungi species listed during the initial IUCN screening were observed during the survey. Nevertheless, habitats potentially suitable for IUCN VU fungi species, such as *Hapalopilus croceus*, *Baerospora myriadophylla*, and *Tricholoma acerbum*, were identified, particularly within the *Quercetum frainetto-cerris* and *Fagetum moesiace submontanum typicum* woodlands. These habitats will be considered in further assessments for potential conservation significance.

The overall findings suggest that while no globally protected plant or fungi species were recorded, the presence of *Rosa canina* as a nationally protected species and the presence of Invasive / non-native plant species will require appropriate management. Additionally, the identified habitats for VU fungi species must be carefully considered to avoid degradation and ensure biodiversity protection during the project.

Dominant habitat type in the project area is Arable land and market gardens, covering of 47,66% of Biodiversity Study Area. *Quercetum frainetto-cerris* and *Fagetum moesiace submontanum typicum* woodlands as habitats with higher ecological values are represented with 24,51%.

4.2 Birds

4.2.1 Survey Methodology

Breeding Birds

Surveys were conducted between May and July 2023, aligning with the breeding season of most bird species. Survey visits were scheduled during suitable weather conditions to record signs of bird breeding activity, with precautions taken to avoid strong winds and prolonged heavy rain. Birds were detected and identified through visual observation and based on their calls/songs.

Due to the weather conditions that resulted in major flooding, the surveying schedule was updated to begin at the end of May 2023 to accommodate these meteorological conditions.

The bird surveys required the use of binoculars to assist with species identification. The survey methodology was as follows:

- Each survey visit was undertaken for up to four hours from sunrise. The route direction was reversed at alternate surveys to account for variations in times and bird activity. At least one of the four

surveys was undertaken in the evening – a four-hour survey extended until one hour after sunset (to detect crepuscular species, such as owls) for each transect.

- Signs of bird breeding activity were recorded:
    - Singing male in suitable nesting habitat;
    - Pair in suitable nesting habitat;
    - Species vocalisation;
    - Courtship and display;
    - Visiting a probable nest site;
    - Agitated behaviour;
    - Adults building a nest;
    - Used nest or eggshells;
    - Recently fledged young;
    - Adults entering or leaving an occupied nest;
    - Adults carrying a faecal sac or food for young;
    - Nest containing eggs; and,
    - Nests with young.

- The location of an occupied nest site or presumed centre of a breeding territory was marked on the survey map for regular breeders of the area.

For bird observation, binoculars with 8x, 10x, 12x, and 20x magnification were used. Transect techniques were applied, and bird taxa identification was done using appropriate taxonomic keys.

Satellite imagery and aerial photographs and initial site visit have been used to select predetermined transects (**Error! Reference source not found.**, Figure 9 and Figure 10) within the Biodiversity Study Area, featuring suitable habitats for 'priority' birds as defined by EBRD PR6. These transects included woodland, grassland, watercourses and riparian habitats, scrub, cultivated fields, and abandoned cultivated fields.

Table 12 - Breeding bird survey locations

Site reference	Location		Additional details
Transect 1	N 44.3992277°	E 19.8850464°	Gola Glava, transect length 3123 meters
	N 44.4012313°	E 19.8765207°	
Transect 2	N 44.4059197°	E 19.898657°	Slatina-Raduša, transect length 5407 meters
	N 44.4147245°	E 19.898657°	
Transect 3	N 44.4249121°	E 19.9080703°	Merkšinac Monastery, transect length 2140 meters
	N 44.4317429°	E 19.911898°	

The relative position of the bird transects in relation to the inundation area of the Pambukovica dam is presented in Figure 9.

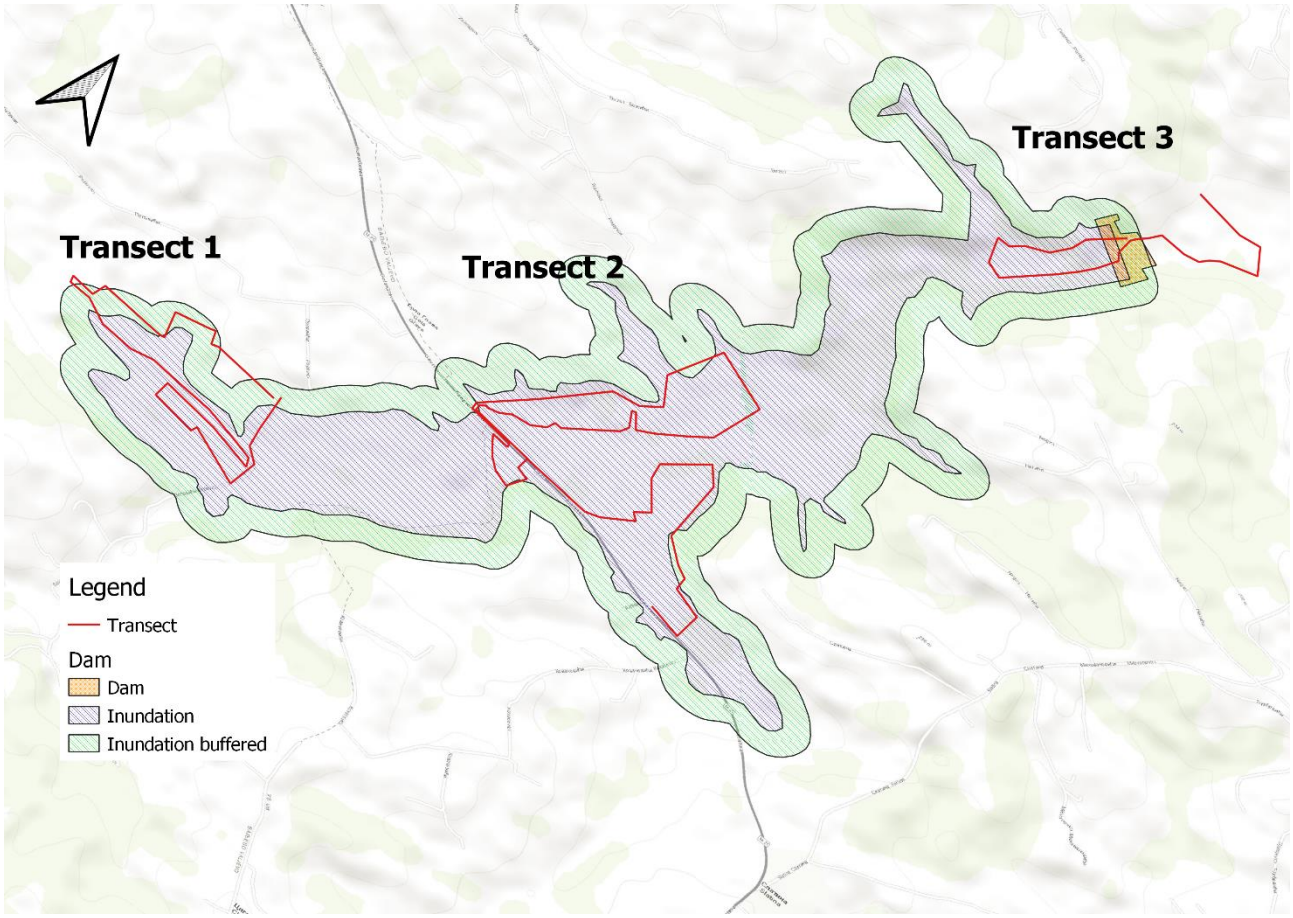


Figure 9 - Position of bird transects relative to Biodiversity Study Area

Figure 10 - Bird survey transects 1 - 3 (from top to bottom)

All observed or heard birds were recorded on a map. The survey was conducted four times, with each transect including both a morning and an evening session to improve detection of crepuscular species such as owls. Each session lasted four hours, extending until one hour before sunrise in the morning and one hour after sunset in the evening.

Occupied nest sites or presumed breeding territories have been marked on the survey map to precisely track the locations of breeding activity. If the same species is recorded in the same vicinity on two or more visits, it was considered as constituting a breeding territory. The surveys aimed to gather a comprehensive understanding of bird breeding patterns and behaviour within the Biodiversity Study Area.

Wintering Birds

The surveys were conducted between October 2023 and March 2024, aligning with the wintering bird season, which lasts from November to February, with some species arriving as early as late October. The peak period occurs between November and February, while departures begin in late February to early March, though some birds may remain until April if temperatures stay low. The purpose of the surveys was to record the distribution and abundance of wintering birds within the Biodiversity Study Area. The survey was undertaken four times. To ensure accurate recording of wintering bird activity, the survey visits were scheduled during suitable weather conditions, avoiding strong winds and prolonged heavy rain.

The bird surveys required the use of binoculars to assist with species identification. The survey methodology was as follows: Each transect was walked four times in suitable weather, for each month. Each survey visit was undertaken for up to four hours from sunrise. The route direction was reversed at alternate surveys to account for variations in times and bird activity.

For bird observation, binoculars with 8x, 10x, 12x, and 20x magnification were used. Transect techniques were applied, and bird taxa identification was done using appropriate taxonomic keys.

During each visit, the pre-determined transect are walked, which are same as for the breeding birds, and all birds observed or heard recorded, including flight paths and direction of flight where relevant. This approach aimed to gather comprehensive data on the wintering bird population within the Biodiversity Study Area.

4.2.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria. Habitat mapping and condition assessment was used to quantify the biodiversity value of the baseline and the potential habitat losses resulting from the project and inform the requirements for offsets (see Section 8).

4.2.3 Survey Results

The bird species observed during the baseline ornithological survey in the village of Pambukovica, near Ub, Serbia, reflect the ecological diversity of the project site. This area is composed of agricultural fields, riverine habitats, shrubland, and patches of mixed woodland, each offering essential resources such as nesting sites, food, and shelter for a variety of avian species.

Error! Reference source not found. and **Error! Reference source not found.** provides an overview of all bi rds recorded during the survey, along with their respective conservation status. One IUCN VU bird species (European Turtle-dove) has been confirmed as breeding in the area. The following species listed on Annex I of the Birds Directive and Resolution 6 of the Bern Convention were also recorded; Middle Spotted Woodpecker *Dendrocoptes medius*, Little Egret *Egretta garzetta* (***Error! Reference source not found.***), R ed-backed Shrike *Lanius collurio* and Grey-headed Woodpecker *Picus canus.* These species were carried forward to the CHA.

Table 13 - Breeding/wandering/migratory bird species findings

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
1.	*Accipiter gentilis (NBr.)*	Eurasian Goshawk	1/1/1	High flight / N	-	Woodland edge	LC	LC	BC	P
2.	*Accipiter nisus (NBr.)*	Eurasian Sparrowhawk	2/2/2	Low flight/N	-	Woodland/ possible breeder of wider area	LC	LC	BN III	SP
3.	*Aegithalos caudatus (Br.)*	Long-tailed Tit	18/3/10	Pair in suitable nesting habitat/Y	5	Woodland	LC	LC		SP
4.	*Alauda arvensis (Br.)*	Eurasian Skylark	8/6/3	Singing male in suitable nesting habitat /Y	2	Grassland	LC	LC	BD AII/B	SP
5.	*Anas platyrhynchos (NBr.)*	Mallard	2/1/2	Low flight / N	-	Woodland edge	LC	LC	BD AII/A	P
6.	*Athene noctua (Br.)*	Little Owl	1/1/1	Agitated behaviour /Y	1	Low density building	LC	LC	BN II	SP
7.	*Buteo buteo (Br.)*	Common Buzzard	6/8/4	Pair in suitable nesting habitat /Y	2	Woodland	LC	LC		SP
8.	*Carduelis carduelis (NBr.)*	European Goldfinch	26/9/10	Small flock feedings/N	-	Grassland/ possible breeder of wider area	LC	LC		SP
9.	*Chloris chloris (Br.)*	European Greenfinch	6/4/2	Singing male in suitable nesting habitat/Y	3	Woodland edge	LC	LC		
10.	*Coccothraustes coccothraustes (Nbr.)*	Hawfinch	5/2/3	High flight / N	-	Woodland/ possible breeder of wider area	LC	LC	BN II	SP
11.	*Columba livia domestica (Nbr.)*	Feral Pigeon	14/3/6	Small flocks in flight/N	-	Arable land margin/				

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
						possible breeder of wider area				
12.	*Columba palumbus (Br.)*	Common Wood Pigeon	8/2/4	Adults building a nest/Y	4	Woodland	LC	LC	BD AIII/A	P
13.	*Corvus corax (NBr.)*	Northern Raven	4/2/2	High flight/N	-	Woodland edge/ possible breeder of wider area	LC	LC		P
14.	*Corvus cornix (Nbr.)*	Hooded Crow	5/2/2	Low flight/N	-	Arable land margin/ possible breeder of wider area				P
15.	*Corvus frugilegus (NBr.)*	Rook	8/3/4	Low flight/N	-	Arable land/ possible breeder of wider area	LC	VU	BD AII/B	P
16.	*Coloeus monedula (Nbr.)*	Western Jackdaw	3/1/3	Low flight/N	-	Arable land/ possible breeder of wider area	LC	LC	BD AII/B	P
17.	*Cuculus canorus (Br.)*	Common Cuckoo	7/1/3	Species vocalisation/Y	-	Woodland edge	LC	LC		SP
18.	*Curruca curruca (Br.)*	Lesser Whitethroat	4/1/2	Singing male in suitable nesting habitat/Y	3	Scrubland	LC	LC		
19.	*Cyanistes caeruleus (Br.)*	Eurasian Blue Tit	4/2/2	Adults building a nest/Y	2	Woodland				
20.	*Dendrocopos major (Br.)*	Great Spotted Woodpecker	6/1/3	Recently fledged young/Y	3	Woodland	LC	LC		SP

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
21.	*Dendrocoptes medius (NBr.)*	Middle Spotted Woodpecker	1/1/1	Pecking/N	-	Woodland/ possible breeder of wider area	LC	LC	BD AI, BC	
22.	*Emberiza cirlus (Br.)*	Cirl Bunting	2/1/2	Singing male in suitable nesting habitat/Y	1	Woodland edge	LC	LC		SP
23.	*Emberiza citrinella (Br.)*	Yellowhammer	6/2/2	Singing male in suitable nesting habitat/Y	3	Woodland edge	LC	LC		
24.	*Erithacus rubecula (Br.)*	European Robin	14/4/5	Recently fledged young/Y	4	Woodland	LC	LC		SP
25.	*Falco subbuteo (NBr.)*	Eurasian Hobby	1/1/1	High flight/N	-	Woodland egde/ possible breeder of wider area	LC	LC		SP
26.	*Fringilla coelebs (Br.)*	Eurasian Chaffinch	8/3/4	Singing male in suitable nesting habitat/Y	4	Woodland	LC	LC		SP
27.	*Garrulus glandarius (Br.)*	Eurasian Jay	4/2/2	Agitated behaviour /Y	2	Woodland	LC	LC	BD AII/B	P
28.	*Hirundo rustica (NBr.)*	Barn Swallow	14/3/4	Low flight/N	-	Arable land/ possible breeder of wider area	LC	LC		SP
29.	*Jynx torquilla (Br.)*	Eurasian Wryneck	4/0/2	Species vocalisation/Y	2	Woodland	LC	LC		SP
30.	*Lanius collurio (Br.)*	Red-backed Shrike	6/3/2	Adults carrying faecal sac of food for young/Y	1	Scrubland	LC	LC	BD AI, BC	SP

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
31.	*Luscinia megarhynchos (Br.)*	Common Nightingale	10/0/4	Singing male in suitable nesting habitat/Y	3	Woodland	LC	LC		SP
32.	*Merops apiaster (NBr.)*	European Bee-eater	22/10/8	Small flocks in high flight/N	-	Grassland/possible breeder of wider area	LC	LC		SP
33.	*Emberiza calandra (Br.)*	Corn Bunting	17/3/4	Singing male in suitable nesting habitat/Y	4	Arable land margin, scrubland	LC	LC		SP
34.	*Motacilla alba (NBr.)*	White Wagtail	4/2/2	Perching/N	-	Low density buildings/ possible breeder of wider area	LC	LC		SP
35.	*Motacilla cinerea (NBr)*	Grey Wagtail	1/1/1	High flight/N	-	Woodland edge/ possible breeder of wider area	LC	LC		SP
36.	*Muscicapa striata (NBr)*	Spotted Flycatcher	1/1/1	Feeding in flight/N	-	Woodland edge/ possible breeder of wider area	LC	LC		SP
37.	*Oriolus oriolus (Br.)*	Eurasian Golden Oriole	8/1/3	Species vocalisation/Y	3	Woodland	LC	LC		SP
38.	*Parus major (Br.)*	Great Tit	26/7/8	Recently fledged young/Y	7	Woodland	LC	LC		SP
39.	*Passer montanus (Br.)*	Eurasian Tree Sparrow	52/10/18	Used nest or eggshells/Y	10	Scrubland	LC	LC		P

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
40.	*Phasianius colchicus (Br.)*	Common Pheasant	17/4/5	Visiting a probable nest site/Y	5	Grassland, arable land	LC	LC		
41.	*Phylloscopus collybita (Br.)*	Common Chiffchaff	16/4/4	Singing male in suitable nesting habitat/Y	4	Woodland	LC	LC		SP
42.	*Phylloscopus sibilatrix (Br.)*	Wood Warbler	1/1/1	Singing male in suitable nesting habitat/Y	1	Woodland	LC	LC		SP
43.	*Pica pica (Br.)*	Eurasian Magpie	16/10/5	Used nest or eggshells/Y	4	Woodland edge	LC	LC	BD AII/B	P
44.	*Picus canus (Br.)*	Grey-headed Woodpecker	2/0/1	Species vocalisation/Y	1	Woodland	LC	LC	BD AI, BC	SP
45.	*Picus viridis (Br.)*	European Green Woodpecker	2/1/1	Species vocalisation/Y	1	Woodland	LC	LC		SP
46.	*Poecile palustris (Br.)*	Marsh Tit	4/1/2	Visiting a probable nest site/Y	1	Scrubland	LC	LC		
47.	*Saxicola rubetra (Br.)*	Whinchat	7/3/2	Singing male in suitable nesting habitat/Y	1	Grassland	LC	LC		SP
48.	*Saxicola rubicola (Br.)*	European Stonechat	5/2/2	Singing male in suitable nesting habitat/Y	1	Grassland				
49.	*Sitta europaea (Br.)*	Eurasian Nuthatch	12/2/6	Recently fledged young/Y	4	Woodland	LC	LC		
50.	*Streptopelia decaocto (NBr.)*	Eurasian Collared Dove	5/3/2	Low flight/N	-	Woodland edge/ possible	LC	LC	BD AII/B	P

No.	Scientific name	Common name	Abundance	Bird Activity	Breeding Pairs	Habitat	IUCN Global	IUCN Europe	Birds Directive/ Bern Convention	Serbian legislation
						breeder of wider area				
51.	*Streptopelia turtur (Br.)*	European Turtle Dove	6/2/2	Species vocalisation/Y	3	Woodland, scrubland	VU	VU	BD AII/B	P
52.	*Sturnus vulgaris (NBr.)*	European Starling	33/18/12	Small flocks in flight/N	-	Woodland edge/ possible breeder of wider area	LC	LC	BD AII/B	P
53.	*Sylvia atricapilla (Br.)*	Eurasian Blackcap	20/2/7	Singing male in suitable nesting habitat/Y	5	Woodland, scrubland				SP
54.	*Curruca communis (Br.)*	Common Whitethroat	8/1/3	Singing male in suitable nesting habitat/Y	4	Scrubland	LC	LC		SP
55.	*Troglodytes troglodytes (Br.)*	Eurasian Wren	3/1/2	Visiting a probable nest site/Y	1	Woodland egde	LC	LC		SP
56.	*Turdus merula (Br.)*	Common Blackbird	15/3/6	Singing male in suitable nesting habitat/Y	3	Woodland edge	LC	LC	BD AII/B	SP
57.	*Turdus philomelos (Br.)*	Song Thrush	8/1/2	Singing male in suitable nesting habitat/Y	3	Woodland edge	LC	LC	BD AII/B	SP
58.	*Upupa epops (Br.)*	Eurasian Hoopoe	1/1/1	Species vocalisation/Y	1	Woodland edge	LC	LC		SP

IUCN Vulnerable (VU) or Least Concern (LC)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

BD A - Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version)

BC - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

NBr. indicates Non-Breeding Visitor
Br. indicates Breeding Species

Abundance is presented as number of detections / number of flights / peak recorded across visits

Bird Activity is presented as comment on behaviour and breeding on site - Yes (Y) / no (N)

Table 14 - Wintering bird species findings

No.	Scientific name	Common name	Abundance	Bird Activity	Habitat	IUCN Global	IUCN Europe	Bird directive/ Bern Convention	Serbian legislation
1.	*Aegithalos caudatus*	Long-tailed Tit	23/2/10	Feeding	Woodland/wintering flocks	LC	LC		SP
2.	*Actitis hypoleucos*	Common Sandpiper	1/1/1	Feeding	Riverbank	LC	LC		SP
3.	*Anas crecca*	Eurasian Teal	3/1/3	Low flight	Woodland edge	LC	LC		P
4.	*Anas platyrhynchos*	Mallard	10/6/4	Low flight	Woodland edge	LC	LC	BD AII/A	P
5.	*Anthus pratensis*	Meadow Pipit	2/2/2	Bird call	Grassland	LC	NT		SP
6.	*Ardea alba*	Great Egret	1/1/1	High flight	Grassland	LC	LC		SP
7.	*Ardea cinerea*	Grey Heron	6/3/2	High flight	Woodland edge	LC	LC		P
8.	*Buteo buteo*	Common Buzzard	15/8/6	Perching/High flight	Woodland edge/northern Populations wintering in the area	LC	LC		SP
9.	*Carduelis carduelis*	European Goldfinch	48/20/18	Feeding	Grassland, scrubland/small to medium wintering flocks	LC	LC		SP

No.	Scientific name	Common name	Abundance	Bird Activity	Habitat	IUCN Global	IUCN Europe	Bird directive/ Bern Convention	Serbian legislation
10.	*Chloris chloris*	European Greenfinch	16/10/5	Bird call	Woodland edge	LC	LC		
11.	*Coccothraustes coccothraustes*	Hawfinch	4/2/2	Bird call	Woodland	LC	LC	BN II	SP
12.	*Corvus corax*	Northern Raven	2/2/2	High flight	Grassland	LC	LC		P
13.	*Corvus cornix*	Hooded Crow	17/12/10	Feeding	Arable land/small wintering flocks				P
14.	*Corvus frugilegus*	Rook	23/2/10	Feeding	Arable land/small to medium wintering flocks	LC	VU	BD AII/B	P
15.	*Coloeus monedula*	Western Jackdaw	1/1/1	Feeding	Arable land/small to medium wintering flocks	LC	LC	BD AII/B	P
16.	*Dendrocopos major*	Great Spotted Woodpecker	3/1/3	Bird call	Woodland	LC	LC		SP
17.	*Erithacus rubecula*	European Robin	10/6/4	"Winter "bird song in evening	Woodland edge	LC	LC		SP
18.	*Fringilla coelebs*	Eurasian Chaffinch	2/2/2	Low flight	Woodland edge	LC	LC		SP
19.	*Fringilla montifringilla*	Brambling	1/1/1	Feeding	Woodland edge/medium wintering flock	LC	LC		SP
20.	*Galerida cristata*	Crested Lark	6/3/2	Bird call	Grassland margin	LC	LC		SP
21.	*Garrulus glandarius*	Eurasian Jay	15/8/6	Bird call	Woodland	LC	LC	BD AII/B	P
22.	*Linaria cannabina*	Common Linnet	48/20/18	Low flight	Grassland	LC	LC		
23.	*Mareca strepera*	Gadwall	16/10/5	High flight	Woodland edge	LC	LC		SP

No.	Scientific name	Common name	Abundance	Bird Activity	Habitat	IUCN Global	IUCN Europe	Bird directive/ Bern Convention	Serbian legislation
24.	*Emberiza calandra*	Corn Bunting	4/2/2	Feeding	Grassland, scrubland/small to medium wintering flocks	LC	LC		SP
25.	*Motacilla alba*	White Wagtail	2/2/2	Feeding	Riverbank	LC	LC		SP
26.	*Parus major*	Great Tit	17/12/10	Feeding	Woodland, scrubland/small to medium wintering flocks	LC	LC		SP
27.	*Passer montanus*	Eurasian Tree Sparrow	23/2/10	Feeding	Arable land, scrubland/small to medium wintering flocks	LC	LC		P
28.	*Phalacrocorax carbo*	Great Cormorant	1/1/1	High flight	Grassland	LC	LC		P
29.	*Phasianius colchicus*	Common Pheasant	3/1/3	Bird call	Grassland, scrubland	LC	LC		
30.	*Pica pica*	Eurasian Magpie	10/6/4	High flight	Woodland edge	LC	LC	BD AII/B	P
31.	*Sitta europaea*	Eurasian Nuthatch	2/2/2	Bird call	Woodland	LC	LC		
32.	*Spinus spinus*	Eurasian Siskin	1/1/1	Feeding	Woodland/small to medium wintering flocks	LC	LC		
33.	*Troglodytes troglodytes*	Eurasian Wren	6/3/2	“Winter” bird song in evening	Woodland edge, scrubland	LC	LC	BD AI	SP
34.	*Turdus merula*	Common Blackbird	15/8/6	Bird call	Woodland edge	LC	LC	BD AII/B	SP

IUCN Vulnerable (VU) or Least Concern (LC)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

BD A - Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version)

BC - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

Abundance is presented as number of detections / number of flights / peak recorded across visits

The agricultural fields, predominantly cultivated with wheat, corn, and other crops, serve as feeding grounds for numerous granivorous and insectivorous birds. The Eurasian Skylark nests directly on the ground within these open landscapes, while the Common Starling and Yellowhammer Forage along field edges, making use of the available seeds and insects.

The Ub River and its adjacent riparian vegetation provide critical habitat for water-dependent and edge-dwelling species. Along the riverbanks, the Grey Heron can be seen hunting fish and amphibians, while the Mallard takes advantage of wetland areas for both nesting and foraging. The species depends on the riverbanks for nesting sites and preys on small fish in the shallows.

Shrubland and hedgerows act as natural corridors for songbirds, offering both shelter and nesting opportunities. The Eurasian Blackcap prefers dense shrubs where it feeds on berries and insects, while the Lesser Whitethroat thrives in low vegetation. European Goldfinches are a frequent sight, flitting through the shrubs.

Patches of mixed woodland in the area provide breeding and foraging sites for a different set of avian species. The Great Spotted Woodpecker depends on mature trees, excavating nest cavities in dead wood, while the Common Buzzard is often detected at higher altitudes, surveying the area for potential prey. At night, the Tawny Owl becomes active, vocalizing from within the forest while hunting small mammals as its primary food source.

4.2.4 Protected or Notable Species / Habitats

Several bird species observed in the project meet the threshold as ‘threatened/priority’ species in accordance with EBRD PR6 and were therefore selected for evaluation in the CHA. Notably, these species include certain birds of conservation interest:

- Middle Spotted Woodpecker (*Dendrocoptes medius*) (IUCN Europe LC and IUCN Global LC; Bird Directive Annex I/B; Protected under Serbian regulation)
- Little Egret (*Egretta garzetta*) (IUCN Europe LC and IUCN Global LC; Bird Directive Annex I; Strictly protected under Serbian regulation)
- Red-backed Shrike (*Lanius collurio*) – Known to breed in the project area (IUCN Europe LC and IUCN Global LC; Bird Directive Annex I, Bern Convention; Strictly protected under Serbian regulation)
- Grey-headed Woodpecker (*Picus canus*) – Known to breed in the project area (IUCN Europe LC and IUCN Global LC; Bird Directive Annex I, Bern Convention; Strictly protected under Serbian regulation)
- European Turtle Dove (*Streptopelia turtur*) – Known to breed in the project area (IUCN Europe VU and IUCN Global VU; Bird Directive Annex II/B; Protected under Serbian regulation)

These priority species have been highlighted for further consideration due to their recognized conservation value under relevant directives and their potential breeding presence within the project boundaries. Additional details on the habitat needs and conservation status of these species will be incorporated as part of the CHA, along with any additional findings regarding other species or notable habitats within the study area.

During the avian survey, a significant number of bird species recorded are either listed as strictly protected (SP) or protected (P) under Serbian legislation. This includes some species that hold critical conservation statuses, both regionally and internationally, reflecting the ecological importance of the surveyed habitats.

The surveyed habitats, including woodland edges, grasslands, and scrublands, support both breeding and wintering bird species, underscoring the diversity and ecological value of the area. The findings highlight the importance of ongoing habitat preservation efforts, as these areas contribute to maintaining species populations and ecological health within the region.

4.2.5 Limitations

Even with the updated schedule for bird surveys in 2023 due to major flooding, there is a possibility that the recorded number of birds does not fully reflect the actual population. Early breeding species detectability may have decreased, as the early part of the breeding season was missed. However, due to the extensive desktop study and data comparison with survey findings, it is believed that any data gap, if present, remains minimal. The results are still considered robust, as species are likely to have been detected despite the adjusted survey timing.

4.3 Bats

4.3.1 Survey Methodology

Field surveys in the form of transect surveys and static detector surveys were undertaken in late July/early August 2023 (one survey visit) and between August and October 2024 inclusive and were led by a combination of suitably experienced ecologists. Surveys were undertaken with reference to:

- EUROBATS[12];
- Bat Surveys for Professional Ecologists: Good Practice Guidelines (4th edition[13]).

The objectives of these surveys were to establish the bat assemblage within the study area and overall use of the site by bats in terms of foraging and commuting, and thus to provide information to be used to assess the impacts of the proposed development on bats and develop appropriate mitigation measures. Arup devised all aspects of these methodologies in accordance with current GIIP and IFIs requirements.

Activity transects surveys

The aim of these surveys was to identify and assess the presence, activity levels, and habitat use of bat species across the biodiversity study area. A selection of pre-determined transects (**Error! Reference source not found.**) were defined to provide thorough coverage and representation of the Biodiversity Study Area, both spatially and ecologically, in line with relevant guidance. Transects were devised from satellite imagery and aerial photographs and encompassed features that are suitable for "Priority" bats e.g. woodland edges, watercourses, lines of trees, and scrub habitat to allow for a comparison of bat activity across the site, throughout the survey period. The approximate distance of each transect was between 2.4 and 5 km, depending on volume of suitable habitat available to bats throughout the duration of each transect. Each transect route was supplemented with three stopping locations where higher levels of bat activity or disturbance are expected, such as areas of favourable habitat and key construction sites (i.e., the proposed dam location and the proposed elevation of the existing road).

Table 15 - Activity transect survey locations

Date of transect survey	Site reference	Location		Transect length
		Latitude	Longitude	
29/07/2023	Transect 1	N 44.402331°	E 19.885573°	3.1km
		N 44.402254°	E 19.885353°	
30/07/2023	Transect 2	N 44.405318°	E 19.902636°	5.4km
		N 44.406764°	E 19.894819°	
07/08/2023	Transect 3	N 44.432188°	E 19.909232°	2.4km
		N 44.428852°	E 19.907902°	

Every survey commenced at sunset, with the duration of each transect extending a maximum of three hours after sunset. The transect routes were walked at a steady constant pace, stopping at the pre-identified stopping locations. Each transect was conducted by two experienced surveyors with one member focused on observing the surrounding bat activity, while the other member documented a time stamped narrative for

[12] The Agreement on the Conservation of Populations of European Bats (EUROBATS), "UNEP/EUROBATS – Agreement on the Conservation of Populations of European Bats," [Online]. Available at: https://www.eurobats.org/. [Accessed January 2025].

[13] Collins, J. The Bat Conservation Trust (BCT) (2023), "Bat Surveys: Bat Surveys for Professional Ecologists: Good Practice Guidelines (4th edition.)" [Report] [Accessed January 2025].

each observation. The time stamped narrative comprised information on the following aspects (where natural light levels were not a major constraint:

- Bat species;
- Number of bats;
- Flight direction;
- Apparent behaviour, e.g. feeding buzzes or social calling; and
- How bats responded to permanent or temporary features on site, e.g. waterbodies, tree lines, watercourses, sheltered areas and artificial lighting.

The pre-determined transects were walked once through the survey period. Throughout the duration of the transect surveys, bat calls were recorded using Petersson 240x and Echo Meter Touch 2 Pro bat detectors, allowing for data to be captured in time expansion, full spectrum and frequency division formats. The location corresponding to each bat pass was also noted by the surveyor at the time of recording and automatically captured via a GPS device, for subsequent data analysis.

Surveys were conducted on three occasions. Surveys were planned to be carried out in optimal conditions with no rain or windy conditions.

Full survey methodology including maps illustrating the activity transect routes can be found in the technical survey report in Appendix **Error! Reference source not found.**.

Automated detector surveys

Automated detector surveys were undertaken at seven locations (SMM-01 to SMM-07) throughout the Biodiversity Study Area between August and October 2024 inclusive. The specification of automated detectors used were Wildlife Acoustics SongMeter Mini Bat full spectrum bat detectors (referred to as 'static detectors or SMM-xx'). Static detectors were set up to begin recording bat calls 30 minutes before sunset, continuing until 30 mins after sunrise, collecting data on at least five consecutive nights per deployment month in appropriate (or best available) weather conditions.

Each static detector location was chosen based on the presence of suitable habitats and features that could be directly or indirectly impacted by the proposed development. The selection process also relied on professional judgment from ecologists to identify habitats likely to be important for bats, both as flight corridors and for foraging. These habitats included hedgerows, woodlands, grasslands, scrub, and arable areas. Descriptions of the habitats and features at each static deployment location are provided in **Error! R eference source not found.** below.

Table 16 - Descriptions of automated static detector locations

Static Detector ID	Location		Feature and connected habitats/features in the wider landscape
	Latitude	Longitude	
SMM-01	19°54'30.71"E	44°25'40.76"N	Detector positioned on a tree leaning over a shallow section of the river with a rocky bed. Both sides of the riverbank are densely vegetated, creating a natural corridor. The detector faced southeast along the river, directly above the water. Signs of human presence were evident, with cornfields located in close proximity to the site.
SMM-02	19°54'07"E	44°25'30"N	Detector location was deep within an open, sparse forest, positioned on a steep slope. The river lies approximately 200 meters away in a straight line. The trees in the area are slender and overgrown with ivy, creating a lightly vegetated understory. The detector's microphone faced southeast into the woodland. Above the forest, there are sunflower fields surrounded by invasive ragweed (*Ambrosia spp*.).
SMM-03	19°54'13.97"E	44°25'24.96"N	Detector location was situated at a river pool, a widened section of the river, with the detector mounted on a tree beside the water. The ground level was rich in scrub vegetation, including climbers and scattered trees such as willow (*Salix* sp.) and alder (*Alnus* sp.). Nearby, there is a cornfield, adding to the

Static Detector ID	Location		Feature and connected habitats/features in the wider landscape
	Latitude	Longitude	
			habitat diversity. The water here is deeper compared to other locations, creating a distinct aquatic environment. The microphone was oriented south along the river corridor.
SMM-04	19°54'06"E	44°25'04"N	Detector was positioned right next to the river, where the riverbed was partially exposed in places, resembling small pools rather than a continuous water flow. Alder trees were present in the area, and the detector was mounted on one of these trees. The microphone faced south-east along the river corridor. In close proximity to the site was a cornfield, with a tractor-access path leading directly to the river, cornfield, located just 5 meters away from water.
SMM-05	19°54'16.38"E	44°24'45.43"N	Detector was situated deep within the forest, with the detector placed on a small elevation. This site featured a natural corridor formed by raised terrain on both sides. The forest was open and easily navigable, with a sparse herbaceous layer. The microphone was oriented south-east, aligned along the natural corridor within the woodland. The location was approximately 300 meters away from the nearest water source in a straight line.
SMM-06	19°53'34.87"E	44°24'24.95"N	Detector was positioned beneath a road bridge, behind a concrete pillar supporting the structure. The surrounding vegetation consisted of scrub and black locust (*Robinia pseudoacacia*). Beneath the bridge, the water formed shallow pools, which were almost entirely dry during certain periods. The detector was placed on a slope just behind the concrete pillar, approximately 3-4 meters from the water.
SMM-07	19°53'42.18"E	44°24'12.13"N	Detector location was situated on the riverbed, with the detector mounted on a branch positioned horizontally above it. Both sides of the riverbed were densely covered with herbaceous vegetation. During the survey months, the water was scarce, and the riverbed was largely dry. This section of the riverbed formed an effective corridor for bats, with the microphone facing south-west along the river corridor.

Each static detector was deployed on a monthly basis between August and October 2024 inclusive. Before each deployment, weather data, including temperature, wind speed, and precipitation, were reviewed using online sources to confirm that conditions were optimal for the entire deployment period. Registered bat calls were recorded upon activation and assigned a timestamp. For consistency, the same model of static bat detector was used throughout the survey duration, with the same parameter settings and microphone type, as recommended in best practice guidance[13]. Detectors were deployed by experienced ecologists, positioning the omnidirectional microphones at appropriate heights and directions to maximise the recorded bat activity and to avoid obstruction of sound by dense foliage or other potential sound barriers where possible.

The complete survey methodology, including details of the monthly survey periods, corresponding weather conditions, and mapping showing the locations of the automated detectors, is presented in the technical survey report in Appendix **Error! Reference source not found.**.

4.3.2 Data Analysis / Assessment Methodology

The detectors recorded bat calls and produced .wav file containing a sequence of calls within a short time duration (15 seconds max was set as parameter). Each file can be considered a time a bat passed the recorder, i.e. a “bat pass”. For the purpose of this report, the number of files recorded by the detectors each night was considered as a proxy value for the number of “bat passes”.

Following the completion of the automated detector surveys the files recorded were uploaded to the British Trust of Ornithology’s (BTO) Acoustic Pipeline for processing and auto identification of bat species. The BTO Acoustic Pipeline utilises machine learning algorithms to analyse and categorise acoustic pulses within uploaded recordings. The Pipeline can assign up to four potential identities to a single recording based on probability distributions derived from detected pulses. These probabilities help determine species identities, along with an estimated likelihood of accurate classification. This estimation specifically refers to the false positive rate, the probability that an assigned identification is incorrect. The Pipeline adjusts this probability

so that a higher probability corresponds to a lower false positive rate, for example, if a species is identified with a probability of 0.9, there is a 10% chance that the classification is incorrect.

As recommended by recent BTO research files that were assigned a probability of less than 0.5 (50%) following processing were immediately discarded. Furthermore, the BTO Acoustic Pipeline states that a number of bat species can be difficult for an experienced analyst to assign species in areas where their ranges overlap. These European species included the following:

1. Whiskered (*Myotis mystacinus*), alcathoe (*Myotis alcathoe*) and Brandt's bats (*Myotis brandtii*)
2. Leisler's (*Nyctalus leisleri*) and parti-coloured bats (*Vespertilio murinus*)
3. Nathusius' Pipistrelle (Pipistrellus nathusii) and Kuhl's Pipistrelle (*Pipistrellus kuhlii*)

This approach is required to lower the probability of misidentification of European bat species recorded throughout the survey period. Without conclusive evidence in the form of diagnostic social and/or feeding buzzes or bats in the hand, the grouping of these cryptic species should be withheld. However, this grouping is not expected to significantly impact the results of this assessment.

All calls that were assigned a species, except those identified as less than 0.5 or labelled as noise, were subject to a two-step verification process using Wildlife Acoustic's Kaleidoscope Pro Software. This verification process followed the specific methods outlined in Appendix 8.8.9. These methods set tailored species-specific thresholds to assist both technician and auditor verify and review recordings accurately.

During the first stage of verification, an experienced ecologist with over 5 years of acoustic analysis experience (technician) manually reviewed at least 10% of files identified to a species and/or species group. After the initial verification stage, a second experienced ecologist (auditor) reviewed the manual verification conducted by the first ecologist (technician). As part of this second verification stage, the auditor reassessed the technician's manual verification before the twice-verified results were finalised and included in this report in the form of proportional results. Proportions were established for each location throughout the survey period. It is important to note that this is used to quantify bat activity, not bat abundance, which cannot be inferred from these acoustic recordings.

4.3.3 Limitations

Ecological surveys are limited by factors which affect the presence of plants and animals such as the time of year, migration patterns and behaviour. Therefore, the absence of evidence of any particular species should not be taken as conclusive proof that the species is not present or that it will not be present in the future. However, professional judgement allows for the likely presence of these species to be predicted with sufficient certainty to not significantly limit the validity of these findings.

Any latitude and longitude coordinates provided within this report are approximate (obtained through handheld GPS devices) and should be used as a guide only to provide further context to the surrounding habitat. Furthermore, the survey schedule was adjusted to accommodate adverse weather conditions, including the major flooding in Central Serbia which occurred which occurred at the end of May 2023 and gradually subsided into early June 2023.

A limitation associated with analysis of the automated static detectors, is related to the confidence thresholds set for each species. Calls above the confidence thresholds as stated in the protocol in Appendix C were accepted without manually checking. The benefit of using Automatic-Identification (Auto-ID) software ensures consistent application of rules for species identification, unlike human observers who vary in experience and capability. This variability makes it challenging to maintain consistency across different observers and even within the same observer over time. Additionally, human errors can become reinforced over time, a phenomenon known as 'concept drift,' which Auto-ID software avoids entirely. However, as the methodology was the same for each static location the results should still provide a reliable assessment on activity across the site, also all species included within the results have been subject to a rigorous two stage QA process and therefore the results provide a reliable assessment of species/species groups present on site.

Additionally, activity levels should not be compared at face value between species, as some species are more detectable than others. For instance, the data recorded using bat detector recordings are biased towards bats that use louder echolocation calls. Therefore, quiet species such as long-eared bats (*Plecotus* sp.) and bats

with directional calls such as horseshoe bats (*Rhinolophus* sp.) may be under recorded due to the limited recording range of the equipment. This is an unavoidable limitation for all surveys using bat detectors, the implications of which have been considered when analysing the results. Bat calls of Myotis and Plecotus genus were not identified to species level. Bats in this genus cannot reliably be separated on calls alone due to the overlap in call characteristics between the species. However, recommended mitigation measures would still be of relevance to grouped species and therefore are not considered to be a significant constraint.

4.3.4 Survey Results

Collectively the combination of the activity transects surveys and automated detector surveys confirmed the presence of a total of 25 species, including those belonging to cryptic species groups within the study area. Summaries and key trends in the results in relation to habitat context are provided below.

Activity transects surveys

The activity transects surveys confirmed the presence of 13 bat species throughout the site. The species recorded included three Annex II; Western Barbastelle Bat, Schreiber's Bent-winged Bat and Bechstein's Bat. In addition to 10 other species; Savi's Pipistrelle, Alcathoe Bat, Daubenton's Bat, Leisler's Bat, Common Noctule, Kuhl's Pipistrelle, Nathusius' Pipistrelle, Common Pipistrelle, Soprano Pipistrelle and Grey Long-eared Bat.

Automated detector surveys

The automated detector surveys recorded a total of 24 species, including those belonging to cryptic species groups. Making up the 24 species recorded was seven Annex II species; Western Barbastelle Bat, Schreiber's Bent-wing Bat, Long-fingered Bat, Geoffroy's Bat, Mediterranean Horseshoe Bat, greater horseshoe bat and lesser horseshoe bat. In addition to 17 further species; common serotine, Savi's pipistrelle, Alcathoe Bat, Brandt's Bat, Daubenton's Bat, whiskered Bat, Natterer's Bat, Leisler's Bat, Common Noctule, Kuhl's Pipistrelle, Nathusius' Pipistrelle, Common Pipistrelle, Soprano Pipistrelle, Brown Long-eared Bat, Grey Long-eared Bat, European Free-tailed Bat and Parti-coloured Bat.

Bat activity across all seven locations showed a general decline from August to October, influenced by seasonal behaviours such as mating, migration, hibernation preparation, and changes in prey availability. High numbers of Nathusius' and Kuhl's Pipistrelle were recorded in August, particularly at Locations 1, 3, and 6, with Nathusius' Pipistrelle showing a sharp decline later, likely due to migration. Location 6 recorded the highest bat activity, especially among pipistrelle species, likely due to the presence of an underpass aiding safe movement. Location 1 showed the greatest species diversity, underscoring its ecological importance, while Location 5 had the lowest bat activity, suggesting less favourable habitat conditions.

Barbastelle and Schreiber's Bent-wing Bat had peak counts in September, likely due to roosting behaviour, as these bats often switch between summer and winter roosts during transitional month. Meanwhile, while Noctule Bat showed sporadic increases likely linked to movement between feeding and mating sites. A late-season peak in grey long-eared bat activity was noted at Location 7, possibly due to increased foraging. The results also confirmed that bat activity was higher near the River Ub (Locations 1, 3, 4, and 6) and lower at woodland sites further from the river (Locations 2, 5, and 7). Daubenton's bat numbers dropped, potentially due to relocation away from water sources, while Schreiber's Bat maintained activity through October, likely due to their preference for stable cave roosting conditions. Overall, bat activity was highest in late summer, with declines as autumn progressed, reflecting changes in foraging, mating, and roosting behaviours, emphasizing the critical role of riparian corridors and man-made structures in supporting diverse bat population.

4.3.5 Protected or Notable Species / Habitats

Due to the large scale tree clearance and woodland loss associated with the proposed Pambukovica Dam reservoir development, a preliminary assessment of roosting resource was conducted to evaluate the potential ecological value of existing woodland habitats within the proposed Pambukovica Dam reservoir area. This assessment integrated a combination of remote sensing and field survey techniques. Desk-based analysis included the interpretation of aerial imagery, while field data encompassed habitat classification gathered during mapping efforts from June to October 2023, bat activity survey data collected in July and August 2023, and static detector survey data collected between August and October 2024. Landscape connectivity and the relationship of these habitats to the broader ecological network were also considered to provide a comprehensive understanding of their conservation value.

The assessment takes into account the likely presence of potential roost features (PRF's) (e.g. cavities, fissures, frost cracks, woodpecker holes, peeling bark etc), and takes into consideration the regular roost switching, fission and fusion behaviours of tree-dwelling bats. **Error! Reference source not found.** and REF _Ref201760428 \h **Error! Reference source not found.** provide a high level qualitative RAG (Red = High, Amber = Moderate or Green = Low) rating for likelihood of Potential Roost Feature (PRF) availability, based on woodland types and surveyor observations throughout site visits.

Table 17 -RAG rating for likelihood of PRF availability based on specification of woodland habitat

Habitat type	EUNIS Code	Habitat category	Habitat condition	RAG rating (High, Moderate and Low)
Fagetum miesiace submontanum typicum woodland	G1.69	Natural	Good	**High**
Quercetum frainetto-cerris woodland	G1.76811	Natural	Good	**High**
Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*	G1.1	Natural	Moderate	**Moderate**
Robinia pseudoacacia woodland	G1.C3	Modified	Poor	**Low**
Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. italica*	G5	Modified	Poor	**Low**

Table 18 - Broad roost resource assessment based on habitats present surrounding each static detector location.

Static Detector ID	Broad assessment of the habitat present	RAG rating for likelihood of PRF availability (High, Moderate and Low)
SMM-01	The habitat surrounding SMM-01 consists primarily of *Fagetum miesiace submontanum typicum* woodland (G1.69), which transitions into broadleaved woodland toward the east and arable land to the west. The immediate section of *Fagetum miesiace submontanum typicum* woodland is densely vegetated, with increasing scrub encroachment observed along the River Ub catchment. As the woodland grades into broadleaved forest, the development of glades and woodland pasture features becomes apparent as the woodland transitions to arable land at the foot of the hill. The dense vegetation along the River Ub catchment offers high-quality foraging and commuting habitat for the bat species across the dam area. Additionally, the surrounding woodland contains predominantly semi-mature standard trees, which provide poor suitability for roosting bats due to the age structure of the trees in this area. However, the semi-mature trees are expected to provide more suitable successional roosting habitats for bats within the next decade as these trees reach maturity.	**Moderate**
SMM-02	The habitat surrounding SMM-02 is predominantly *Robinia pseudoacacia* woodland situated on a steep western valley slope. This woodland has a relatively open structure, particularly on the upper slopes, where semi-mature deciduous and mature coniferous standards are present. These coniferous stands transition downslope into semi-mature broadleaved standards, with a dense scrub layer developing toward the lower gradient as the woodland grades into arable land. Adjacent to the *Robinia pseudoacacia* woodland are two more mature fragments of *Quercetum frainetto-cerris* woodland further west. Based on the age and species composition, it is assumed that the *Robinia pseudoacacia* woodland habitat in this area provides moderate suitability for roosting bats. However, the surrounding *Quercetum frainetto-*	**High**

Static Detector ID	Broad assessment of the habitat present	RAG rating for likelihood of PRF availability (High, Moderate and Low)
	cerris woodland habitat and associated woodland edges offer enhanced opportunities for both foraging and roosting bats also.	
SMM-03	The habitat surrounding SMM-03 closely resembles that of SMM-01, though with reduced scrub encroachment. This provides a relatively open corridor along the River Ub, both upstream and downstream, which facilitates foraging and commuting activity for bats upstream and downstream. SMM-03 lies adjacent to an extensive area of *Quercetum frainetto-cerris* woodland that continues southward along the River Ub corridor, offering moderate to high suitability for roosting bats. However, this woodland is significantly affected by dense scrub encroachment, rendering certain areas difficult to access. In contrast, the landscape to the west comprises a mosaic of mesic grasslands and arable land, which supports additional foraging opportunities for bats. The mosaic of woodland to the east and scrub habitats make this area moderately suitable for roosting bats due to the immature age of the tree species and extensive scrub growth close to this location. However, the *Quercetum frainetto-cerris* woodland further east transitions to semi-mature woodland with opportunities for successional roosting habitats for bats within the next decade as these trees reach maturity.	**Moderate**
SMM-04	The immediate habitat surrounding SMM-04 comprises arable land that transitions westward into *Quercetum frainetto-cerris* woodland on higher ground. The ecotone between the arable fields and woodland serves as a foraging and commuting corridor, facilitating connectivity within the broader landscape. While the arable land itself offers limited roosting opportunities for bats, the adjacent *Quercetum frainetto-cerris* woodland provides low to moderate bat roosting suitability due to the age composition of these trees. However, the *Quercetum frainetto-cerris* woodland in this area is tall and straight in structure with limited opportunities for PRF's to develop on tree limbs.	**Moderate**
SMM-05	The habitat surrounding SMM-05 is predominantly composed of *Quercetum frainetto-cerris* woodland. In the northern portion of this parcel, the woodland exhibits a semi-mature structure with an increasing presence of encroaching scrub. Towards the east, the woodland becomes more mature in structure, with evidence of historical management observed by surveyors. This section represents the highest-quality woodland across the dam site. The presence of paths and rides within the woodland enhances structural heterogeneity and provides safe commuting routes for bats throughout the dam area. However, based on the age and species composition within the *Quercetum frainetto-cerris* woodland in this area it is assumed that this parcel of woodland would offer moderate to high suitability for tree-roosting bat species.	**High**
SMM-06	The habitat surrounding SMM-06 primarily comprises encroaching scrub along the River Ub corridor. To the east lies a *Robinia pseudoacacia* woodland parcel; however, the presence of roads and bridges has resulted in significant habitat fragmentation, limiting ecological connectivity to a few isolated pockets. Consequently, opportunities for tree-roosting bats within this area are largely restricted to the woodland parcel. To the west, SMM-06 borders arable land and associated farm buildings, which may offer additional roosting opportunities for bats, particularly in built structures.	**Low**
SMM-07	The habitat surrounding SMM-07 is predominantly composed of riparian and gallery woodland, with *Alnus glutinosa, Populus nigra, and Salix alba* as the dominant species. This parcel is semi-mature and structurally dense, resulting in sections of the River Ub corridor being largely impassable further downstream. The woodland immediately adjacent to the river consists primarily of unmanaged scrub, while areas further from the river exhibit a more open structure. Although roosting opportunities within this area are limited, the primary ecological function of the habitat is to provide connectivity to higher-quality, roost-suitable woodland located further south and downstream within the wider surrounding landscape.	**Low**

Overall, the potential loss of bat roosting habitat is expected to be most pronounced in the wooded areas situated to the north-east, east, and north-west of the site. These regions encompass ecologically significant woodland parcels, including *Quercetum frainetto-cerris* and *Fagetum moesiacae submontanum typicum*

woodland. Given the species composition and successional age structure of these habitats, they are more likely to support a higher density of roosting sites compared with other habitats in the Pambukovica Dam area.

All bat species recorded within the project area qualify as ‘priority species’ under EBRD PR6 and were therefore selected for further evaluation in the Critical Habitat Assessment (CHA) detailed in Chapter 6. In Serbia, all bat species are under strict legal protection. They are listed in Annex IV of the EU Habitats Directive, which mandates their strict protection under Serbian law through the Decree on the Proclamation and Protection of Strictly Protected and Protected Wild Species of Plants, Animals, and Fungi. Additionally, 13 of these species are also included in Annex II of the Directive, which forms the foundation for establishing and managing Natura 2000, a network of protected areas across EU Member States. **Error! R eference source not found.** below presents the bat species recorded within the study area, along with their corresponding global, European and national conservation status’s.

Table 19 - Results of bat species recorded collectively between July 2023 and October 2024

No.	Scientific name	Common name	IUCN global status [14]	IUCN European status [14]	Habitats Directive Annex IV [15]	Habitats Directive Annex II [15]	Bonn Convention (Appendix II)	Bern Convention (Annex I of Resolution 6)	Bern Convention (Appendix II)	Serbian Legislation [16]	Serbian national status [17]
1.	*Barbastella barbastellus*	Western Barbastelle Bat	NT	VU	✓	✓	✓	✓	✓	SP	VU
2.	*Eptesicus serotinus*	Common Serotine	LC	LC	✓		✓		✓	SP	LC
3.	*Hypsugo savii*	Savi's Pipistrelle	LC	LC	✓		✓		✓	SP	LC
4.	*Miniopterus schreibersii*	Schreiber's Bent-wing Bat	NT	NT	✓	✓	✓	✓	✓	SP	LC
5.	*Myotis alcathoe*	Alcathoe Bat	DD	DD	✓		✓		✓		DD
6.	*Myotis bechsteinii*	Bechstein's Bat	NT	VU	✓	✓	✓	✓	✓	SP	NT
7.	*Myotis brandtii*	Brandt's Bat	LC	LC	✓		✓		✓	SP	DD
8.	*Myotis capaccinii*	Long-fingered Bat	VU	VU	✓	✓	✓	✓	✓	SP	LC
9.	*Myotis daubentonii*	Daubenton's Bat	LC	LC	✓		✓		✓	SP	LC
10.	*Myotis emarginatus*	Geoffroy's Bat	LC	LC	✓	✓	✓	✓	✓	SP	NT
11.	*Myotis mystacinus*	Whiskered Bat	LC	LC	✓		✓		✓	SP	LC
12.	*Myotis nattereri*	Natterer's Bat	LC	LC	✓		✓		✓	SP	NT
13.	*Nyctalus leisleri*	Leisler's Bat	LC	LC	✓		✓		✓	SP	LC

[14] The ICUN Red List of Threatened Species (2024) - IUCN Vulnerable (VU), Near Threatened (NT), Least Concern (LC), Data Deficient (DD). Available [ONLINE] at: https://www.iucnredlist.org. [Accessed January 2025].

[15] Joint Nature Conservation Committee (JNCC), "Council Directive 92/43/EEC (The Habitats Directive) Annex II and Annex IV Species List," [Online]. Available at: https://sac.jncc.gov.uk/species/. [Accessed January 2025].

[16] Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016)

[17] Ministry of Environment and Spatial Planning, Republic of Serbia, "National report on the implementation of the agreement on the conservation of bats in Europe – Serbia 2010," [Online]. Ava: https://www.eurobats.org/sites/default/files/documents/pdf/National_Reports/nat_rep_Serb_2010.pdf [Accessed January 2025].

No.	Scientific name	Common name	IUCN global status[14]	IUCN European status[14]	Habitats Directive Annex IV[15]	Habitats Directive Annex II[15]	Bonn Convention (Appendix II)	Bern Convention (Annex I of Resolution 6)	Bern Convention (Appendix II)	Serbian Legislation[16]	Serbian national status[17]
14.	*Nyctalus noctula*	Common Noctule	LC	LC	✓		✓		✓	SP	LC
15.	*Pipistrellus kuhlii*	Kuhl's Pipistrelle	LC	LC	✓		✓		✓	SP	LC
16.	*Pipistrellus nathusii*	Nathusius' Pipistrelle	LC	LC	✓		✓		✓	SP	LC
17.	*Pipistrellus pipistrellus*	Common Pipistrelle	LC	LC	✓		✓		✓	SP	LC
18.	*Pipistrellus pygmaeus*	Soprano Pipistrelle	LC	LC	✓		✓		✓	SP	DD
19.	*Plecotus auritus*	Brown Long-eared Bat	LC	LC	✓		✓		✓	SP	NT
20.	*Plecotus austriacus*	Grey Long-eared Bat	LC	LC	✓		✓		✓	SP	LC
21.	*Rhinolophus euryale*	Mediterranean Horseshoe Bat	NT	VU	✓	✓	✓	✓	✓	SP	NT
22.	*Rhinolophus ferrumequinum*	Greater Horseshoe Bat	LC	LC	✓	✓	✓	✓	✓	SP	LC
23.	*Rhinolophus hipposideros*	Lesser Horseshoe Bat	LC	LC	✓	✓	✓	✓	✓	SP	NT
24.	*Tadarida teniotis*	European Free-tailed Bat	LC	LC	✓		✓		✓	SP	DD
25.	*Vespertilio murinus*	Parti-coloured Bat	LC	LC	✓		✓		✓	SP	LC

All bat species recorded in the project area meet the criteria as ‘priority species’ in accordance with EBRD PR6 and are therefore selected for further evaluation in the Critical Habitat Assessment (CHA). All bats in Serbia are Strictly protected (SP) under Serbian legislation[16].

4.4 Amphibians

4.4.1 Survey Methodology

The start period of the surveys was postponed from May to June 2023 due to the extreme weather conditions, which led to major flooding in the area. Surveying sites included waterbodies, watercourses, and adjacent habitats within the Biodiversity Study Area. These surveys encompassed both diurnal and nocturnal observations. During the daytime, searches for amphibians included listening for calls, spotlighting, and direct observation. At night, surveys involved listening for calls, spotlighting, and physical searches.

4.4.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria.

4.4.3 Survey Results

Detected amphibian species are primarily associated with aquatic environments such as small muddy ponds, roadside water bodies, and riparian zones along the river. These habitats are critical for breeding, foraging, and overall species survival, with various species showing specific habitat preferences.

The surveys confirmed the presence of a number of amphibians species, recorded across different transects within the Biodiversity Study Area. **Error! Reference source not found.** contains the species recorded d uring the July 2023 surveys, the survey transect they were recorded within and their conservation status.

Table 20 - Amphibian species findings

No.	Scientific name	Common name	IUCN Global	IUCN Europe	Habitats and species directive	Serbian legislation
1.	*Bombina variegata*	Yellow-bellied Toad	LC	LC	II, IV	SP
2.	*Bufo bufo*	Common Toad	LC			SP
3.	*Pseudepidalea viridis*	European Green Toad	LC	LC	IV	SP
4.	*Pelobates fuscus*	Common Spadefoot Toad	LC	LC	IV	SP
5.	*Pelophylax ridibundus*	Marsh Frog	LC	LC		P
6.	*Pelophylax kl. esculentus*	Edible Frog				P
7.	*Pelophylax lessonae*	Pool Frog	LC	LC		P
8.	*Rana graeca*	Greek Stream Frog	LC	LC	IV	SP
9.	*Salamandra salamandra*	Fire Salamander	VU	LC		SP

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia);

IUCN Vulnerable (VU), Least Concern (LC), Near Threatened (NT), Data Deficient (DD)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Species such as the Yellow-bellied Toad, European Green Toad and Common Spadefoot Toad are typically found in temporary or semi-permanent water bodies, particularly in shallow, muddy ponds near roadsides

and depressions. These species breed in still or slow-moving water, and the ephemeral nature of these water bodies is crucial for their reproduction, providing a safe space for larvae development. The proximity of these habitats to the Ub River likely facilitates adult dispersal and movement between breeding sites and foraging grounds.

The Marsh Is commonly found in ponds that are more permanent or semi-permanent and feature dense aquatic vegetation. While they primarily rely on stable water sources for breeding, the temporary ponds near the river provide additional breeding opportunities during wetter periods. These species help maintain ecological balance by controlling invertebrate populations in these aquatic habitats.

The Greek Stream Frog is typically associated with flowing water environments and is found along the banks of the Ub River, where it takes advantage of the invertebrate-rich environment for both foraging and breeding. The river's dynamic habitat is essential for the development of larvae, with its flowing waters providing suitable conditions for growth.

The Fire Salamander although primarily terrestrial, also relies on moist environments near water bodies for shelter and breeding. In the study area, Fire Salamanders are often found in riparian zones, particularly along the riverbanks, where the combination of water and moisture-rich surroundings creates an optimal microclimate for their survival.

In summary, the amphibian species detected in the project area show a strong association with both temporary and permanent aquatic habitats. Small ponds, roadside depressions, and the river's riparian zones provide essential breeding and foraging grounds for these species. The presence of these water bodies facilitates critical ecological interactions, supporting amphibian populations by offering varied environments for different life stages.

4.4.4 Protected or Notable Species / Habitats

Several amphibian species observed in the project area meet the threshold as ‘threatened/priority’ species in accordance with EBRD PR6 and were therefore selected for evaluation in the Critical Habitat Assessment (CHA). These species are:

- Yellow-bellied Toad (*Bombina variegata*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex II and IV; Strictly protected under Serbian regulation)
- Common Spadefoot Toad (*Pelobates fuscus*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV; Strictly protected under Serbian regulation)
- European Green Toad (*Pseudepidalea viridis*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV; Strictly protected under Serbian regulation)
- Greek Stream Frog (*Rana graeca*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV; Strictly protected under Serbian regulation)
- Fire Salamander (*Salamandra salamandra*) (IUCN Europe LC and IUCN Global VU; Strictly protected under Serbian regulation)

During the amphibian survey, some recorded species are either listed as strictly protected (SP) or protected (P) under Serbian legislation. Strictly protected species are: Yellow-bellied Toad (*Bombina variegata*), Common Toad (*Bufo bufo*), European Green Toad (*Pseudepidalea viridis*), Common spadefoot toad *(Pelobates fuscus*), Greek Stream Frog (*Rana graeca*) and Fire Salamander (*Salamandra salamandra*). Protected species are: Marsh Frog (*Pelophylax ridibundus*), Edible Frog (*Pelophylax kl. esculentus*) and Pool Frog (*Pelophylax lessonae*).

4.5 Reptiles

4.5.1 Survey Methodology

Surveys were conducted twice a month in June, August and September 2023. Survey visits were scheduled during favourable weather conditions, avoiding strong winds and prolonged heavy rain. Additionally, the timing of the visits was synchronized with the period of the day when reptiles were most likely to be

basking, maximizing the chances of detecting their presence. The team carried out the reptile surveys along pre-defined transects.

At each sample site, the survey applied the following methodology:

Suitable naturally occurring refugia likely to be used by reptiles for basking were identified;
Refugia were supplemented within these areas through the relocation of flat stones, logs, etc., from adjacent and unsuitable habitat to achieve approximately 10 refugia per hectare;
Refugia were searched once per survey visit;
Species and abundance of all reptiles were recorded. If species identification required the capture of reptiles, surveyors caught individuals to record this information;
Signs of the presence of reptiles were also noted during the surveys, including skin sloughs or direct observations.

4.5.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria.

4.5.3 Survey Results

Detected reptile species are predominantly associated with a variety of terrestrial and semi-aquatic habitats, including woodlands, scrubland, and areas with rocky or sun-exposed surfaces. These species utilize these habitats for basking, foraging, and shelter, with some species showing specific habitat preferences based on microhabitat conditions.

The surveys confirmed the presence of several reptile species. **Error! Reference source not found.** contains s pecies recorded during the June, August and September 2023 surveys, their location within the Biodiversity Study Area and their conservation status. None of the detected species are listed on Resolution 6 of the Bern Convention.

Table 21 - Reptilian species findings

No.	Scientific name	Common name	IUCN Global	IUCN Europe	EU Habitats Directive	Serbian legislation	
1.	*Anguis fragilis*	Slow Worm	LC	LC			
2.	*Podarcis muralis*	Common Wall Lizard	LC	LC	IV		
3.	*Lacerta viridis*	European Green Lizard	LC	LC	IV		
4.	*Lacerta agilis*	Sand Lizard	LC	LC	IV		
5.	*Natrix natrix*	Grass Snake	LC			SP	
6.	*Natrix tessellata*	Dice Snake	LC	LC	IV	SP	
7.	*Zamenis longissimus*	Aesculapian Snake	LC	LC	IV	SP	

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

IUCN Least Concern (LC)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

The Slow Worm, a legless lizard, is commonly found in areas with dense vegetation or under rocks and debris. Its preference for sheltered microhabitats, including areas with moderate sunlight, allows it to thermoregulate effectively. The Slow Worm is primarily a burrower, often found in areas with a combination of loose soil and organic matter, which provide optimal conditions for hiding and foraging.

The Common Wall Lizard and the European Green Lizard are more commonly found in sunny, open areas with suitable basking sites, such as rocky outcrops, walls, and woodland edges. Both species prefer areas with abundant vegetation for shelter, yet they depend on open, sun-exposed surfaces for thermoregulation. These species exhibit strong territorial behaviours, with males often observed defending basking territories from other individuals.

The Sand Lizard is typically found in dry, sandy, and well-vegetated habitats. This species is most active in areas where the vegetation provides both hiding spaces and a habitat for its preferred insect prey. Sand Lizards tend to favour areas with low vegetation or sparse scrubland where they can easily bask and escape predators.

The Grass Snake is commonly found near water sources, including ponds, streams, and riverbanks. In the study area, this species uses the aquatic habitats for foraging, as it preys on amphibians and fish. While the Grass Snake is primarily aquatic, it also uses terrestrial habitats for basking and shelter.

The Dice Snake, similar to the grass snake, is associated with aquatic environments, including rivers and ponds. The dice snake prefers slow-moving waters with abundant vegetation, where it can hunt fish and amphibians. The species also seeks out basking sites along the water's edge, particularly in the warmer months.

The Aesculapian Snake prefers forested areas with a mix of dense vegetation and open spaces. This species is often found in the vicinity of riverbanks or woodlands, where it can use trees or rocky outcrops as basking sites. It is known for its ability to climb, which allows it to explore a variety of vertical surfaces, such as tree trunks or walls, in search of prey.

Overall, the reptile species detected in the Pambkovica area show a range of ecological preferences. While some species favour open, sun-exposed habitats for basking, others rely on the proximity to water or vegetated areas for foraging and shelter. The riparian zones along the Ub River and surrounding terrestrial habitats provide essential resources for food and refuge, supporting the reptilian populations in the area.

4.5.4 Protected or Notable Species / Habitats

Several reptilian species observed in the project, as listed on Annex IV of EU habitat Directive, area meet the threshold as ‘threatened/priority’ species in accordance with EBRD PR6 and were therefore selected for evaluation in the Critical Habitat Assessment (CHA). These species are:

- Sand Lizard (*Lacerta agilis*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV)
- European Green lizard (*Lacerta viridis*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV)
- Dice Snake (*Natrix tessellata*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV; Strictly protected under Serbian regulation)
- Common Wall Lizard (*Podarcis muralis*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex IV)

Species recorded as strictly protected under Serbian legislation are Grass Snake (*Natrix natrix*), Dice Snake (*Natrix tesellata*) and Aesculapian Snake (*Zamenis longissimus*).

4.6 Riparian and Other Mammals

4.6.1 Survey Methodology

Transects (Figure 11and **Error! Reference source not found.**) were designated for riparian mammal surveys, with survey visits focusing on otters at each transect location. The visits were undertaken from July to September 2023. Further otter surveys were conducted in 2024., alongside data collection for the hydrological study. These surveys covered a broader area, including transects of up to 200 meters along the rivers in the confluence zones of the Ub and Tamnava rivers, as well as the Tamnava and Kolubara rivers (Figure 12).

Both banks of the watercourse, including adjacent habitat within the banks and bank tops, were surveyed along each transect. The following signs of otters were searched for and recorded if noticed, with GPS coordinates noted when identified: spraints (including number, recent or older), food remains, rolling places, slides down to riverbanks, footprints or paths, and shelters such as holts, couches, or lay-up sites.

Surveys were conducted during suitable conditions, avoiding days following heavy rain to prevent field signs from being washed away. Similar to the otter surveys, both sides of the watercourse were surveyed along each transect.

The following signs of other riparian mammals are searched for and recorded, with GPS coordinates noted when identified: sightings of individual riparian mammals, burrows, feeding platforms and evidence of feeding, food remains, latrines, footprints.

Table 22 - Riparian mammals survey locations

Site reference	Location		Additional details
Transect 1	N 44.399930°	E 19.889157°	Transect length 526 meters
	N 44.400343°	E 19.883307°	
Transect 2	N 44.405153°	E 19.894337°	Transect length 510 meters
	N 44.408512°	E 19.895381°	
Transect 3	N 44.430879°	E 19.912577°	Transect length 550 meters
	N 44.428444°	E 19.908643°	

Figure 11 - Otter and riparian mammal survey transects (from top to down) 1, 2 and 3.

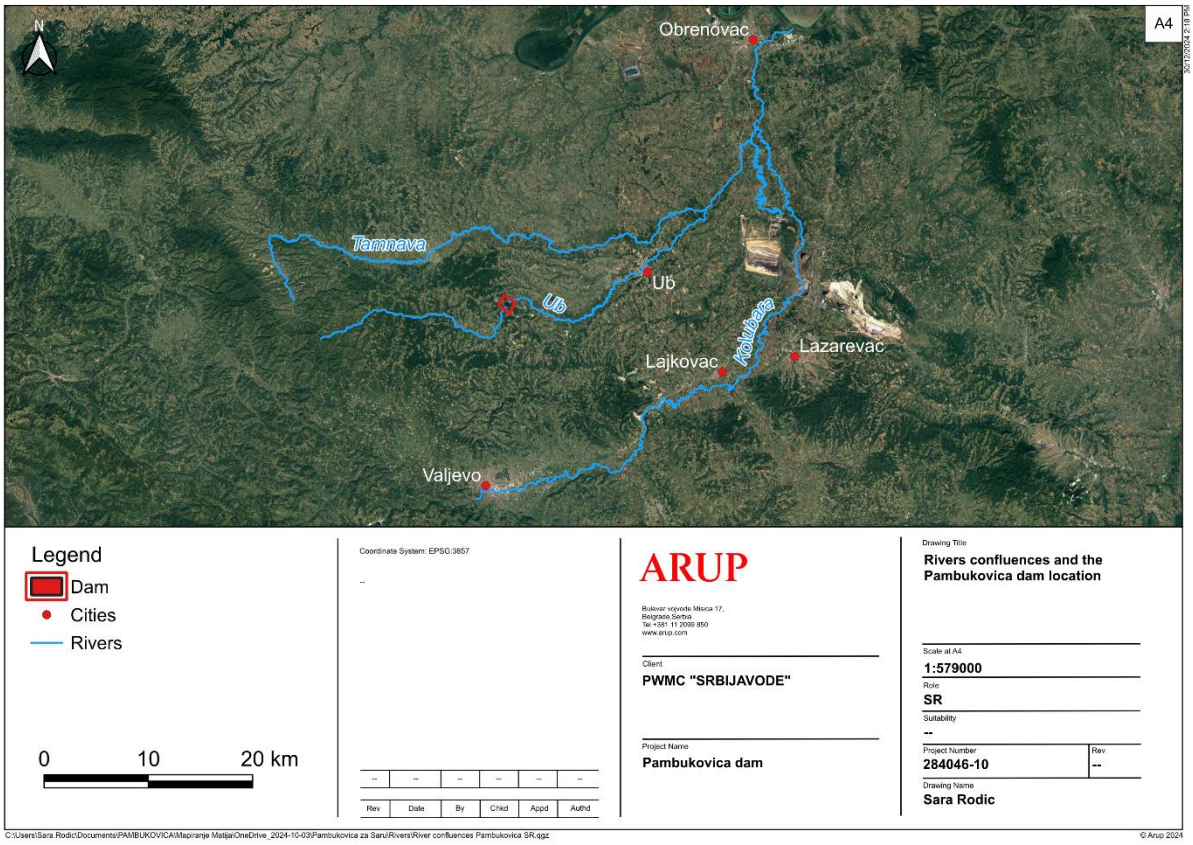


Figure 12 - Rivers confluences and the Pambukovica dam location

4.6.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria.

4.6.3 Survey Results

During the surveys, several riparian mammal species were detected, with notable findings including the Eurasian Water Shrew, which was observed near the aquatic survey site UB 04 (**Error! Reference source n ot found.**). The Eurasian Water Shrew is typically found in moist, riparian habitats, often in areas with dense vegetation and abundant water. It is associated with riverbanks, marshes, and wetlands, where it feeds on invertebrates and small fish.

Eurasian Otter (*Lutra lutra*) was not observed at the survey transects, nor were there any incidental findings during river mapping, which covered both the upstream and downstream sections of the river, including the area that will be affected by the dam's future inundation and river confluences of the flood zone impact.

None of the detected species are listed on Resolution 6 of the Bern Convention.

Table 23 - Riparian and other mammal species findings

No.	Scientific name	Common name	IUCN Global	IUCN Europe	Habitats and species directive	Serbian legislation
1.	*Vulpes vulpes*	Red fox	LC	LC	-	P

No.	Scientific name	Common name	IUCN Global	IUCN Europe	Habitats and species directive	Serbian legislation
2.	*Erinaceus roumanicus*	Northern White-breasted Hedgehog	LC	LC	-	P
3.	*Glis glis*	European Edible Dormouse	LC	LC	-	P
4.	*Sorex minutus*	Eurasian Pygmy Shrew	LC	LC	-	P
5.	*Microtus arvalis*	Common Vole	LC	LC	-	-
6.	*Microtus subterraneus*	European Pine Vole	LC	LC	-	-
7.	*Clethrionomys glareolus*	Bank Vole	LC	LC	-	-
8.	*Apodemus flavicollis*	Yellow-necked Mouse	LC	LC	-	-
9.	*Apodemus sylvaticus*	Wood Mouse	LC	LC	-	-
10.	*Apodemus agrarius*	Striped Field Mouse	LC	LC	-	-
11.	*Talpa europaea*	European Mole	LC	-	-	P
12.	*Neomys fodiens*	Eurasian Water Shrew	LC	LC	-	SP
13.	*Capreolus capreolus*	Roe Deer	LC	LC	-	P
14.	*Lepus europaeus*	European Hare	LC	LC	-	P
15.	*Canis aureus*	Golden Jackal	LC	LC	-	P

* Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

IUCN Vulnerable (VU), Least Concern (LC), Near Threatened (NT), Data Deficient (DD)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Other species such as the Red Fox, Northern White-breasted Hedgehog, and European Mole are commonly found in riparian habitats, where they utilize the edges of the watercourses for foraging, shelter, and movement. These species are adaptable and can thrive in a range of habitats, but they benefit from proximity to water, which provides both food sources and suitable environments for shelter.

Species like the Roe Deer and European Hare also use riparian zones for movement and feeding, often venturing to the riverbanks for water, vegetation, and escape routes from predators. The diversity of mammal species detected suggests that the riparian zones offer a variety of ecological niches, supporting both water-dependent and more terrestrial mammal species.

4.6.4 Protected or Notable Species / Habitats

No riparian and other mammal species (excluding bats) observed in the project area met the threshold as ‘threatened/priority’ species in accordance with EBRD PR6. However, the following species are designated as "Strictly Protected" or "Protected" under Serbian legislation:

- Golden Jackal – *Canis aureaus* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)

- Roe Deer – *Capreolus capreolus* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)
- Northern White-breasted Hedgehog – *Erinaceus roumanicus* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)
- European Edible Dormouse – *Glis glis* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)
- European Hare – *Lepus europaeus* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)
- Eurasian Water Shrew – *Neomys fodiens* (IUCN Europe LC and IUCN Global LC; Strictly protected under Serbian regulation)
- Eurasian Pygmy Shrew – *Sorex minutus* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)
- European Mole – *Talpa europaea* (IUCN Global LC; Protected under Serbian regulation)
- Red Fox – *Vulpes vulpes* (IUCN Europe LC and IUCN Global LC; Protected under Serbian regulation)

While these species do not meet the "threatened/priority" thresholds under EBRD PR6, they are acknowledged in national conservation frameworks.

4.7 Terrestrial Invertebrates

4.7.1 Survey Methodology

Surveys were undertaken three times, between July and September 2023, aligning with the adult phase of many insect life cycles. Direct observation and inspection of pitfall traps has taken place in suitable conditions to ensure accurate recording of insects, avoiding strong winds and prolonged heavy rain. The team carried out the surveys along pre-defined transects.

4.7.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria.

4.7.3 Survey Results

The surveys confirmed the presence of several invertebrate species. **Error! Reference source not found.** c ontains species recorded during the summer / autumn surveys, their location within the Biodiversity Study Area and their conservation status. None of the detected species are listed on Resolution 6 of the Bern Convention.

Table 24 - Terrestrial invertebrate species findings

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive	Serbian legislation
1.	*Decticus verrucivorus*	Common Wart-biter	LC		-	
2.	*Polysarcus denticauda*	Large Saw-tailed Bush-cricket	LC	LC	-	
3.	*Pholidoptera femorata*		LC	LC	-	
4.	*Odontopodisma decipiens*	Spur-throated Grasshopper	LC		-	
5.	*Papilio machaon*	Swallowtail	LC	LC	-	

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive	Serbian legislation
6.	*Vanessa atalanta*	Red Admiral	LC	LC	-	
7.	*Aglais io*	European Peacock Butterfly			-	
8.	*Speyeria aglaja*	Dark Green Fritillary	LC		-	
9.	*Agriotes ustulatus*	Wireworm			-	
10.	*Oulema melanopus*	Cereal Leaf Beetle			-	
11.	*Hycleus polymorphus*				-	
12.	*Coccinella septempunctata*	Seven Spotted Ladybird			-	
13.	*Trichius fasciatus*	Bee Beetle	LC		-	
14.	*Carabus clatratus*				-	
15.	*Carabus coriaceus*				-	
16.	*Harpalus rufipes*	Strawberry Seed Beetle			-	
17.	*Xylocopa violacea*	Violet Carpenter Bee	LC		-	
18.	*Orthetrum coerulescens*	Keeled Skimmer	LC	LC	-	
19.	*Limax cinereoniger*	Ash-black Slug	LC	LC	-	
20.	*Limax maximus*	Giant Garden Slug	LC	LC	-	
21.	*Helix pomatia*	Roman Snail	LC	LC	V	P
22.	*Cepaea nemoralis*	Brown-lipped Snail	LC	LC	-	
23.	*Cepaea hortensis*	White-lipped Snail	LC	LC	-	
24.	*Araneus diadematus*	Cross Orb-weaver			-	
25.	*Lyristes plebejus*				-	
26.	*Cicada orni*	Ash Cicada			-	
27.	*Cicadatra atra*				-	
28.	*Tettigetta dimissa*		LC		-	
29.	*Gryllus campestris*	Field Cricket	LC		-	
30.	*Pteronemobius heydenii*		LC		-	
31.	*Oecanthus pellucens*	Tree Cricket	LC		-	
32.	*Tettigonia viridissima*	Great Green Bush-cricket	LC		-	
33.	*Phaneroptera falcata*	Sickle-bearing Bush-cricket	LC		-	
34.	*Ephipihher ephipigger*		LC		-	
35.	*Poecilimon ornatus*	Ornate Bright Bush-cricket	LC	LC	-	

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive	Serbian legislation
36.	*Poecilimon thoracicus*	Bellied Bright Bush-cricket	LC	LC	-	
37.	*Pholidoptera fallax*	Fischer's Bush-cricket	LC		-	
38.	*Pholidoptera griseoaptera*	Dark Bush-cricket	LC		-	
39.	*Pachytrachis gracilis*		LC	LC	-	
40.	*Isophya sp.*				-	
41.	*Roeseliana roeselii*	Roesel's Bush-cricket	LC		-	
42.	*Chorthippus brunneus*	Common Field Grasshopper	LC	LC	-	
43.	*Pseudochorthippus parallellus*	Meadow Grasshopper			-	
44.	*Iphiclides podalirius*	Scarce Swallowtail	LC		-	
45.	*Gonopteryx rhamni*	Common Brimstone	LC		-	
46.	*Nympahlis antiopa*	Mourning Cloak			-	
47.	*Brintesia circe*	Great Banded Grayling	LC		-	
48.	*Aglais urticae*	Small Tortoiseshell	LC		-	
49.	*Argynnis paphia*	Silver-washed Fritillary	LC		-	
50.	*Pieris rapae*	Cabbage White	LC		-	
51.	*Colias croceus*	Clouded Yellow			-	
52.	*Aporia crataegi*	Black-veined White	LC		-	
53.	*Erebia aethiops*	Scotch Argus	LC		-	
54.	*Melanagria galathea*	Marbled White			-	
55.	*Maniola jurtina*	Meadow Brown	LC		-	
56..	*Polyommatus icarus*	Common blue	LC		-	
57.	*Lycaena tityrus*	Sooty Copper	LC		-	
58.	*Ochlodes sylvanus*	Large Skipper	LC		-	
59.	*Ochlodes venatus*	Large Skipper			-	
60.	*Hesperia comma*	Common Branded Skipper	LC		-	
61.	*Heteropterus morpheus*	Large Chequered Skipper	LC		-	
62.	*Melitaea diamina*	False Heath Fritillary	LC		-	
63.	*Zygaena ephialtes*				-	
64.	*Macroglossum stellatarum*	Hummingbird Hawkmoth			-	
65.	*Mylabris variabilis*				-	

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive	Serbian legislation
66.	*Phyllobius pomaceus*	Nettle Weevil			-	
67.	*Harmonia axyridis*	Harlequin Ladybird			-	
68.	*Cetonia aurata*	Rose Chafer			-	
69.	*Carabus nemoralis*	Bronze Carabid			-	
70.	*Harpalus affinis*	Harpale Polychrome			-	
71.	*Lygus pratensis*	The Tarnished Plant Bug			-	
72.	*Adelphocoris lineolatus*	Lucerne Bug			-	
73.	*Leptionarsa decemlineata*	Colorado Potato Beetle			-	
74.	*Tabanus sp.*	Greenhead Horse Fly			-	
75.	*Apis mellifera*	European Honeybee	DD		-	
76.	*Bombus sp.*	Bumblebees			-	
77.	*Vespa crabro*	European Hornet			-	
78.	*Vespula vulgaris*	Common Wasp			-	
79.	*Culicidae sp.*	Mosquitoes			-	
80.	*Formicidae spp.*	Ants			-	
81.	*Cordulegater boltonii*	Golden-ringed Dragonfly			-	
82.	*Aeshna viridis*	Green Hawker	LC	NT	IV	
83.	*Calopteryx splendens*	Banded Demoiselle	LC		-	
84.	*Calopteryx virgo*	Beautiful Demoiselle	LC	LC	-	
85.	*Enallagma cyathigerum*	Common Blue Damselfly	LC		-	
86.	*Ischnura elegans*	Blue-tailed Damselfly	LC		-	

* Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia);

IUCN Data Deficient (DD), Least Concern (LC), Near Threatened (NT)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

4.7.4 Protected or Notable Species / Habitats

No terrestrial invertebrate species observed in the project area meet the threshold as ‘threatened/priority’ species in accordance with EBRD Performance Requirement 6 (PR6). However, Roman Snail (*Helix pomatia*) is protected under Serbian legislation.

5. Biodiversity Site Surveys: Freshwater

5.1 Fish Habitat Mapping

5.1.1 Survey Methodology

River habitat mapping was conducted along the entire length of the river within the proposed inundation (reservoir) area, as well as 1 km upstream and 1 km downstream. The sampling was carried out in May 2023. This approach can be used to assess and understand the river's habitat characteristics and dynamics over a significant stretch, considering both the impact of the dam reservoir and the conditions in the surrounding areas.

Habitat descriptions (**Error! Reference source not found.**) were adapted from Hendry and Cragg-Hine[18] a nd Harvey and Cowx[19]. Juvenile lamprey habitat definitions were based on descriptions in "Conserving Natura 2000 Rivers: Monitoring the River, Brook and Sea Lamprey". This method is considered appropriate since the same species (with the same life cycle) have been documented in the region[20].

The main objective of the method is to obtain a detailed representation of the precise location, extent, condition, and juxtaposition of habitats within the wetted width of the river. This is recorded by walking the riverbank and annotating high-resolution maps with the habitats present. Crucially, the 'habitat' types for salmonids (e.g., fry, parr, mixed juvenile, etc.), as opposed to 'flow' types, are recorded. Fish habitat types are defined by the interaction of the following variables: water depth, water velocity, substrate composition, and cover.

Table 25 - Fish habitat types adapted from Hendry and Cragg-Hine (1997) and Harvey and Cowx (2003)

Habitat type Definition	Definition
Spawning gravel	Ideally stable (but not compacted) gravel. Mean grain size ≤ 25mm for trout and up to 80mm for salmon. 'Fines' (< 2mm grain size) to be less than 20% by weight. Water depth 17-76cm. Velocity 25-90cm/s.
Fry habitat	Shallow fast flowing (50-65cm/s) water (predominantly run and riffle). Water depth ⩽ 20cm. Substrate pebble and cobble dominated.
Parr habitat	Fast flowing water generally with a broken surface (predominantly run and riffle). Water depth 20-40cm. Substrate cobble and boulder dominated.
Mixed juvenile (parr/fry)	Sections of river with varied depth and substrate, with localised habitat areas meeting the definition of both fry and parr habitat.
Run (adult)	Fast flowing water with a broken surface that is deeper than 40cm. Water depth >40cm.

[18] K. Hendry and C.-H. D., Restoration of Riverine Salmon Habitats A Guidance Manual, London: Environment Agency Publications, 1996.

[19] J. Harvey and I. Cowx, Monitoring the River, Brook and Sea Lamprey, Lampetra fluviatilis, L. planeri and Petromyzon marinus. Conserving Natura 2000 Rivers Monitoring Series No. 5, York: Natural England, 2003.

[20] P. Tutman, I. Buj, M. Ćaleta and Z. Marčić, "Review of the lampreys (Petromyzontidae) in Bosnia and Herzegovina: a current status and geographic distribution," BioOne, vol. 69, no. 1, pp. 1-13, 2020.

Habitat type Definition	Definition
	Substrate varied, often not visible.
Pools (adult)	No perceptible flow, smooth surface. Water depth usually > 0.6m. Substrate typically fine; often not visible.
Glides (adult)	Smooth surface with little turbulence. Water depth typically < 30cm. Substrate generally fine dominated by pebbles and fines.
Juvenile lamprey habitat	Optimal habitat: stable fine sediment or sand > 15cm deep, low water velocity and the presence of organic detritus. Sub-optimal habitat: shallow sediment, often patchy and interspersed among coarser substrate. Also includes areas of organic detritus overlying bedrock, submerged tree roots trapping organic material, submerged silt banks, silt-dominated cattle drinks, and submerged bankside vegetation rooted in sand/silt.

Further to in-stream habitat, additional features of the watercourse were recorded and mapped to provide a broader understanding of the watercourse, anthropogenic modifications and any pressures which may alter the suitability of the river for fish. Where present, these include:

- In-stream and riparian habitat features such as width-depth measurements, exposed substrate, bars, macrophytes, redds and coarse woody debris,
- In-stream obstacles to fish passage including natural obstacles, weirs, sluices, dams, flap gates, culverts and fords. These obstacles were assessed for fish passability based on professional judgement,
- Point and diffuse sources of catchment pollution including domestic and industrial discharges or runoff, arable fields, livestock fields and forestry plantations,
- River abstractions and details on fish screening facilities.

5.1.2 Survey Results

The River Ub flows flow in a generally west to east direction through the Biodiversity Study Area and proposed inundation zone, in the length of 5.3km. The approximately 7 km survey stretch of river can be characterised as semi-natural gravel bed river of medium size (river width ranged from 6 m to 12m) and depth ranged from very shallow (<20cm) to up to a maximum of 2m in pools. In-stream habitats recorded were diverse and varied with riffle, glide and pool sequences present and extensive areas of habitat meeting the flow, depth and substrate requirements of fry, parr and adult stage species. Based on habitat assessment, complimented by the desk study records, the survey section of the River Ub is characteristic of the boundary between the grayling and barbel zone and exhibits the flow characteristics likely to support a combination rheophilic (flow loving) species, as well as species indicative of slower moving rivers.

Whilst no sign of spawning or spawning ‘redds’ were noted gravel was often the dominate substrate type and extensive areas of gravel that would be suitable for spawning were recorded. Localised areas of marginal silt with the potential to support juvenile (ammocoete) lamprey species were also recorded however this species group is considered unlikely to be present based on survey data.

A key finding of the site walkover as the presence of a large impassable weir (Figure 13), located approximately 7.05 km downstream of the Biodiversity Study Area. This existing structure that was used to impound and transfer water to a now redundant fish farm is considered a barrier to all fish species under all flows. During the survey an adult coarse fish (suspected to be a chub) was observed trying and failing to jump from the plunge pool attempting to pass the weir. The freshwater habitat map is presented in **Error! R eference source not found.**.

Figure 13 - Impassable weir on River Ub

5.1.3 Protected or Notable Species / Habitats

The classification of water habitats was only possible at higher ranks. It is worth noting that these higher ranks primarily serve for grouping purposes. The detected freshwater habitats do not fit into any lower categories listed in the EUNIS habitat classification or any other protected habitat classifications. However, this does not mean that these habitats cannot be classified as critical, given the presence of protected species inhabiting them (see chapter 0).

5.2 Fish

5.2.1 Survey Methodology

Surveys were conducted using a combination of eDNA and electric fishing methodologies. The surveys aimed to provide data on the fish species present and various aspects of fish population health, including abundance, densities, and age classes.

eDNA sampling

eDNA was collected (Figure 14) from river water samples to determine the presence of native and/or INNS of fish at each site. Samples were collected on two occasions in May and July 2023. Samples were sent to Nature Metrics Ltd. for laboratory analysis; 400ml of river water was filtered on site to obtain a sample and preserved. During sampling sterile gloves provided were used to avoid DNA contamination. Subsamples were collected using the sterile sampling bag provided. After collecting a sufficient amount of water, the bag was closed, shaken, and secured in a stable position. Water samples were then filtered on site by drawing 50 mL into a syringe, attaching it to the filter, and pressing the plunger to filter. This process was repeated until 400ml of water was filtered or the filter clogged.

Samples were preserved on site and transported to the UK before being sent to the laboratory.

Figure 14 - Riverine eDNA sampling

eDNA analysis

DNA from each filter was extracted in the laboratory using a commercial DNA extraction kit, with a protocol modified to increase DNA yields. An extraction blank was also processed for the extraction batch. DNA was purified to remove polymerase chain reaction (PCR)[21] inhibitors using a commercial purification kit. DNA yields were as expected, and the DNA was tested with a 16S bacterial PCR to determine the presence of PCR inhibitors and/or DNA degradation in the samples. The samples successfully amplified, indicating no inhibition or degradation.

Purified DNA was then subject to Nature Metrics fish metabarcoding analysis which identifies the presence of all fish DNA within the sample.

Table 26 - eDNA sampling sites (2023)

Site Name	Coordinates	
UB 01	N 44.417044	E 19.797442
UB 02	N 44.405825	E 19.864322
UB 03	N 44.407036	E 19.892894
UB 04	N 44.426067	E 19.906844
UB 05	N 44.432328	E 19.920464
UB 06	N 44.414722	E 19.976272
UB 07	N 44.449325	E 20.050356
Sediment trap dams 1 - Stream Babinac	N 44.429414	E 19.893072
Sediment trap dam 3 - River Joševa	N 44.388081	E 19.876925
Sediment trap dam 4 - River Joševa	N 44.387617	E 19.869303

[21] Polymerase chain reaction is a process by which millions of copies of a particular DNA segment are produced through a series of heating and cooling steps, known as an 'amplification' process. One of the most common processes in molecular biology and a precursor to most sequencingbased analyses

Site Name	Coordinates	
Sediment trap dam 5 - Stream Jasenovac	N 44.424592	E 19.825428
Sediment trap dam 6 - Stream Medvednjak	N 44.421322	E 19.804483
Sediment trap dam 7 - River Oglađenovačka	N 44.393664	E 19.763019

Electric fishing

The survey sites (**Error! Reference source not found.** and Figure 15) were 100m in length or 50m in cases where access or high fish densities restricted the survey length. At all sites, electric fishing was conducted in an upstream direction where access and available channel existed. Electric fishing surveys were carried out during the optimal season (warmer months June-August) to maximize catch efficiency.

In 2024, second year fish surveys were conducted to complement previous data collection efforts and enhance understanding of fish population structure within the Ub River catchment. Sampling was carried out in September, aligning with the optimal season to maximize catch efficiency. Fish samples were collected along a 30 m profile using an AquaTech electrofishing device, with stop nets (5 mm mesh size) placed at both ends to ensure quantitative sampling. Additionally, targeted surveys for juvenile lamprey were undertaken in identified suitable habitats, following standardized methodologies for monitoring lamprey species in Serbia.

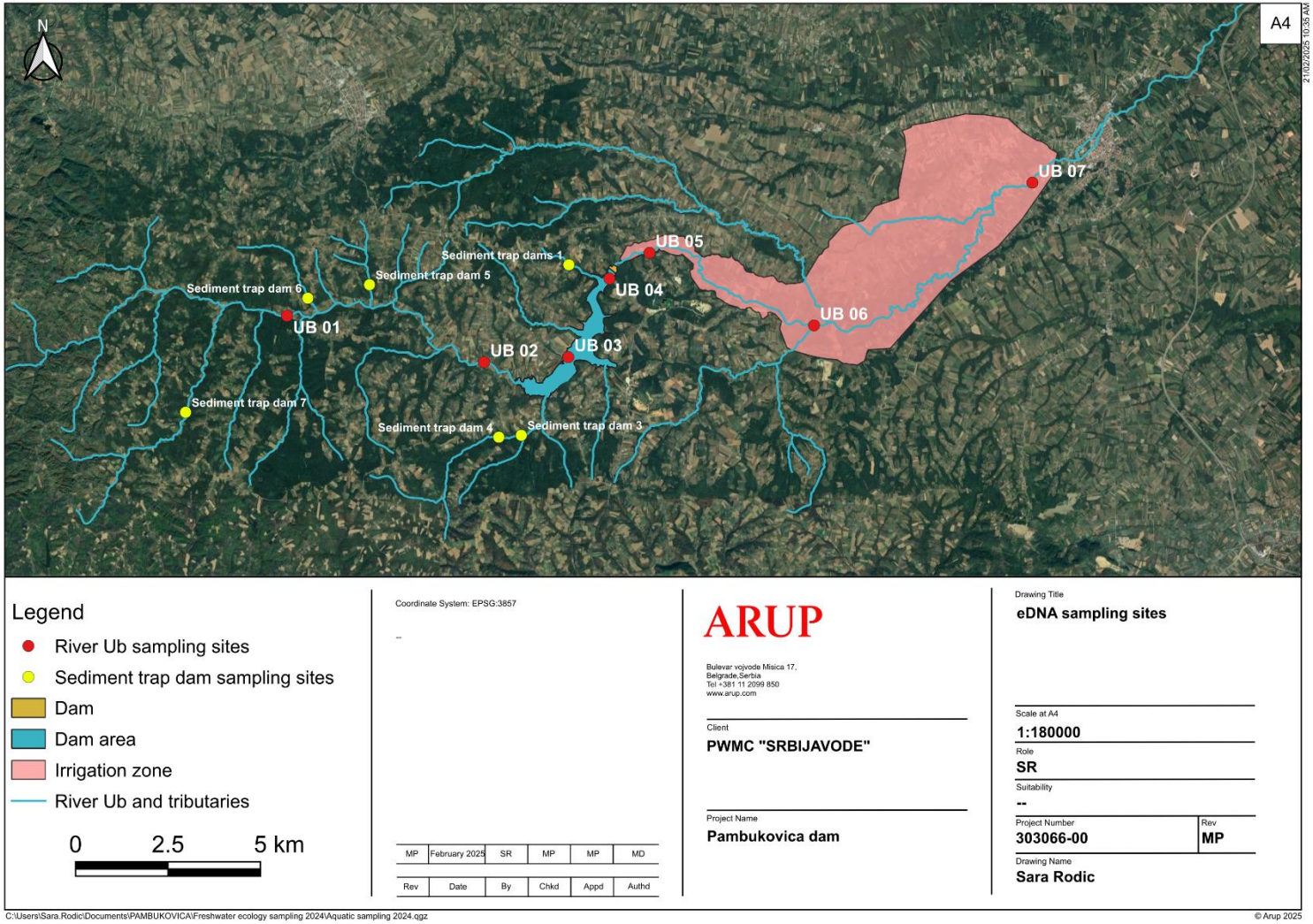


Figure 15 - eDNA sampling sites

5.2.2 Data Analysis / Assessment Methodology

The survey methodology followed the Carle & Strub method, enabling absolute estimates of population density, while capture probability (P) was validated using the Chi-squared test. At each site, the number of fish of each species was recorded, along with their fork length (FL, to the nearest millimeter). Specimens were marked (cyprinids by clipping the tip of the anal fin, loaches by clipping the tip of the caudal fin) before being released back into the water. Photographs of stop net locations were recorded to facilitate future monitoring during the dam's construction and operation phases.

For electric fishing surveys, the biomass (g) of each species has been calculated for all sites. These data are presented in **Error! Reference source not found.** to **Error! Reference source not found.** in **Error! Reference source not found.**.

5.2.3 Survey Results 2023

Error! Reference source not found. lists the fish species recorded within the Biodiversity Study Area d uring surveys, considering both the physical (electric fishing) and eDNA results. **Error! Reference source not found.** presents the number of individuals of each species recorded at each site; for each site and species a positive eDNA record is indicated by a tick (✓). The diagrams in Figure 16 and Figure 17 provide a 'tree-of-life' view of the fish assemblage of the River Ub and tributary sites respectively, based eDNA analysis.

A total of 16 fish species were recorded including '*threatened species'* as defined by EBRD criteria (EBRD GN6[22]) and invasive / non-native non-native species. Whilst no species assessed by IUCN as VU, EN or CR were identified, two species listed on both Annex II of the Habitats Directive and Resolution 6 of the Bern convention were recorded: Balkan loach *Cobitis elongata* and spined loach *Cobitis taenia.*

A number of fish species recorded display very similar ecological requirements and life history characteristics and can therefore be grouped into distinct 'functional guilds' for the purpose of ecological assessment (Cowx et al, 2004)[23]; Fieseler and Wolter (2006)[24]. The majority of species recorded can be defined as either rheophilic or eurytopic in nature. Rheophilic fish display a preference for areas of moderate to fast flowing water; spawning habitat for these species is therefore typically associated with coarse gravel and cobble substrate. In contrast, eurytopic fish species display a much wider preference range with regards to habitat requirements, although optimal habitat is typically characterised by areas of static or low velocity water with a greater mean depth, such as pools.

Two highly Invasive / non-native fish species were also recorded; Topmouth Gudgeon *Pseudorasbora parva* and Prussian Carp - *Carassius gibelio*. Both species are Invasive / non-native and to Serbia, according to the Global Register of Introduced and Invasive / non-native Species (GRIIS) in Serbia[25]. GRIIS is an IUCN Invasive / non-native Species Specialist Group initiative.

The functional guilds within the Biodiversity Study Area can be described as follows:

- Rheophilic coarse fish (including chub, barbel, minnow, gudgeon and loach species);
- Eurytopic coarse fish (comprising roach, bleak, schneider and bitterling species);
- Invasive / non-native (Asian) species (Topmouth Gudgeon and Prussian carp).

Salmo sp. DNA was detected at site Ub 02. This is considered likely to be as a result of contamination from food waste or effluent from households. This assessment is made based on the distribution of salmonids in

[22] EBRD (2020) Guidance Note for Performance Requirement 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.

[23] Cowx I.G., Noble R.A., Nunn A.D., Harvey J.P., Welcomme R.L. & Halls A.S. (2004) Flow and Level Criteria for Coarse Fish and Conservation Species. Science Report SC020112/SR. EA, Bristol.

[24] Fieseler, C., & Wolter, C. (2006). A fish-based typology of small temperate rivers in the northeastern lowlands of Germany. Limnologica, 36(1), 2-16.

[25] Invasive Species Specialist Group ISSG (2020) Global Register of Introduced and Invasive Species - Serbia https://www.gbif.org/dataset/7d22d94b-61e5-4d34-9156-eeddd2cd5f59

Serbia (they are not expected in the Ub catchment based on known distribution in Serbia) and the fact that salmonid species were absent from all other surveys, both electric fishing and eDNA.

Where taxa were not identified to the species level by eDNA (**Error! Reference source not found.**), p ossibly because those species are not included in the eDNA library, assumptions have been made about the potential species. In cases where there was clear morphological identification by experts and no occurrence of other species from the same family, an assumption was made and those species were treated as the same (e.g. *Gobio sp.* detected by eDNA is assumed to be *Gobio obtusirostris* based on morphological determination. *Phoxinus sp.* is assumed to be *Phoxinus phoxinus*, *Rhodeus* sp. is assumed to be *Rhodeus amarus* and *Carassius* sp. is assume to be *Carassius gibelio*).

Table 27 - eDNA fish species findings

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive / Bern Convention	Serbian legislation
1.	*Alburnus alburnus*	Common Bleak		LC		
2.	*Alburnoides bipunctatus*	Schneider				P
3.	*Barbatula barbatula*	Stone Loach	LC	LC		
4.	*Barbus balcanicus*	Balkan Barbel	LC	LC		P
5.	*Carassius gibelio*	Prussian Carp	N/A	N/A		INNS
6.	*Cobitis elongata*	Balkan Loach	LC	LC	HD AII, BC R6	SP
7.	*Cobitis taenia*	Spined Loach	LC	LC	HD AII, BC R6	SP
8.	*Gobio gobio*	Common Gudgeon	LC	LC		
9.	*Gobio obtusirostris*	Balkan Gudgeon	LC			P
10.	*Phoxinus phoxinus*	Minnow	LC	LC		
11.	*Pseudorasbora parva*	Topmouth Gudgeon	N/A	N/A		INNS
12.	*Rhodeus amarus*	Bitterling	LC	LC		SP
13.	*Rutilus rutilus*	Roach	LC	LC		
14.	*Sabanejewia balcanica*	Golden Spined Loach	LC			SP
15.	*Squalius cephalus*	Common Chub	LC	LC		P

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

IUCN Least Concern (LC)

BC R6 - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

INNS – Invasive / non-native Species in Serbia

Table 28 - Fish community composition

No.	Scientific name	Common name	UB 1	UB 2	UB 3	UB 4	UB 5 (no eDNA)	UN 6 (eDNA only)	UB 7	STD 1 Babinac	STD 3 Joševa	STD 4 Joševa	STD 5 Jasenovac	STD 6 Medvednjak	STD 7 Ogladenovačka
1	*Alburnus alburnus*	Common Bleak				24		✓	26 ✓	✓				✓	
2	*Alburnoides bipunctatus*	Schneider	14	14	27										
3	*Barbatula barbatula*	Stone Loach	✓	✓	9 ✓	✓	10	✓	✓	✓	✓	✓	✓	✓	✓
4	*Barbus balcanicus*	Balkan Barbel	21	15	30	10			12				18		
5	*Carassius gibelio*	Prussian Carp	3			6								✓	✓
6	*Cobitis elongata*	Balkan Loach				9			12						
7	*Cobitis taenia*	Spined Loach							✓						
8	Cyprinidae		✓	✓	✓	✓		✓	✓	✓		✓		✓	✓
9	*Gobio obtustirostris*	Balkan Gudgeon		18 ✓	21	16	20		21				15	9	
10	*Gobio gobio*	Common Gudgeon	18		✓	✓		✓	✓	✓				✓	✓
11	*Gobio sp.*			✓	✓	✓		✓	✓	✓				✓	✓
12	*Phoxinus phoxinus*	Minnow	15	24	25		36				14		26	16	12
13	*Phoxinus sp.*		✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	✓
14	*Pseudorasbora parva*	Topmouth Gudgeon	✓	3		✓		✓	✓		✓				✓
15	*Rhodeus amarus*	Bitterling		✓	✓	28 ✓	32	✓	30 ✓	✓				✓	✓
16	*Rutilus rutilus*	Roach				10			14 ✓						
17	*Sabanejewia balcanica*	Golden Spined Loach	9	30 ✓	16 ✓	✓	14	✓	✓	✓				✓	✓
18	*Squalius cephalus*	Common Chub	24 ✓	21 ✓	35 ✓	22 ✓	28	✓	18 ✓	✓	✓	✓		✓	✓
19	*Salmo sp.*			✓											

Three DNA records from the cyprinid family could not be determine to the species level.

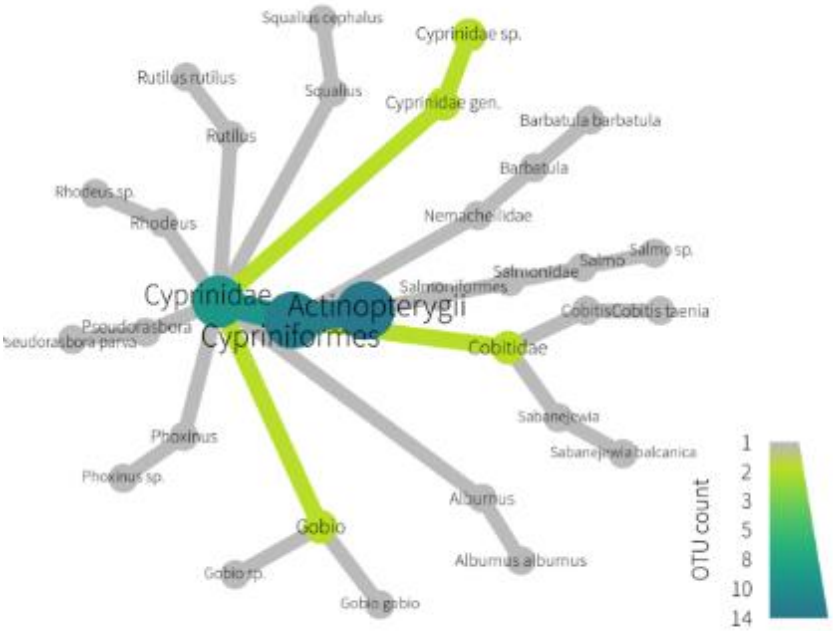


Figure 16 - Phylogenetic position of the detected fish species in the River UB

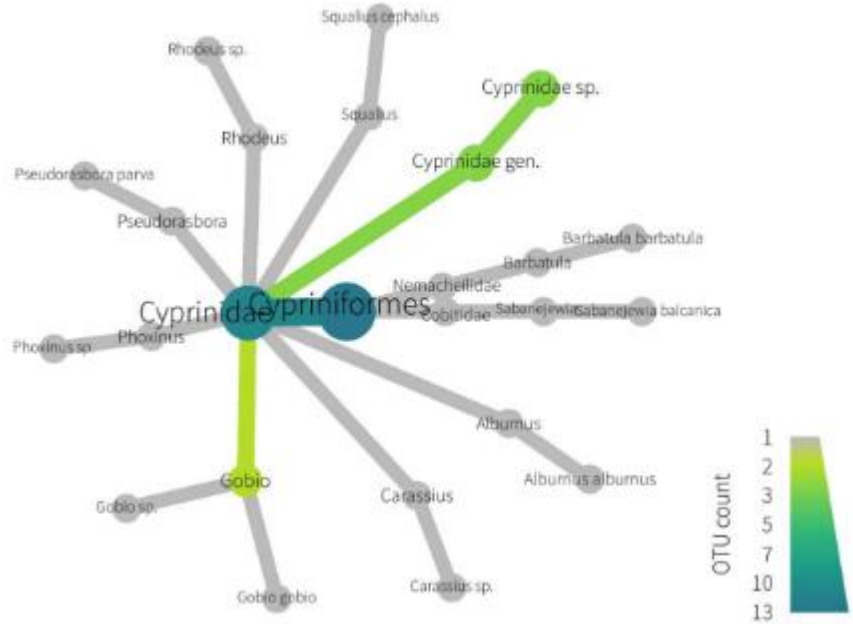


Figure 17 - Phylogenetic position of the detected fish species in the tributaries

5.2.4 Survey Results 2024

Error! Reference source not found. presents the fish species recorded during the 2024 survey.

Table 29 - Fish species findings (2024)

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive / Bern Convention	Serbian legislation
1.	*Barbus balcanicus*	Balkan Barbel	LC	LC		P
2.	*Cobitis elongata*	Balkan Loach	LC	LC	HD AII, BC R6	SP
3.	*Gobio obtustirostris*	Gudgeon	LC			P
4.	*Squalius cephalus*	Common Chub	LC	LC		P
5.	*Rhodeus amarus*	Bitterling	LC	LC		SP

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

IUCN Least Concern (LC)

BC R6 - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Relevant data on fish species are presented in **Error! Reference source not found.**. A total of five fish s pecies were recorded at the UB 6.5 sampling site, while four species were observed at UB 6.25. The low fish diversity is likely influenced by the river's variable hydrological conditions during the summer period. Most recorded species are characteristic of lowland and submountain streams, following the river's longitudinal gradient.

During electrofishing, no target lamprey species from the genera *Lampetra*, *Eudontomyzon*, or *Petromyzon* were detected in the Ub River.

The majority of recorded fish species have a Least Concern (LC) status on both the European and global IUCN Red List. However, two species—Balkan loach and Bitterling—are classified as strictly protected under Serbian legislation (**Error! Reference source not found.**).

5.2.5 Protected or Notable Species / Habitats

Some fish species observed in the project area meet the threshold as 'threatened/priority' species in accordance with EBRD PR6 and were therefore selected for evaluation in the Critical Habitat Assessment (CHA). These species are:

- Balkan Loach (*Cobitis elongata*) (IUCN Europe LC and IUCN Global LC LC; Habitats and Species Directive Annex II, Bern Convention R6; Strictly protected under Serbian regulation)
- Spined Loach (*Cobitis taenia*) (IUCN Europe LC and IUCN Global LC; Habitats and Species Directive Annex II, Bern Convention R6; Strictly protected under Serbian regulation)

During the survey, two higly Invasive / non-native species were recorded: Prussian Carp (*Carassius gibelio*) and Topmouth Gudgeon (*Pseudorasbora parva*).

Furthermore, certain fish species in the project area are listed as "Strictly Protected" or "Protected" under Serbian legislation. These species, along with their protection status, are as follows:

- Schneider - Alburnoides bipunctatus (Protected)

- Balkan Barbel - Barbus balcanicus (Protected)
- Balkan Loach - Cobitis elongata (Strictly protected)
- Spined Loach - Cobitis taenia (Strictly Protected)
- Balkan Gudgeon - Gobio obtusirostris (Protected)
- Bittiling - Rhodeus amarus (Strictly Protected)
- Golden Spined Loach - Sabanejewia balcanica (Strictly Protected)
- Common Chub - Squalius cephalus (Protected)

These protection statuses underscore the conservation value of specific fish populations within the project area and highlight the importance of maintaining biodiversity in line with Serbian conservation policies.

5.2.6 Fish Habitat Requirements

The habitat and ecological requirements of the fish species present in the Biodiversity Study Area are provided in **Error! Reference source not found.**. This includes the location species have been recorded w ith respect to the prosed dam, their spawning preferences and timings, and whether the act as a host fish for the parasitic life-stage of TSM (see Section 5.4 for more information on the interaction between TSM and fish). This information will be used to inform the assessment of impacts in the Biodiversity Impact Assessment (Section 8).

All species are indicative of gravel bed streams, but many can also inhabit stillwater environments. Spawning typically occurs on gravel substrate, with some species more adaptable, spawning on gravel and vegetation. All fish in the Biodiversity Study Area are late spring/summer spawning species. No species present are cold water / winter spawners.

Potential hosts for TSM (present within the Biodiversity Study Area) include: Common Bleak, European Stone Loach, Minnow, Roach and Chub.

Table 30 - Habitat and ecological requirements of the fish species present in the Biodiversity Study Area

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
1	*Alburnus alburnus*	Common Bleak	-	**Distribution**: Europe and Asia: it inhabits most rivers draining to the Baltic, western Black and northern Azov sea basins. **Habitat**: inhabits **open waters of lakes and medium to large rivers**. Forms large aggregations in backwaters and other still waters during winter. Larvae live in littoral zone of rivers and lakes while juveniles leave shores and occupy a pelagic habitat, feeding on plankton, drifting insects or invertebrates fallen on the water surface.[26] Has a wide oxygen and temperature tolerance, is **able to colonise lentic and heavily-modified habitats, and tends to be particularly abundant in eutrophic and mesotrophic waters**. Fluvial (river) subpopulations inhabit low-velocity stretches of both natural and regulated river channels, including floodplains, side-channels and canals, while lacustrine subpopulations are found in lakes, marshlands, oxbows and artificial reservoirs. **Lacustrine subpopulations tend to migrate into flowing tributaries to spawn**.[27]	**Spawning**: in shallow riffles or along stony shores of lakes, occasionally above submerged vegetation. Usually spawns only one or two seasons. Spawning occurs at temperatures above 12° C, 2-4 times at 1-2 weeks intervals, early morning. **Time:** May – August[28]	d/s only (UB4 and UB7) **Non-host**
2	*Alburnoides bipunctatus*	Spirlin / Schneider	-	**Distribution**: Europe and Asia: Loire drainage in France eastward, in nearly all rivers draining to southern Baltic, North, Black and Azov Seas; Caspian basin, in upper Volga and from Kura drainage southward to Iranian tributaries of Caspian; widespread in Iran. **Habitat**: Inhabit **streams and rivers in foothills with well oxygenated, fast-flowing water**. All age classes occur in open water of streams and small rivers. Found also in rivers with very calm waters. Locally threatened by stream regulation, trout stocking and pollution. Spirlin is sensitive to the changes caused by the degradation of small rivers, especially from dam constructions, considering its migratory behavior; local migration patterns have been observed,	**Spawning**: in small groups and lay eggs deep into gravel with swift current. Spawning occurs at temperatures above 12° **Time**: Mid-April to early July[30]	u/s only (UB1, UB2 and UB 3) **Poor-host**

[26] Fishbase (2025) Kottelat, M., 1997. European freshwater fishes. An heuristic checklist of the freshwater fishes of Europe (exclusive of former USSR), with an introduction for non-systematists and comments on nomenclature and conservation. Biologia, Bratislava, 52/Suppl. 5:1-271.

[27] Ford, M. 2024. Alburnus alburnus. The IUCN Red List of Threatened Species 2024: e.T789A135064432. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T789A135064432.en

[28] Fishbase (2025) Kottelat, M. and J. Freyhof, 2007. Handbook of European freshwater fishes. Publications Kottelat, Cornol and Freyhof, Berlin. 646 pp.

[30] Polačik, M and Kovac, V (2006) Folia Zool.– 55(4): 399–410 (2006) Fecundity and annual course of maturation in *spirlin, Alburnoides bipunctatus, Folia Zool.– 55(4): 399–410 (2006)*

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
				in which spirlin migrate upstream to sites at a higher altitude in early summer and autumn.[29]		
3	*Barbatula barbatula*	European Stone Loach	-	**Distribution**: This species occurs all over Europe north of the Caucasus mountains and east of the Pyrénées, from the Garonne River system in France to the British Isles (except northern Scotland), southern Sweden and Finland, and west to the Black Sea, Sea of Azov and northern Caspian Sea Basins. **Habitat**: This species usually inhabits flowing stretches of **streams and medium-sized rivers with gravel to stone bottoms**, but also occurs in a variety of other habitat including **sandy canals and lake shores**. Larvae and small juveniles prefer sand bottoms and slow current, shifting to gravel bottoms and fast current when growing.[31] Tolerant to moderate organic pollution and stream canalisation, but very sensitive to pollution by heavy metals.	**Habitat**: Spawning takes place on gravel, sand or among aquatic vegetation. Spawning takes place at water temperatures above 10°C, usually in the early morning. It is a multiple spawner and the eggs are released in open water, often close to the surface, from where they drift and adhere to different substrates. They are often covered by sand or detritus. **Time**: April to June[31]	u/s and d/s (all sites) **Potential host**
4	*Barbus balcanicus*	Balkan Barbel / Large-spot Barbel / Danube Barbel	PBF	**Distribution:** Adriatic basin: Soča drainage (Italy, Slovenia). A number of mainly right-bank tributaries in the middle Danube drainage, including the Drava, Sava, Morava, Mlava and Pek, plus the Timiș and Nera left-bank tributaries. It is possibly more widespread in upper Danube drainage. Aegean basin: Gallikos, Vardar, Loudias and Haliacmon drainages (Greece, North Macedonia).[32] **Habitat:** This species inhabits fast to moderately-flowing premontane and montane **streams and small rivers with gravel bottom**.	**Habitat:** In May-July it migrates to riffles in the upper reaches of tributaries to spawn. **Time:** May - July[28]	u/s and d/s (UB 1-4 and Ub7 and STD 5)
5	*Carassius gibelio*	Prussian Carp	-	**Distribution:** This species is native to the North, Baltic, White, Barents, Black and Caspian Sea basins, the Aegean Sea basin (Maritsa River drainage), eastward to the Kolyma River drainage (Russia) and westward to the Rhine River drainage. It has been introduced to areas outside its native range in Croatia west of the **Danube River**, northern Italy and France west of the Rhine River. **Non-native in Serbia.** **Habitat:** This species almost exclusively inhabits lentic ecosystems, including lakes, ponds and river floodplains or backwaters. It tolerates high summer temperatures and very low oxygen concentrations in summer and under ice	**Habitat:** Spawning takes place among dense submerged vegetation from May-July at temperatures above 18°C. Eggs are sticky and are attached to water plants. **Time**: May - July[33]	u/s and d/s (UB1 and UB4, STD6 and STD 7)

[29] Jakovljevi´c, M.; Nikoli´c, M.; Kojadinovi´c, N.; Đuretanovi´c, S.; Radenkovi´c, M.; Veli˘ckovi´c, T.; Simi´c, V. Population Characteristics of Spirlin Alburnoides bipunctatus (Bloch, 1782) in Serbia (Central Balkans): Implications for Conservation. Diversity (2023), Population Characteristics of Spirlin Alburnoides bipunctatus (Bloch, 1782) in Serbia (Central Balkans): Implications for Conservation.

[31] Freyhof, J. 2024. Barbatula barbatula. The IUCN Red List of Threatened Species 2024: e.T259121878A259153340. https://dx.doi.org/10.2305/IUCN.UK.2024-1.RLTS.T259121878A259153340.en

[32] Freyhof, J. 2024. Barbus balcanicus. The IUCN Red List of Threatened Species 2024: e.T135564A137227824. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T135564A137227824.en

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
				cover, and is able to survive in almost completely frozen water or almost-dry habitats by burying itself in wet mud. Its growth and life history traits vary considerably, both within and between countries across its native and non-native ranges. It seems to be a weak competitor, and is usually absent from waters with rich ichthyofauna and abundant predatory species, but can be very abundant in the absence of other fish species.[33]		
6	*Cobitis elongata*	Balkan Loach	PBF	**Distribution**: This species is native to the Danube River system in central Europe. It occurs in a number of mostly right-bank tributary systems, including the **Sava**, Morava, Mlava, Pek, Timok, Lom, Ogosta, Iskar, Vit, Osam and Yantra rivers. On the left bank of the Danube records exist only from the Nera and Jiu rivers. **Habitat**: This small, strictly benthic species **inhabits flowing, shallow stretches of moderately-sized tributary rivers**. It has not been collected from small streams or major river channels. It displays a preference for **substrates of gravel or sand close** to river banks, often where aquatic plants proliferate. Like other Cobitis species, it feeds by filtering mouthfuls of fine substrate through the gills, from which minute organic particles and small benthic organisms are extracted and consumed. Little is known of its life history, but related species tend to spawn among submerged vegetation, where the eggs are retained until they hatch. This species is plausibly **threatened by habitat degradation driven by extraction of gravel and other sediments, alteration of flow and sediment regimes due to dam construction and other forms of river regulation**, water abstraction for agriculture, pollution from agricultural, domestic and industrial sources and introduction of non-native fish species.[34]	**Habitat:** among submerged vegetation, where the eggs are retained until they hatch. **Time**: May-July[35]	d/s (UB4 and UB7)
7	*Cobitis taenia*	Spined Loach	PBF	**Distribution:** This species is native to northeast Atlantic river drainages from the eastern United Kingdom and central France to the central Baltic Sea basin (it is absent in the Gulf of Bothnia), plus the upper Volga River, northern and southwestern Black Sea, and southern Sea of Marmara basins.	**Habitat:** a fractional spawner, with eggs released in batches throughout the reproductive period, typically deposited among aquatic vegetation, where they remain until they hatch.	d/s (UB7 only)

[33] Freyhof, J. 2024. Carassius carassius. The IUCN Red List of Threatened Species 2024: e.T3849A58294635. https://dx.doi.org/10.2305/IUCN.UK.2024-1.RLTS.T3849A58294635.en

[34] Ford, M. 2024. Cobitis elongata. The IUCN Red List of Threatened Species 2024: e.T5031A137242218. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T5031A137242218.en

[35] Bohlen, J. 2008. Spawning marks in spined loaches (Cobitis taenia, Cobitidae, Teleostei). Folia Zool. – 57(1–2): 168–171 (2008)

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
				Habitat: This small, benthic species is relatively eurytopic. It inhabits **river and stream channels of all sizes** and with diverse flow regimes, plus oxbow lakes, backwaters, permanent lakes and ponds, freshwater springs, artificial channels and man-made reservoirs. In the Baltic Sea region it has even been collected from weakly brackish water. **It appears to be relatively adaptable to anthropogenic habitat modification and can survive over a wide range of environmental conditions**, from dystrophic to hypereutrophic.[36]	**Time:** April - July.	
8	*Gobio obtusirostris*	Balkan Gudgeon	-	**Distribution**: Native to the middle and upper Danube River, but the boundaries of its range are unclear and there is a suspected hybrid zone with the congeneric Common Gudgeon (Gobio gobio) in the upper Danube. It has been introduced to some rivers in Slovenia and Croatia, lakes in the upper Elbe River (Czechia) and appears to have invaded the upper Rhine River through the Rhine-Main-Danube Canal. **Habitat:** Inhabits **rivers and lakes with sand bottom**. Breeds in shallow water, over stones, sand or plant material.[37]	**Habitat:** Spawns in shallow water, over stones, sand or plant material. **Time**: April-August (based on *Gobio gobio*)	d/s (UB4 and UB7)
9	*Gobio gobio*	Common Gudgeon	-	**Distribution:** Native to the Atlantic, North, Baltic, Mediterranean and Black sea basins, from the Loire drainage eastward, eastern Great Britain and Rhône drainages, upper Danube and middle and upper Dniester, Southern Bug and Dnieper drainages. The eastern and southern limits of the range are not clear, but might be limited by the Daugava and Dnieper river systems, and the Danube main stem, respectively. **Habitat**: This species is found in nearly all types of riverine and lacustrine habitats with sand bottoms. It is known from small mountain streams, large lowland rivers and large lakes. Larvae and juveniles are benthic and prefer detritus-rich sandy habitats and low current. It is a gregarious species and lives up to five years. It feeds on a wide variety of large benthic invertebrates.[38]	**Habitat:** It spawns in shallow water, over stones, sand or plant material, often at lakes shores or in riffles. It spawns for the first time at one to three years; most individuals spawn at one to two years. It spawns several times in April-August at temperatures above 13°C. Eggs are released above the substrate and drift with the current, sinking to the bottom and sticking to substrate. **Time**: April-August	u/s and d/s (most sites)

[36] Ford, M. 2024. Cobitis taenia. The IUCN Red List of Threatened Species 2024: e.T5037A135084497. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T5037A135084497.en

[37] Mendel, J., S. Lusk, E.K. Vasil'eva, V.P. Vasil'ev, V. Lusková, F.G. Ekmekci, F. Erk'akan, A. Ruchin, J. Kosco, L. Vetesnik, K. Halacka, R. Šanda, A.N. Pashkov and S.I. Reshetnikov, 2008. Molecular phylogeny of the genus Gobio Cuvier, 1816 (Teleostei: Cyprinidae) and its contribution to taxonomy. Mol. Phylo. Evol. 47:1061-1075. (Ref. 76908)

[38] Freyhof, J. 2024. Gobio gobio. The IUCN Red List of Threatened Species 2024: e.T184448A137266233. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T184448A137266233.en

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
10	*Phoxinus phoxinus*	Eurasian Minnow	-	**Distribution:** Introduced subpopulations are established in Ireland, the island of Corsica (France), Austria, and possibly elsewhere in Europe. In Serbia it is found in the rivers: Drine, Dunava, Egejskog mora, Južne Morave, Kolubare, Save, Timoka, Velike Morave, Zapadne Morave.[39] . **Habitat**: This small-bodied, gregarious species is most frequently encountered in the middle and upper reaches of rivers and streams, but also inhabits oligotrophic lakes and artificial reservoirs created by dams. It is somewhat eurytopic, but demonstrates a preference for relatively shallow lake shorelines or fluvial pools and glides with well-oxygenated, clear water and slow to moderate water movement. At some locations it may move to deeper areas during periods of cold weather. It mostly feeds on aquatic invertebrates, supplemented by smaller quantities of organic detritus and plant material.[40]	**Habitat**: The annual reproductive period extends from April to June, but may commence several weeks later and continue until July or August at higher altitudes. Spawning behaviour is characterised by mature adults migrating short distances to specific sites, usually comprising beds of aquatic vegetation or well-washed gravel. Reproductive males develop a conspicuous epigamic colour pattern, and often aggregate **Time**: April – August[40]	u/s and d/s (most sites inc. STD 5, 6 and 7)
11	*Pseudorasbora parva*	Topmouth Gudgeon	-	**IUCN Justification:** n/a – non-native **Distribution:** native to East Asia. This species was introduced to various areas in Europe and Asia including Serbia. **Non-native in Serbia.** **Habitat:** occurs in a wide variety of habitats, most abundantly in well vegetated small river channels, ponds and small lakes. A residential species, the adults occur in cool running water. This species feeds on small insects, fish and fish eggs, and plant material. It is regarded as pest which competes with the fry of other species due to its high reproductive rate. Topmouth gudgeon has the potential to spread rapidly due to a combination of small body size, broad environmental/habitat tolerance, hiding in densely vegetated parts of water bodies, multi-litter spawning and parental care. Competes for food with native and farmed fish species, plus competition for space and spawning habitat, especially where it is abundant; densities of 60 or more fish per square metre have been recorded. Direct impacts via predation e.g. on invertebrates and fish fry/eggs may occur. It may seriously deplete (or even	**Habitat:** It usually breeds in habitats with still or very slow-flowing water. Females spawn 3-4 times in a season Males clear the surface of the spawning site and guard the eggs until they hatch. Spawning takes place when one year old, requiring a water temperature of 15-19°C (May-August in its native range, sometimes earlier in Europe). **Time:** May – August[41]	u/s and d/s (most sites based on physical records and eDNA)

[39] Fish of Serbia – guide: European minnow *Phoxinus Phoxinus,* https://www.inaturalist.org/guide_taxa/905757

[40] Ford, M. 2024. Phoxinus phoxinus. The IUCN Red List of Threatened Species 2024: e.T17067A135091520. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T17067A135091520.en

[41] GB non-native species secretariat (2025) Topmouth Gudgeon *Pseudorasbora parva* https://www.nonnativespecies.org/non-native-species/information-portal/view/2876

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
				eradicate) native fish and invertebrate populations as well as reducing productivity of farmed fish.[41]		
12	*Rhodeus amarus*	Bitterling		**Distribution:** This species is traditionally considered native to much of western, central and eastern Europe, plus the Black and southern Caspian sea basins. It is naturally absent from the United Kingdom plus the Iberian and Apennine peninsulas. **Habitat:** This species is thermophilous and requires warmer conditions than the majority of native European freshwater fishes. It sometimes occurs in fast-flowing water, but mostly inhabits lowland lotic or lentic habitats including slow-moving rivers, backwaters, oxbows, lakes, ponds, and man-made canals. These requirements suggest it is likely to be benefiting from a warming climate plus the tendency towards reduced river discharge due to anthropogenic regulation and other forms of habitat modification. Bitterlings exhibit a unique reproductive strategy whereby their eggs are deposited into the gill cavity of unionid river mussels. A variety of different mussel species are exploited across the European bitterling's range.[42]	**Habitat**: Bitterlings exhibit a unique reproductive strategy whereby their eggs are deposited into the gill cavity of unionid river mussels, which act as hosts. During the reproductive period, which extends from April to August in western Europe, males are territorial and defend groups or individuals of unionid mussels. **Time:** April to August	u/s and d/s (most sites based on physical records and eDNA)
13	*Rutilus rutilus*	Roach		**Distribution:** This species is native to the majority of Western Eurasia north of the Pyrenees and Alps, where its range extends eastwards from Great Britain, southeastern Norway and France to the Russian Federation. It occupies most river systems draining to the North, Baltic, and White seas, plus the Rhône River and rivers of the northern Aegean Sea and Sea of Marmara in the Mediterranean basin, most watersheds from the Dnieper River southward to the Filyos River in the western Black Sea basin, and the Volga River catchment in the Caspian Sea basin. **Habitat:** This gregarious, eurytopic species is present in a wide variety of freshwater habitats, although it demonstrates a general preference for lentic water bodies in lowland areas. It occupies river and stream channels, backwaters, oxbows, lakes, ponds, and coastal wetlands, plus littoral or supratidal brackish environments where it is able to withstand salinities of 10-14 ‰. It can be particularly abundant in productive lake systems, and readily colonises artificial canals and fluvial accumulation lakes. It is able to tolerate and even thrive in eutrophic conditions,	**Habitat:** It is a fractional, polygamous spawner; spawning sites tend to comprise shallow littoral habitats or riffles with dense submerged vegetation or coarse, stony substrata. **Time:** April – August.	d/s (Ub 4 and Ub 7)

[42] Ford, M. 2024. Rhodeus amarus. The IUCN Red List of Threatened Species 2024: e.T135635A135108660. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T135635A135108660.en

No.	Scientific name	Common name	PBF / CH	Distribution / Habitat	Spawning	U/S or D/s Mussel Host?
				and can withstand a water temperature range of four to over 30° C, although growth is largely restricted below 12° C.[43]		
14	*Sabanejewia balcanica*	Golden Spined Loach	PBF	**Distribution**: This species is native to the Danube River system, plus a series of rivers draining to the northern Aegean Sea from Greece, North Macedonia, Bulgaria and the Republic of Türkiye. The latter portion of its range extends from the Pineios to the Anthemountas rivers, with a disjunct subpopulation inhabiting the Evros River. **Habitat**: This small, strictly benthic species **inhabits the middle and upper reaches of small- to medium-sized rivers with clea**r, shallow (depth <1.5 metres), flowing water and low concentrations of dissolved nutrients. The substrate is typically a mixture of fine-grained gravel or sand mixed with pebbles, cobbles and boulders, and sparse patches of aquatic vegetation. It has occasionally been collected from larger, lowland river channels, and also occurs in Lake Doiran at the border between Greece and North Macedonia.	**Habitat:** Spawning takes place from April to June, amongst submerged vegetation, where they are retained until hatching. **Time**: April to June	u/s and d/s (most sites)
15	*Squalius cephalus*	Common Chub		**Distribution:** This species is native to the North, Baltic, White, northern Black, Azov and Caspian Sea basins, Atlantic basin southward to Adour drainage (France), Great Britain north to 56°N, Scandinavia: southern Finland, Sweden north to about Stockholm. Mediterranean basin from Var to Hérault (possibly Aude) (France) drainages. Introduced elsewhere. It has been introduced to Ireland, Croatia, and reportedly Spain and Italy. Its alien distribution in the latter two countries could not be confirmed within the scope of this assessment. **Habitat:** This species is most abundant in **small rivers and large streams of barbel zone with riffles and pools**. Also along shores of slow-flowing lowland rivers, even in very small mountain streams. **Also in large lakes, undertaking spawning migrations to inflowing streams**. Feeding larvae and juveniles inhabit very shallow shoreline habitats. Feeds on a wide variety of aquatic and terrestrial animal and plant material. Large individuals become predominantly piscivorous.[44]	**Habitat:** Spawns in fast-flowing water above gravel bottom, rarely among submerged vegetation. **Time:** May – August	u/s and d/s (most sites)

[43] Ford, M. 2024. Rutilus rutilus. The IUCN Red List of Threatened Species 2024: e.T19787A58301083. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T19787A58301083.en

[44] Freyhof, J. 2024. Squalius cephalus. The IUCN Red List of Threatened Species 2024: e.T61205A135101356. https://dx.doi.org/10.2305/IUCN.UK.2024-2.RLTS.T61205A135101356.en

5.3 Aquatic Macroinvertebrates

5.3.1 Survey Methodology

Invertebrate surveys in 2023 were carried out at 13 sites (**Error! Reference source not found.** and Figure18). Samples were collected in both spring and autumn to ensure that sample data collected reflects the variety of invertebrate species present in a river. Sampling consisted of a 3-minute kick sample and a one-minute hand search following benthic invertebrates sampling techniques. The three minutes only covers the time spent actively sampling; it excludes time spent emptying the net or moving around the site.

Second year freshwater ecology surveys in 2024 were carried out at 6 sites (**Error! Reference source not found.** and Figure18). Aquatic macroinvertebrate sampling followed the same methodology, consisting of a standard 3-minute kick sample and a one-minute hand search. Surveys were conducted in early autumn (October 2024) to account for previously observed unstable weather conditions and low water temperatures. The sampling time covered only active sampling and excluded time spent emptying the net or moving around the site.

Table 31 - Freshwater ecology survey locations (2023)

Site Name	Coordinates	
UB 01	N 44.417044	E 19.797442
UB 02	N 44.405825	E 19.864322
UB 03	N 44.407036	E 19.892894
UB 04	N 44.426067	E 19.906844
UB 05	N 44.432328	E 19.920464
UB 06	N 44.414722	E 19.976272
UB 07	N 44.449325	E 20.050356
Sediment trap dams 1 - Stream Babinac	N 44.429414	E 19.893072
Sediment trap dam 3 - River Joševa	N 44.388081	E 19.876925
Sediment trap dam 4 - River Joševa	N 44.387617	E 19.869303
Sediment trap dam 5 - Stream Jasenovac	N 44.424592	E 19.825428
Sediment trap dam 6 - Stream Medvednjak	N 44.421322	E 19.804483
Sediment trap dam 7 - River Ogladenovačka	N 44.393664	E 19.763019

Table 32 - Freshwater ecology survey locations (2024)

Site Name	Coordinates		Description / Comments
**UB 06	N 44.414722	E 19.976272	Not sampled in 2023
*UB 0.5	N 44.420934	E 19.767988	u/s of UB 01
*UB 1.5	N 44.418163	E 19.835679	d/s of UB 01
***UB 5.5	N 44.420667	E 19.952312	d/s of UB 05

Site Name	Coordinates		Description / Comments
UB 6.25	N 44.419309	E 20.004447	d/s of UB 06
UB 6.5	N 44.430199	E 20.025803	d/s of UB 06

* dry stream bed

** intermittent water flow and absence of aquatic macroinvertebrate and fish taxa (puddles/lentic habitats)

*** unreachable location for aquatic invertebrate sampling and electric fishing due to very deep water

Abbreviations: u/s – upstream; d/s – downstream

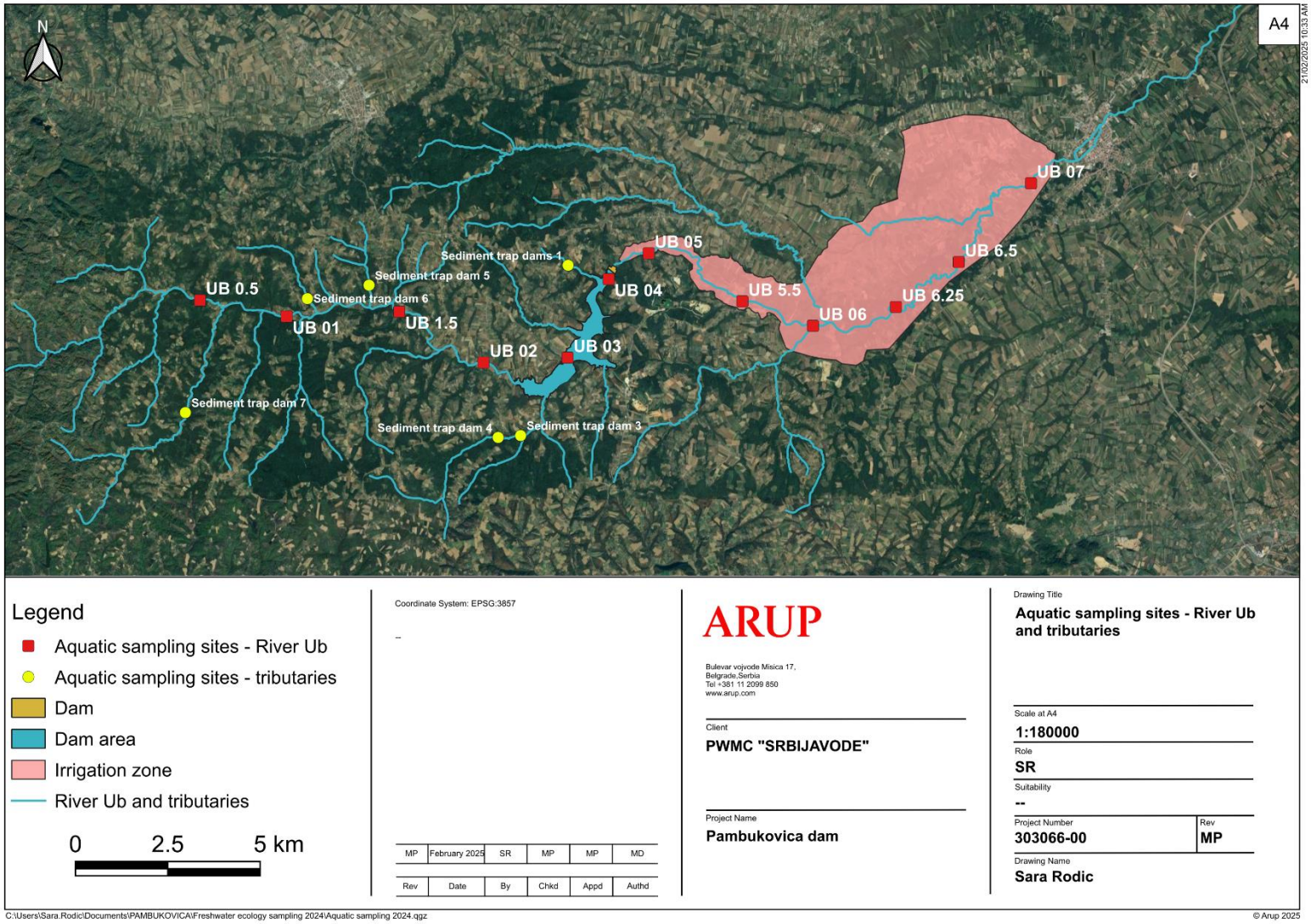


Figure18 - Aquatic sampling sites - River Ub and tributaries

5.3.2 Data Analysis / Assessment Methodology

The macroinvertebrate analysis included determining species richness (NTAXA) and other relevant indices for assessing invertebrate communities in Serbian rivers, Type 3 (the Ub River), or flood barrier streams and rivers - Type 6 (Official Gazettes of the RS; 96/2010, 74/2011). These indices include the Zelinka-Marvan Saprobic Index, Shannon-Weaver Diversity Index, EPT Taxa, percentage participation of Oligochaeta/Tubificidae in the total macroinvertebrate community, number of families, and number of sensitive taxa (Austrian list). The calculation of these biological indices (and other local indices as appropriate) followed best practice guidance, including the:

- The biological monitoring working party (BMWP); the BMWP score system is based on families of benthic macroinvertebrates that have been given a score between 1 and 10 based on their pollution tolerance, with the most sensitive receiving the highest score.
- Average Score Per Taxon (ASPT)
- Number of Scoring Taxa (NTAXA); this is a count of the number of macroinvertebrate taxa that have a score in relation to a particular index.
- Lotic-invertebrate Index for Flow Evaluation[45](LIFE); this is an index is a scoring system developed to assess the potential impacts of low flows / changes in flow regime based on the macroinvertebrate communities present.
- Ecological status/potential assessment

The ecological potential assessment of waterbodies based on the aquatic macroinvertebrate community was conducted according to national regulations (Official Gazette of the RS 74/2011) as well as the recommendations of the Water Framework Directive 2000/60/EC. The assessment's confidence level can be considered medium due to the exclusion of some biological elements. However, the most indicative type-specific parameters were measured.

The distribution of microhabitats at the aquatic macroinvertebrate sampling sites within the project area provides insights into the ecological diversity of the aquatic ecosystems. At these sites, various microhabitats were identified and characterized using the Austrian/German Rapid Bioassessment Method (AQEM). These microhabitats include cobble, pebble, boulder, sand, clay, phytal (associated with aquatic vegetation), and xylal (associated with submerged wood or debris). The distribution of these microhabitats varies across the different sites. For instance, at UB 01, cobble and pebble substrates dominate, comprising 30% and 30%, respectively, of the microhabitat composition. Meanwhile, boulder and sand microhabitats contribute 20% and 10%, respectively. Phytal and xylal, associated with aquatic plants and submerged wood, each constitute 5% of the microhabitat composition. This diverse array of microhabitats plays a crucial role in shaping the aquatic macroinvertebrate communities present at each site, reflecting the ecological complexity and richness of these freshwater ecosystems. **Error! Reference source not found.** and **Error! Reference source not fo und.** provides a breakdown of microhabitat distribution at each sampling site (expressed as a percentage), which further aids in understanding the unique characteristics of these aquatic environments.

Table 33 - Microhabitat distribution at aquatic macroinvertebrate sampling sites (2023)

Sites	Microhabitat (%) distribution (AQEM)						
	Cobble	Pebble	Boulder	Sand	Clay	Phytal	Xylal
UB 01	30%	30%	20%	10%	-	5%	5%
UB 02	10%	20%	15%	10%	15%	25%	5%
UB 03	30%	35%	5%	5%	5%	10%	10%
UB 04	35%	35%	5%	5%	5%	10%	5%

[45] Chadd, R., Balbi B.M. & Extence, C. (1999), River flow indexing using British benthic macroinvertebrates: a framework for setting hydroecological objectives. Regulated rivers: research and management 15: 543-574.Added in main text

Sites	Microhabitat (%) distribution (AQEM)						
	Cobble	Pebble	Boulder	Sand	Clay	Phytal	Xylal
UB 05	20%	10%	15%	5%	5%	45%	-
UB 07	40%	10%	20%	-	5%	25%	-%
Catchment sediment dam 4 River Joševa	20%	-	80%	-	-	-	-
Catchment sediment dam 5 Stream Jasenovac	20%	40%	25%	15%	-	-	-
Catchment sediment dam 6 Stream Medvednjak	35%	30%	10%	10%	-	10%	5%

- Not present at the site

Table 34 - Microhabitat distribution at aquatic macroinvertebrate sampling sites (2024)

Sites	Microhabitat (%) distribution (AQEM)						
	Cobble	Pebble	Boulder	Sand	Clay	Phytal	Xylal
UB 6.5	30%	15%	20%	5%	5%	10%	15%
UB 6.25	20%	30%	10%	5%	20%	10%	5%
**UB 06	n/a						
*UB 0.5	n/a						
*UB 1.5	n/a						
***UB 5.5	n/a						

* dry stream bed

** intermittent water flow and absence of aquatic macroinvertebrate and fish taxa (puddles/lentic habitats)

*** unreachable location for aquatic invertebrate sampling and electric fishing due to very deep water

n/a – not applicable

The distribution of microhabitats plays a crucial role in understanding the ecological health and diversity of aquatic macroinvertebrate communities within the River Ub and its surrounding catchment sediment dams. The composition of these microhabitats varies across different sampling sites, influencing the overall habitat suitability for aquatic macroinvertebrates. These variations are depicted in the **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.** for River Ub, **Error! Reference source not found.** and **Error! Reference source not found.** for tributaries, which highlight key parameters and ecological assessments for each site.

Table 35 - Selected metric of aquatic macroinvertebrate community at sampling sites of the River Ub and *ecological status/potential assessment of waterbodies – Spring period 2023

Parameter / Site	UB 01	UB 02	UB 03	UB 04	UB 05	UB 07
BMWP	134	88	27	76	56	43
ASPT	7.1	6.1	5.4	5.8	5.6	5.4
NTAXA	30	28	9	15	12	11
LIFE	8.3	8	6.2	7.8	7.2	6
Ecological status/potential assessment	High	Good	Bad	Moderate	Moderate	Poor

*Regulation on parameters of ecological and chemical status of surface waters and parameters on chemical and quantitative status of groundwaters (Official Gazette of the Republic of Serbia No. 74/2011)

**Regulation on establishment of surface and groundwater bodies (Official Gazette of the Republic of Serbia No. 96/2010)

UB 01 - 06 belong to the UB2 waterbody (natural), and UB 07 to the UB1 waterbody (heavily modified waterbody – HMWB

Table 36 - Selected metric of aquatic macroinvertebrate community at sampling sites of the River Ub and *ecological status/potential assessment of waterbodies – Summer period 2023

Parameter / Site	UB 01	UB 02	UB 03	UB 04	UB 05	UB 07
BMWP	123	110	25	66	56	58
ASPT	6.8	6.5	5	5.5	5.6	5.8
NTAXA	27	29	6	14	12	17
LIFE	8.1	8	6.4	7.3	7	5.8
Ecological status/potential assessment	Good	Good	Bad	Moderate	Moderate	Moderate

*Regulation on parameters of ecological and chemical status of surface waters and parameters on chemical and quantitative status of groundwaters (Official Gazette of the Republic of Serbia No. 74/2011)

**Regulation on establishment of surface and groundwater bodies (Official Gazette of the Republic of Serbia No. 96/2010)

UB 01 - 06 belong to the UB2 waterbody (natural), and UB 07 to the UB1 waterbody (heavily modified waterbody – HMWB

The LIFE index cannot be calculated for some tributaries due to the low benthic macroinvertebrate diversity at sampling sites and the absence of taxa considered for ecological flow group association.

Table 37 - Selected metric of aquatic macroinvertebrate community at the catchment dams and ecological status assessment of waterbodies – Spring period

Parameter / Site	Joševa 4	Jasenovac	Medvednjak	Ogladenovačka
BMWP	48	37	55	90
ASPT	6.0	5.3	6.1	6.9
NTAXA	12	10	11	18
LIFE	Not calculated	Not calculated	Not calculated	8.0
Ecological status/potential assessment	Moderate	Poor	Moderate	Good

Investigated waterbodies belong to the Type 6 - small stream out of the Pannonian Plain which is not categorized in Type 3 and Type 4*, and not defined in national waterbody regulation**)

*Regulation on parameters of ecological and chemical status of surface waters and parameters on chemical and quantitative status of groundwaters (Official Gazette of the Republic of Serbia No. 74/2011)

**Regulation on establishment of surface and groundwater bodies (Official Gazette of the Republic of Serbia No. 96/2010)

Table 38 -Selected metric of aquatic macroinvertebrate community at the catchment dams and ecological status assessment of waterbodies – Summer period

Parameter / Site	Joševa 4	Jasenovac	Medvednjak	Ogladenovačka
BMWP	35	37	34	100
ASPT	5.8	5.3	5.7	6.7
NTAXA	8	9	8	22
LIFE	Not calculated	Not calculated	Not calculated	7.7

Parameter / Site	Joševa 4	Jasenovac	Medvednjak	Ogladenovačka
Ecological status/potential assessment	Poor	Poor	Poor	Good

Investigated waterbodies belong to the Type 6 - small stream out of the Pannonian Plain which is not categorized in Type 3 and Type 4*, and not defined in national waterbody regulation**)

*Regulation on parameters of ecological and chemical status of surface waters and parameters on chemical and quantitative status of groundwaters (Official Gazette of the Republic of Serbia No. 74/2011)

**Regulation on establishment of surface and groundwater bodies (Official Gazette of the Republic of Serbia No. 96/2010)

Table 39 - Selected metric of aquatic macroinvertebrate community at sampling sites of the River Ub and *ecological status/potential assessment of waterbodies (2024)

Parameter / Site	UB 6.5	UB 6.25
BMWP	63	82
ASPT	4.5	4.6
NTAXA	17	22
LIFE	5.2	5.5
Zelinka & Marvan SI	2.55	2.16
Shannon-Weaver Diversity Index	2.43	2.79
No. of families	15	21
EPT	2	3
Oligochaeta/Tubificidae [%]	16.36	13.95
Ecological status/potential assessment	Moderate	Moderate

*Regulation on parameters of ecological and chemical status of surface waters and parameters on chemical and quantitative status of groundwaters (Official Gazette of the Republic of Serbia No. 74/2011)

**Regulation on establishment of surface and groundwater bodies (Official Gazette of the Republic of Serbia No. 96/2010)

UB 01 - 06 belong to the UB2 waterbody (natural), and UB 07 to the UB1 waterbody (heavily modified waterbody – HMWB

The tables above provide information on the ecological status and potential of the watercourses within the Biodiversity Study Area. The BMWP, ASPT, and NTAXA values are key indicators of aquatic macroinvertebrate community health. The LIFE index is a scoring system developed to assess the potential impacts of low flows / changes in flow regime based on the macroinvertebrate communities present.

The ecological status/potential assessment categorizes these waterbodies, ranging from ‘High’ and ‘Good’ to ‘Moderate’ and ‘Poor’.

River Ub

Ecological status was higher further up in the catchment, with UB 01 and UB 02 calculated to be of ‘High’ status. A comparatively higher number of species (NTAXA) were recorded, and these sites had a higher ASPT.

The ecological status of Site UB 03 was calculated to be of ‘Bad’ status. This was reflected in the comparatively lower number of species (NTAXA) and lower BMWP and ASPT scores. These results suggest this site is subject to pollution pressures.

The ecological status of sites UB 04, UN 05 and UB 06 were calculated to be of ‘Moderate’ status. This was reflected in the comparatively lower number of species (NTAXA) and lower BMWP and ASPT scores. These findings are in compliance with the regulations governing the ecological and chemical status of

surface waters and the establishment of surface and groundwater bodies, as stipulated by the Official Gazette of the Republic of Serbia (No. 74/2011 and No. 96/2010).

Tributaries

The ecological status of the tributary sites was all poor (Joševa 4, Jasenovac and Medvednjak) with the exception of the Oglađenovačka site, which was poor.

5.3.3 Survey Results 2023

Surveys included sampling sites along the River Ub, its tributaries and within the location of the catchment sediment dams (**Error! Reference source not found.**). The presence and distribution of these taxa is p rovided in **Error! Reference source not found.**, **Error! Reference source not found.**, **Error! Reference source not found.**, **Error! Reference source not found.** and **Error! Reference source not found.**. The aquatic ecosystem of the Ub River and its tributaries presents a complex and diverse habitat for a range of macroinvertebrate species.

Table 40 - Taxa list of the aquatic macroinvertebrate taxa at sampling sites of the River Ub - Spring

No.	Taxon	UB01	UB02	UB03	UB04	UB05	UB07
1.	*Allogamus auricollis*	+	-	-	-	-	-
2.	*Anabolia nervosa*	-	+	-	-	-	-
3.	*Ancylus fluviatilis*	+	+	-	+	-	-
4.	*Asellus aquaticus*	-	-	-	-	+	-
5.	*Baetis buceratus*	-	+	-	-	-	-
6.	*Baetis fuscatus*	-	+	-	+	+	-
7.	*Baetis lutheri*	+	+	-	+	-	+
8.	*Baetis rhodani*	-	+	-	-	-	-
9.	*Baetis sp.*	+	+	-	-	-	-
10.	*Beraea pullata*	+	+	-	-	-	-
11.	*Caenis luctuosa*	+	+	-	+	-	-
12.	*Calopteryx splendens*	-	-	-	+	-	-
13.	*Ceratopogonidae* sp.	-	-	-	+	-	-
14.	*Chironomidae* spp.	-	+	+	+	-	-
15.	*Corduelgaster boltonii*	+	-	-	-	-	-
16.	*Donacia* sp.	-	-	+	-	-	-
17.	*Ecdyonurus venosus*	+	-	-	-	-	-
18.	*Elmis maugetii*	-	-	-	-	-	+
19.	*Enchytraeidae* spp.	+	+	+	-	+	+
20.	*Ephemera vulgata*	+	-	-	-	-	-
21.	*Ephemerella mucronata*	-	+	-	+	+	-
22.	*Erpobdella octoculata*	-	-	-	-	-	+
23.	*Gomphus flavipes*	+	+	-	-	-	-
24.	*Gordius aquaticus*	+	-	-	-	-	-
25.	*Haitia acuta*	-	-	-	+	+	-
26.	*Halesus digitatus*	+	+	-	-	-	+
27.	*Halesus radiatus*	-	+	-	-	-	-

No.	Taxon	UB01	UB02	UB03	UB04	UB05	UB07
28.	*Heptagenia longicauda*	+	-	-	-	-	-
29.	*Leuctra* sp.	+	-	-	-	-	-
30.	*Limnephilus* sp.	+	+	+	-	-	-
31.	*Micropterna sequax*	-	-	-	-	+	-
32.	*Micropterna testacea*	-	-	-	-	-	+
33.	*Notidobia ciliaris*	+	-	-	-	-	-
34.	*Oecetis* sp.	+	+	+	+	-	-
35.	*Ophiogomphus cecilia*	-	-	-	-	+	-
36.	*Pisidium casertanum*	+	-	-	-	-	-
37.	*Platambus maculatus*	+	+	-	-	+	-
38.	*Pomatinus substriatus*	+	+	-	-	-	-
39.	*Potamophylax latipennis*	+	+	+	-	-	-
40.	*Potamophylax rotundipennis*	+	+	-	-	-	-
41.	*Radix auricularia*	-	+	-	-	-	-
42.	*Radix labiata*	+	+	-	+	-	-
43.	*Rhithrogena germanica*	-	-	-	-	-	+
44.	*Rhyacophila fasciata*	-	-	+	+	-	-
45.	*Rhyacophila vulgaris*	+	-	-	-	-	-
46.	*Schmidtea lugubris*	-	+	-	-	-	-
47.	*Sericostoma personatum*	+	+	-	+	+	-
48.	*Serratella ignita*	+	+	-	-	-	-
49.	*Simuliidae* spp.	-	+	-	+	+	+
50.	*Stenophylax* sp.	+	-	+	-	-	-
51.	*Stratiomyiidae* sp.	-	-	-	-	-	+
52.	*Sympetrum striolatum*	-	-	-	-	-	+
53.	*Tabanus* sp.	-	-	-	-	+	-
54.	*Tubifex tubifex*	+	+	-	+	-	-
55.	*Tubificidae* spp.	-	-	+	-	+	+
56.	*Allogamus auricollis*	+	-	-	-	-	-
57.	*Anabolia nervosa*	-	+	-	-	-	-

+ - taxon is present on the site

- - taxon is absent on the site

Table 41 - Taxa list of the aquatic macroinvertebrate taxa at sampling sites of the River Ub - Summer

No.	Taxon	UB01	UB02	UB03	UB04	UB05	UB07
1.	*Aeshna viridis*	-	-	-	-	-	+
2.	*Anabolia nervosa*	+	+	-	-	-	-
3.	*Ancylus fluviatilis*	+	+	-	+	-	-

No.	Taxon	UB01	UB02	UB03	UB04	UB05	UB07
4.	*Asellus aquaticus*	-	-	-	-	+	-
5.	*Baetis buceratus*	-	+	-	-	-	-
6.	*Baetis fuscatus*	-	+	-	+	+	-
7.	*Baetis libenauae*	+	-	-	-	-	-
8.	*Baetis lutheri*	+	+	-	+	-	+
9.	*Baetis muticus*	+	+	-	-	-	-
10.	*Baetis scambus*	-	+	-	-	+	-
11.	*Baetis rhodani*	-	+	-	-	-	-
12.	*Baetis* sp.	+	+	-	-	-	+
13.	*Brachycentrus maculatus*	+	-	-	-	-	-
14.	*Caenis luctuosa*	+	+	-	+	-	-
15.	*Calopteryx splendens*	-	-	-	+	-	+
16.	*Calopteryx virgo*	-	-	-	-	-	+
17.	*Ceratopogonidae* sp.	-	-	-	+	-	-
18.	*Capnia* sp.	+	+	-	-	-	-
19.	*Chironomidae* spp.	-	+	+	+	-	-
20.	*Coenagrion* sp.	-	-	-	-	-	+
21.	*Diura bicaudata*	-	+	-	-	-	-
22.	*Ecdyonurus insignis*	-	+	-	-	-	-
23.	*Ecdyonurus venosus*	+	-	-	-	-	-
24.	*Elmis maugetii*	-	-	-	-	-	+
25.	*Enchytraeidae*	+	+	+	-	+	+
26.	*Ephemerella mucronata*	-	+	-	+	+	-
27.	*Erpobdella octoculata*	-	-	-	-	-	+
28.	*Gomphus flavipes /Stylurus flavipes*	+	+	-	-	-	-
29.	*Gordius aquaticus*	+	-	-	-	-	+
30.	*Haitia acuta*	-	-	-	+	+	-
31.	*Halesus digitatus*	+	+	-	-	-	-
32.	*Heptagenia flava*	+	-	-	-	-	-
33.	*Heptagenia longicauda*	+	-	-	-	-	-
34.	*Leuctra*	+	-	-	-	-	-
35.	*Limnephilus*	+	+	+	-	-	-
36.	*Micropterna sequax*	-	-	-	-	+	-
37.	*Nemoura*	+	+	-	-	-	-
38.	*Onychogomphus forcipatus*	-	+	+	-	-	-
39.	*Ophiogomphus cecilia*	-	-	-	-	+	-
40.	*Orthetrum coerulescens*	-	-	-	-	-	+

No.	Taxon	UB01	UB02	UB03	UB04	UB05	UB07
41.	*Pisidium casertanum*	+	-	-	-	-	-
42.	*Platambus maculatus*	+	-	-	-	+	-
43.	*Pomatinus substriatus*	+	+	-	-	-	-
44.	*Radix auricularia*	-	+	-	-	-	-
45.	*Radix labiata*	+	+	-	+	-	-
46.	*Rhithrogena germanica*	-	-	-	-	-	+
47.	*Rhyacophila fasciata*	-	-	+	+	-	-
48.	*Rhyacophila vulgaris*	+	-	-	-	-	-
49.	*Schmidtea lugubris*	-	+	-	-	-	-
50.	*Sericostoma personatum*	+	+	-	+	+	-
51.	*Serratella ignita*	+	+	-	-	-	-
52.	*Simuliidae* spp.	-	+	-	+	+	+
53.	*Stratiomyiidae* sp.	-	-	-	-	-	+
54.	*Sympetrum meridionale*	-	-	-	-	-	+
55.	*Sympetrum striolatum*	-	-	-	-	-	+
56.	*Tubifex tubifex*	+	+	-	+	-	-
57.	*Tubificidae* spp.	-	-	+	-	+	+

+ - taxon is present on the site

- - taxon is absent on the site

Table 42 - Taxa list of the aquatic macroinvertebrate taxa at sediment trap dams - Spring

No.	Taxon	Joševa	Jasenovac	Medvednjak	Ogladjenovačka
1.	*Anabolia nervosa*				+
2.	*Araneae* sp.	+		+	
3.	*Baetis lutheri*				+
4.	*Baetis rhodani*				+
5.	*Baetis muticus*				+
6.	*Baetis fuscatus*				+
7.	*Chironomidae* spp.	+			+
8.	*Diura bicaudata*				+
9.	*Ecdyonurus venosus*			+	+
10.	*Enchytraeidae* spp.		+	+	
11.	*Gammarus pulex*	+	+	+	+
12.	*Gerris argentatus*	+	+	+	
13.	*Gomphus flavipes / Stylurus flavipes*		+		
14.	*Halesus digitatus*		+		
15.	*Heptagenia flava*				+
16.	*Leuctra* sp.				+
17.	*Limnephilus* sp.			+	

No.	Taxon	Joševa	Jasenovac	Medvednjak	Ogladjenovačka
18.	*Limnius volckmari*				+
19.	*Micropterna sequax*	+			
20.	*Nemoura* sp.				+
21.	*Onychogomphus forcipatus*				+
22.	*Ophiogomphus cecilia*				+
23.	*Platambus maculatus*			+	+
24.	*Schmidtea lugubris*		+		
25.	*Sericostoma personatum*	+			+
26.	*Serratella ignita*				+
27.	*Simuliidae* spp.	+	+		+
28.	*Tubifex tubifex*		+		+
29.	*Tubificidae* spp.		+	+	+

+ - taxon is present on the site

- - taxon is absent on the site

Table 43 - Taxa list of the aquatic macroinvertebrate taxa at sediment trap dams - Summer

No.	Taxon	Joševa	Jasenovac	Medvednjak	Ogladjenovačka
1.	*Allogamus auricollis*	-	-	+	-
2.	*Anabolia nervosa*	-	-	-	+
3.	Araneae sp.	-	-	-	+
4.	*Anacaena limbata*	-	-	-	+
5.	*Baetis lutheri*	-	-	-	+
6.	*Baetis rhodani*	-	-	-	+
7.	Baetis sp.	-	-	-	+
8.	*Beraea pullata*	-	-	-	+
9.	Chironomidae spp.	+	-	-	+
10.	*Cordulegaster boltonii*	-	-	-	+
11.	*Ecdyonurus venosus*	-	-	+	+
12.	Enchytraeidae spp.	-	+	+	-
13.	*Ephemera lineata*	-	-	+	-
14.	*Gammarus pulex*	+	+	+	+
15.	*Gerris argentatus*	+	+	+	-
16.	*Gomphus flavipes*	-	+	+	-
17.	*Halesus digitatus*	-	+	-	-
18.	*Hirudo verbana*	-	-	+	-
19.	*Limnephilus* sp.	+	-	+	-
20.	*Limnius volckmari*	-	-	-	+
21.	*Micropterna sequax*	+	-	-	+
22.	*Notidobia ciliaris*	+	-	-	+
23.	*Ophiogomphus cecilia*	+	-	-	+

No.	Taxon	Joševa	Jasenovac	Medvednjak	Ogladjenovačka
24.	*Platambus maculatus*	-	-	+	+
25.	*Potamophylax rotundipennis*	+	+	-	-
26.	*Schmidtea lugubris*	+	+	-	-
27.	*Sericostoma personatum*	+	-	-	+
28.	*Serratella ignita*	-	-	-	+
29.	Simuliidae spp.	+	+	-	-
30.	*Stenophylax* sp.	+	-	-	-
31.	*Tubifex tubifex*	-	+	-	-
32	Tubificidae spp.	-	+	+	-

+ - taxon is present on the site

- - taxon is absent on the site

5.3.4 Survey results 2024

During the surveys, a total of 27 aquatic macroinvertebrate taxa were recorded at the Ub River sampling sites (**Error! Reference source not found.**). Among the identified taxa, several notable alien, non-native, and i nvasive species were observed.

Table 44 - Taxa list of the aquatic macroinvertebrate taxa at sampling sites of the River Ub (2024)

No.	Taxon	UB 6.5	UB 6.25
1.	*Asellus aquaticus*	+	+
2.	*Baetis fuscatus*	+	-
3.	*Baetis lutheri*	-	+
4.	*Baetis pavidus*	-	+
5.	*Caenis luctuosa*	+	+
6.	*Calopteryx virgo*	+	+
7.	*Chironomidae Gen.* sp.	+	+
8.	*Donacia* sp.	-	+
9.	*Enchytraeidae* spp.	+	+
10.	*Erpobdella octoculata*	+	+
11.	*Erpobdella vilnesis*	+	-
12.	*Gammarus pulex*	-	+
13.	*Gerris sp.*	-	+
14.	*Glossiphonia complanata*	-	+
15.	*Gordius aquaticus*	-	+
16.	*Haitia acuta*	+	+
17.	*Helobdella stagnalis*	+	-
18.	*Nepa cinerea*	+	+
19.	*Onychogomphus forcipatus*	-	+
20.	*Ophiogomphus cecilia*	+	-
21.	*Orthetrum cancellatum*	+	-
22.	*Platambus maculatus*	-	+

No.	Taxon	UB 6.5	UB 6.25
23.	*Pomatinus substriatus*	-	+
24.	*Radix labiata*	+	+
25.	*Simuliidae spp.*	+	+
26.	*Tubifex tubifex*	+	-
27.	*Tubificidae spp.*	+	+

+ - taxon is present on the site

- - taxon is absent on the site

Mayflies are particularly sensitive to the quality of water, with their presence being a strong indicator of well-oxygenated and relatively clean environments. They are typically found in fast-flowing waters where the current allows them to attach to substrates such as gravel and cobble. In the Ub River, sites like UB 01 and UB 02 provide the ideal conditions for Mayflies, where clean, gravel-rich substrates offer the perfect environment for their nymphs to thrive.

Alongside the Mayflies, the Stoneflies also prefer cool, fast-flowing waters. Their presence in the same areas is not coincidental, as they share similar habitat preferences. These species, which are highly sensitive to pollution, rely on streams that offer high levels of dissolved oxygen and clean substrates. The gravel beds and fast currents of UB 01 and UB 02 provide the perfect conditions for Stoneflies larvae, which, like the Mayflies, depend on these habitats for respiration, feeding, and growth.

In addition to Mayflies and Stoneflies, the Caddisflies are another prominent group in the river's ecosystem. These insects, particularly their larvae, are known for building protective cases from aquatic materials like stones, sand, and plant debris. The mix of moderate current and stable substrates in sites like UB 01 and UB 02 supports a high diversity of Caddisfly species. These insects are often found attached to the riverbed or submerged vegetation, where their larvae continue to build cases while feeding on detritus and algae.

The Beetles, particularly the predatory Dytiscidae, also inhabit the river, although they are more adaptable to a range of water qualities. Some beetles are found in fast-flowing waters, while others prefer slower, more stagnant areas. In the Ub River, sites such as UB 01 and UB 02, with their mix of substrates and moderate flow, support a diverse beetle population, with species found both on the water’s surface and in submerged vegetation. These beetles are important predators within the ecosystem, feeding on smaller invertebrates and contributing to the control of invertebrate populations.

The Earthworms, commonly found in slower-moving, organic-rich waters, are a significant part of the ecosystem in areas with silty or muddy substrates. These worms play a crucial role in breaking down organic matter, recycling nutrients, and enriching the soil. In the Ub River, slower tributaries like UB 06 and sediment trap dams, such as those found in Stream Babinac, provide the ideal conditions for Earthworms to thrive. These sites, with their higher organic content and lower water flow, support large populations of Oligochaeta, which feed on decaying plant material and contribute to the overall health of the ecosystem.

Similarly, Non-biting Midges are prevalent in these areas. These species are highly tolerant of low-oxygen conditions and organic enrichment, making them particularly abundant in slow-moving waters or sites with poor water quality. In the Ub River, sediment trap dams and areas with organic accumulation, such as Stream Babinac and Stream Jasenovac, provide a habitat for their larvae. The larvae, which are often found buried in mud or organic detritus, serve as a food source for a variety of fish and invertebrate predators.

The Amphipods, typically found in cool, clear waters with stable, clean substrates, are a key component of the river’s biodiversity. These small crustaceans are often seen in sites with moderate to fast currents, where they burrow into gravel and cobble beds. In the Ub River, UB 01 and UB 02 provide the ideal conditions for Gammaridae, where they are an essential part of the food web, serving as prey for fish species and other predators. Their presence also indicates the overall health of the river ecosystem, as they require high-quality water and undisturbed habitats.

The Water Mites, typically found in areas with moderate water quality, are another important group in the river. They inhabit both slow-moving and fast-flowing streams, often living on aquatic vegetation or submerged surfaces where they can feed on small invertebrates. Sites such as Stream Babinac, Stream

Jasenovac, and River Oglađenovačka provide sheltered, organic-rich conditions where they thrive. These areas, with their slower currents and abundant organic material, are perfect for water mites, which play a role in controlling the populations of smaller invertebrates and contributing to the nutrient cycling in the ecosystem.

Finaly, Gastropods such as snails are common in various habitats, from fast-flowing to stagnant waters. These species are found in both clear and more organic-rich waters, where they feed on algae, detritus, and plant material. In the Ub River, sites with slow-moving waters and organic accumulation, like UB 06 and UB 05, provide ideal habitats for Gastropods. These species contribute to the health of the ecosystem by grazing on algae and detritus, helping to maintain water quality and prevent excessive algal growth.

5.3.5 Protected or Notable Species / Habitats

Notable aquatic invertebrate species, including '*threatened species'* as defined by EBRD criteria (EBRD GN6) were recorded during surveys (**Error! Reference source not found.**). These were all dragonflies l isted on Annex II and/or IV of the Habitats Directive; the Green Hawker - *Aeshna viridis*, the River Clubtail - *Stylurus flavipes* and the Green Snaketail - *Ophiogomphus cecilia.* These species were carried forward to the CHA.

Table 45 - Notable aquatic macroinvertebrate species

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats Directive / Bern Convention Resolution 6	Serbian legislation	Sites
1.	*Aeshna viridis*	Green Hawker	NT	LC	HD AIV		UB 7
2.	*Stylurus flavipes*	River Clubtail	LC	LC	HD AIV		UB 01, UB 02, Jasenovac
3.	*Ophiogomphus cecilia*	Green Snaketail	LC	LC	HD AII and AIV, BC R6	P	UB 05, UB 6.5, Ogladjenovačka

* Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia);

IUCN Data Deficient (DD), Least Concern (LC), Near Threatened (NT)

HD - EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

BC - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

5.4 Mussels

5.4.1 Survey Methodology

The IUCN desk study screening (**Error! Reference source not found.**) identified the potential for presence o f Depressed River Mussel *Pseudanodonta complanata* (i.e. the published spatial distribution of this species was within a 20km buffer of the Biodiversity Study Area). For that reason, mussel searches were conducted as part of the river mapping process, encompassing the entire length of the River Ub within the inundation area, as well as the upstream and downstream section during 2023. Surveyors undertaking the aquatic macroinvertebrate kick sampling were also instructed to be extra vigilant with respect to freshwater mussel presence.

Presence of Thick-shelled Mussel (TSM) *Unio crassus* was confirmed in 2023, both from physical (shell) records and subsequent eDNA analysis (Section 5.4.2). Follow up TSM survey were carried out in 2024 (**Error! Reference source not found.** and Section 5.4.3). TSM surveys were carried at the 11 locations (**Error! Reference source not found.** and Figure 19); each site had optimal habitat was identified within a 500 m river length.

Table 46 - Thick-shelled mussel (TSM) survey locations (2024)

Site Name	Coordinates		Description / Comments
*UB 01	N 44.417044	E 19.797442	Same site location as 2023 freshwater surveys
*UB 02	N 44.405825	E 19.864322	Same site location as 2023 freshwater surveys
**UB 03	N 44.407036	E 19.892894	Same site location as 2023 freshwater surveys
***UB 04	N 44.426067	E 19.906844	Same site location as 2023 freshwater surveys
***UB 05	N 44.432328	E 19.920464	Same site location as 2023 freshwater surveys
**UB 06	N 44.414722	E 19.976272	Same site location as 2023 freshwater surveys
*UB 0.5	44.420934	19.767988	u/s of UB 01; new location in 2024
*UB 1.5	44.418163	19.835679	d/s of UB 01; new location in 2024
***UB 5.5	44.420667	19.952312	d/s of UB 05; new location in 2024
UB 6.25	44.419309	20.004447	d/s of UB 06; new location in 2024
UB 6.5	44.430199	20.025803	d/s of UB 06; new location in 2024

* dry stream bed

** intermittent water flow (not running water, puddles/lentic habitats which are not representative)

***unreachable location for TSM survey due to very deep water

Abbreviations: u/s – upstream; d/s – downstream

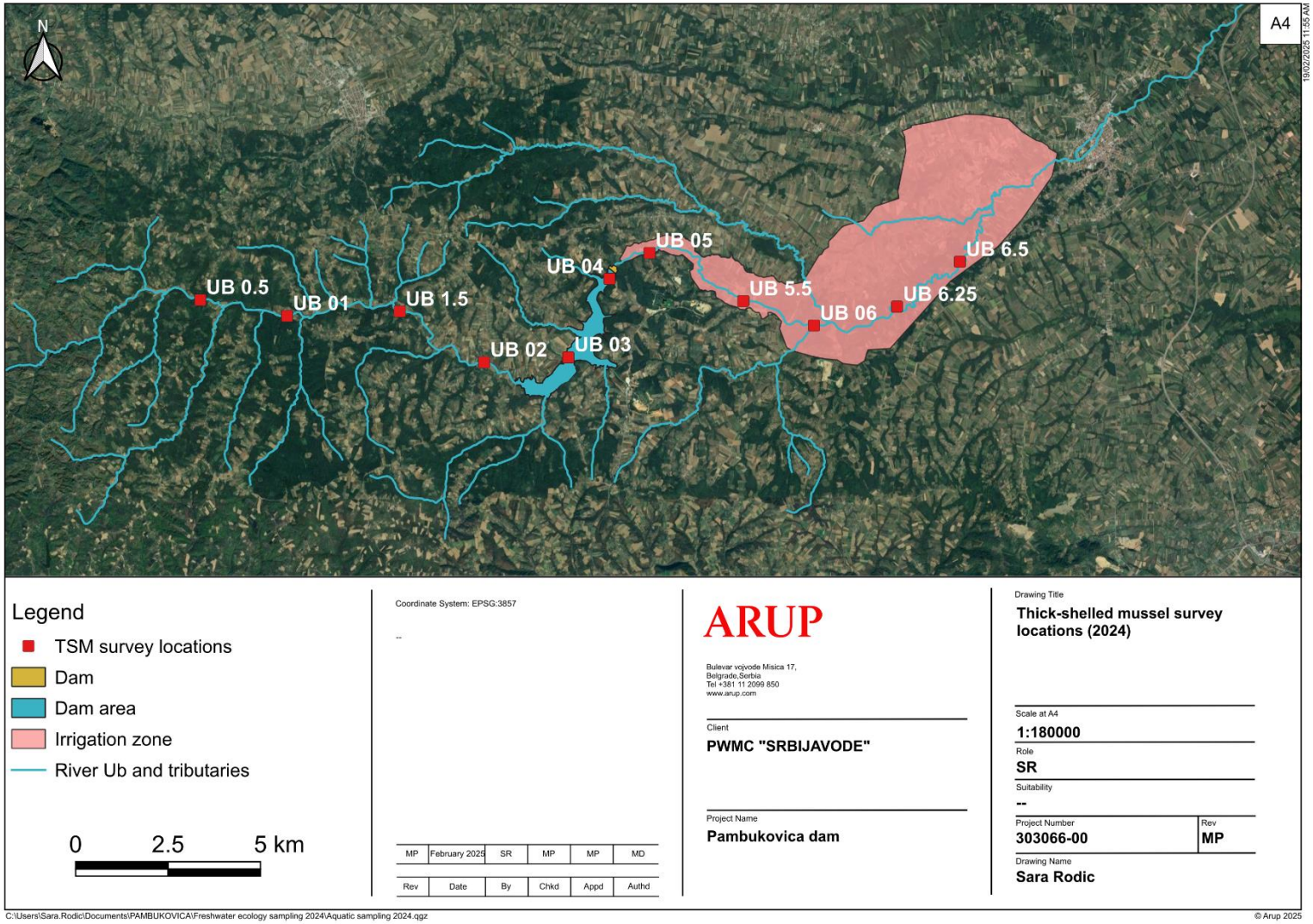


Figure 19 - Thick-shelled mussel survey locations (2024)

5.4.2 eDNA

Following positive physical (shell) records of TSM (IUCN EN in globally, and VU in Europe), environmental DNA (eDNA) analysis was undertaken using water samples prepared for fish eDNA. The sampling sites and methodology for the eDNA analysis are outlined in Chapter 5.2 (fish eDNA survey). DNA already extracted for the purpose of identify fish species was reanalysed using a Nature Metrics *Unionidae* metabarcoding analysis.

5.4.3 2024 TSM physical survey / Assessment Methodology

During the 2024 surveys, the methodology was consistent with the previous year, ensuring comparability of data. Surveyors conducted thorough searches along designated transects and recorded the presence of mussels, noting their abundance and condition. Despite challenging hydrological conditions, including high water levels and increased turbidity following heavy rainfall, the surveys successfully identified several mussel specimens.

The aim of the 2024 physical mussel surveys was to gather information in the potential condition of the mussel population through population attributes, including density, age structure, and recruitment. Fish surveys were also carried out as they play a critical role in the life cycle of this species, which are parasitic as larvae, living on the gills of fish for the primary purpose of dispersal.

The main objective of the 2024 TSM surveys was to determine health and population attributes for this species (e. g. metrics relating to population density, age structure and recruitment).

At each site the objective was to understand the following population attributes:

- Population density – number of individuals per m^2.
- Age structure and recruitment – ratio of young: old individuals.

Survey and assessment methodology followed relevant elements of Monitoring the Freshwater Pearl Mussel, *Margaritifera margaritifera* (Young *et al* 2003).[46] Whilst developed for Freshwater Pearl Mussel, this protocol has been designed to establish standardised methods for:

- Baseline surveys of unstudied populations.
- The assessment of the conservation status of freshwater populations within individual rivers.
- Collecting data for comparison with previous surveys as part of a monitoring programs.
- Collecting data on environmental variables that might influence the status of mussel populations.

As part of the survey the information on the attributes of the supporting habitat (e.g. flow regime, water quality, levels of suspended solids, and river morphology) were recorded visually and with photographs.

5.4.4 Limitations and adapted methodology

The recommended transect approach is applicable only in wadeable rivers; however, certain sites along the Ub River were inaccessible in 2024 due to high water levels following heavy rainfall. Furthermore, low numbers of TSM specimens were identified during the surveys. Given the low density of the mussel population, an alternative procedure was implemented to accommodate the limitations of standard sampling; this is aligned with guidance set out in Young *et al* 2003 for where the mussel population is too low for standard sampling. This states that:

If the mussel population in a river is either very small and/or very localised, then standard sampling may not be practical. In this case, an exhaustive, generalised search should be made, and any mussels or mussel beds mapped individually as closely as possible. The use of historical data and a focus on suitable substrate will

[46] Young MR, Hastie LC & Cooksley SL (2003). Monitoring the Freshwater Pearl Mussel, *Margaritifera margaritifera*. Conserving Natura 2000 Rivers Monitoring Series No. 2, English Nature, Peterborough.

assist such a search. If very few mussels are present, it may also be inappropriate to search a quadrat to provide mussels for an age profile. However, some effort should be made to disturb suitable substrate near the remaining mussels, to see if juveniles are present.

The exact locations of 50-meter transect were chosen to include mussels whenever possible. Within each selected area, the starting point of each transect was carefully positioned to ensure the inclusion of mussels. Start points were placed at least 1 meter away from the riverbank to avoid areas prone to drying out during low flow conditions. Each starting location was recorded using GPS, accompanied by target notes and positional photographs.

Transects were sampled following the standardized methodology outlined in this document. The presence of dead mussels was documented. Random sampling of at least 150 mussels is typically conducted to establish a population profile. However, due to the low mussel density in the Ub River, a full population profile could not be obtained. Mussel counts were recorded and reported using standardized terminology. The total number of mussels, adult shells (defined as >30 mm for TSM), dead shells, visible mussels, and those found within quadrats were all noted on the standard recording form. Additional information, including the date and time of the survey, weather conditions, surveyor's name, and location, was also documented.

Live TSM specimens were not measured; instead, only shells were recorded before returning them to the water due to their protected status. Abundance categories, as outlined in **Error! Reference source not found.**, were applied for freshwater mussel surveys, adhering to recommended codes for standardization and reporting in England, Wales, and Northern Ireland.

Table 47 - Mussel abundance categories

Numbers of live mussels per 50 x 1 m transect	Equivalent numbers of live mussels per m^2	Abundance level (letter code)
0	0	E – Absent
1 – 49	1	D – Rare
50 – 499	2 – 10	C – Scarce
500 – 999	11 – 20	B – Common
> 1000	> 21	A – Abundant

Substrate type was estimated, assessed by eye, of the percentage area of riverbed covered by each of the Wentworth scale substrate grades should be made for each transect area.

An assessment of habitat was carried out at each mussel sampling location. Initial site selection and location of areas suitable for transects were taken between one and three hours. Each transect were taken approximately one hour, and each quadrat 20–30 minutes for both the sampling and completing the paperwork.

5.4.5 Desk Study Results

Tomovic *et al* (2023)[47] published a data review paper which sought to collate information on the distribution of TSM in Serbia, over three time periods from 1953 to 2019. The paper summarises all the available literature data, field research and information obtained during the collection of malacological material of the Natural History Museum in Belgrade.

[47] Tomović, J., Simić, V., Petrović, A., Atanacković, A., Zorić, K., Paunović, M., Raković, M., (2023) Distribution Range of the Endangered Species Unio crassus Philipsson, 1788 in Serbia (Western Balkans Region), Historical and Recent Data. Water, volume 15, issue 24, pages 4248- (2023).

In relation to the review of current data (1990 – 2019), the authors concluded that of the 540 sites surveyed, mussels were detected at 46 sites. TSM was detected in the Kolubara, Pusta reka, Tisa Rivers, Crni Timok, and at two sites on the Danube (Stari Banovci and Smederevo).

More recently (since 2009), TSM was detected in the Danube, Tisa, Sava, Velika and Zapadna Morava Rivers, as well as in the Kolubara River basin (three sites on the main course of the Kolubara and in the Peštan and Ljig Rivers), and according to the literature data, it was also detected in the Južna Morava and Nišava Rivers. During this period, the species was sporadically detected along the Danube, with a low frequency of occurrence and abundance (up to 0.48% of the total mussel community). The occurrence of TSM in the Kolubara River basin was also confirmed in repeated sampling in the period 2009–2019, but with a low abundance. The River Ub it a tributary of the Tamnava, which flows into the Kolubara, so this is of note.

5.4.6 Survey Results 2023

Two species of mussel were recorded using the *Unionidae* metabarcoding analysis. TSM presence was confirmed at all sites sampled of the River Ub (Figure 21); this species is assessed as VU (in Europe) and EN (globally) according to IUCN. It is strictly protected by Serbian legislation, specifically the decree on the proclamation and protection of strictly protected and protected wild species of plants, animals, and fungi. It is also listed in Annex II and IV of the EU Habitats Directive and Resolution 6 of the Bern Convention.

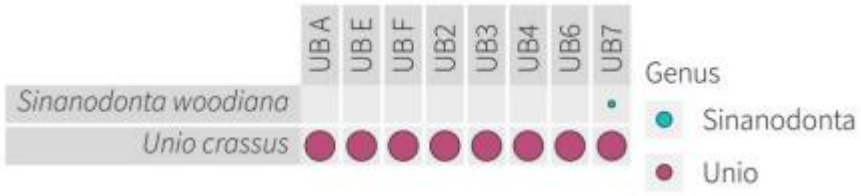


Figure 20 - Community composition of the detected mussels in the River Ub

Figure 20 and **Error! Reference source not found.** show lists of the species detected in each sample. A bubble (in Figure 20) means a species was detected in that sample. The size of the bubbles represents the proportion of DNA sequences within a sample. A larger bubble size can indicate a stronger eDNA signal. This signal may be linked to abundance of species in the environment but should be interpreted only as a coarse measure because the signal is also impacted by biological (e.g., biomass, life stage, activity, body condition), environmental (e.g., temperature, pH, salinity, conductivity), and technical factors (e.g., primer bias, PCR stochasticity).

Table 48 - Mussel species findings in River Ub

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats Directive / Bern Convention Resolution 6	Serbian legislation	Sites
1.	*Unio crassus*	Thick-shelled River Mussel	VU	EN	HD AII and AIV, BC R6	SP	Numerous Sites – see Table 47**Error! Reference source not found.Error! Reference source not found.**
28.	*Sinanodonta woodiana*	Chinese Pond Mussel	N/A INNS	LC		INNS	UB 07

Figure 21 - Thick-shelled River Mussel sampled in river Ub

It should be noted that the life cycle of the TSM, like most freshwater mussels, has a temporary obligate parasitic life stage (glochidia) on fish. Glochidia live on the gills of host fish which included common coarse fish that have been recorded in the Biodiversity Study Area (see chapter 5.2).

Additionally, DNA of the invasive / non-native species (INNS) Chinese Pond Mussel *Sinanodonta woodiana* was identified at one site (UB7). Notably, this INNS was recorded at the furthest downstream sampling site, situated approximately 17 km downstream of the proposed dam and inundation area.

5.4.7 Survey Results 2024

During the second-year surveys conducted in 2024 at TSM sites and surrounding areas, only three adult specimens were recorded, at the UB 6.5 site and a single adult dead shell found at the UB 03 site (**Error! R eference source not found.**). Detailed measurements of living specimens, which require opening the shells which would result in specimen destruction. Therefore, during the TSM survey, only shells were measured.

Table 49 - TSM Physical Survey Results

Site Name	Coordinates		2023 Results	2024 Results
*UB 0.5	44.420934	19.767988	Not surveyed for TSM in 2023	dry stream bed, survey could not be undertaken
*UB 01	N 44.417044	E 19.797442	Not surveyed for TSM in 2023	dry stream bed, survey could not be undertaken
*UB 1.5	44.418163	19.835679	Not surveyed for TSM in 2023	dry stream bed, survey could not be undertaken
*UB 02	N 44.405825	E 19.864322	Present eDNA	dry stream bed, survey could not be undertaken
**UB 03	N 44.407036	E 19.892894	Present eDNA	**single adult dead shell** - intermittent water flow (not running water, pool / lentic habitats which are not representative)
***UB 04	N 44.426067	E 19.906844	Present eDNA	Too deep / turbid to undertake robust survey
***UB 05	N 44.432328	E 19.920464	Not surveyed for TSM in 2023	Too deep / turbid to undertake robust survey

Site Name	Coordinates		2023 Results	2024 Results
***UB 5.5	44.420667	19.952312	Not surveyed in 2023	Too deep / turbid to undertake robust survey
**UB 06	N 44.414722	E 19.976272	Present eDNA	**No catch** - intermittent water flow (not running water, pool / lentic habitats which are not representative)
UB 6.25	44.419309	20.004447	Not surveyed in 2023	**No catch**
UB 6.5	44.430199	20.025803	Not surveyed in 2023	Three adult specimens were recorded.
UB 7	44.449325	20.050505	Present eDNA	No surveyed

* dry stream bed

** intermittent water flow (not running water, puddles/lentic habitats which are not representative)

***unreachable location for TSM survey due to very deep water

The findings indicate that suitable habitats for TSM exist in the Ub River, particularly downstream of the Pambukovica Dam. However, surveys results indicate that they are present in very low abundance at the sites surveyed. There are factors that may be driving the low abundance, such as poor water quality as a result of water pollution, particularly from communal wastewater discharge from nearby settlements and agriculture. Drought and extreme floods, as well as the availability of host fish may also be factors. Based on local researchers' professional experience, TSM in Serbia prefers deep water stretches of streams and small to medium rivers with medium-sized particle substrate and high dissolved oxygen concentrations. The most abundant populations in Serbia are found in the southeastern region, in non-polluted, small to medium hilly or submountain streams and rivers, particularly in the tributaries of the Nišava River. Hydrological variability, as observed in 2024, may has also affected TSM populations in the Ub River. The surveyors also noted that mussels may have been displaced following heavy rainfall / flooding. TSM specimens may have been displaced or washed out from the upper stretches of the Ub River and its tributaries, making it difficult to determine precise locations where they persist as sedentary species in optimal habitats. Additionally, riverbed and substrate restructuring, coupled with increased levels of suspended solids and turbidity, have further impacted the population.

Given the low number of live specimens recorded, estimating the precise population size and health and trends of TSM in the Ub River remains challenging, however, the species is considered present in low abundance. It should be noted that where TSM have been recorded downstream in the Kolubara River basin (nearest desk study records), repeated sampling in the period 2009–2019 has shown presence, but also in low abundance.

The habitat preference of TSM is further discussed in Section 5.4.10.

5.4.8 Protected or Notable Species / Habitats

The screening of survey results included an assessment against multiple conservation frameworks, specifically the IUCN Red List (covering CR, EN, VU categories), Annexes II and IV of the EU Habitats Directive, Annex I of the EU Birds Directive, Resolution 6 of the Bern Convention, Serbian Red Lists, and Serbian "Strictly Protected" and "Protected" species lists.

From this review, one mussel species observed in the project area meet the threshold as 'threatened/priority' species in accordance with EBRD PR6 and was therefore selected for evaluation in the Critical Habitat Assessment (CHA). This species is:

- Thick-shelled River Mussel (*Unio crassus*) (IUCN Europe VU and IUCN Global EN; Habitats Directive AII and AIV, Bern Convention R6; Strictly protected under Serbian regulation)

Additionally, an invasive / non-native species, the Chinese Pond Mussel (*Sinanodonta woodiana*), was recorded at site UB 07, downstream of the project area. This species is classified as an Invasive / Non-Native Species (INNS) and poses potential ecological risks to local aquatic habitats.

5.4.9 Thick Shelled Mussel (TSM) taxonomy and characterisation of the *Unio crassus* complex

Whilst TSM are afforded various protections (see above), it should be noted that there is ongoing research within the scientific community around the taxonomy, phylogeny and phylogeography of the *Unio crassus* complex. This was recently investigated by an international scientific collaboration (Lopes-Lima *el al,* 2024)[48], who used and integrative approach present the case for 12 species within the *Unio crassus* complex. Of the twelve species proposed, the geographic distribution of three species overlap with Serbia and the Project area. These are:

- ***Unio crassus s. str.*** -restricted to Europe, including the Danube basin. This species overlaps with *Unio nanus* in most of its western range including Serbia. Because of its shell morphological plasticity and wide distribution, it is very difficult to distinguish *U. crassus s. str.* from other species in the complex using only shell morphological characters. This species is the subject of an increasing number of captive breeding efforts and reintroductions.
- ***Unio nanus stat. rev.*** - restricted to Europe, with a core distribution in the Saône sub-catchment of the Rhône, the Rhine, and the Danube basins (the Project area). As for *Unio crassus s. str.* shell morphology is unreliable for species diagnosis, which has been shown be determined by microhabitat and river type.[49] The species overlaps geographically with *U. crassus s. str*. over most of its range and with *U. vicarius* in the middle and lower Danube sections (the Project area).
- ***Unio vicarious stat. rev.*** – This species has been reported from the middle and lower Danube basin in Croatia, Romania, and Bulgaria, and is expected to occur in rivers within the same basin in Slovenia, Hungary, Bosnia and Herzegovina, and Serbia. As for *Unio crassus s. str*. and *Unio nanus* shell morphology is unreliable for species diagnosis. The species overlaps with *U. nanus* and *U. crassus s. str*. in an extended area of the middle and lower Danube basin.

Based on this literature and recent DNA studies, there is potential for the TSM recorded in the River Ub catchment to be any of three aforementioned species within the *Unio crassus* complex, or indeed more than one. This does not affect the formal conservation status of the TSM, or its classification under EBRD PR6, but may have implications for site specific conservation measures, including conservation propagation and/or translocation; such activities should be informed by molecular testing to ensure accurate species identification. The extent to which the ecological and environmental requirements differ between these species is also poorly understood, as historically research on ecological/habitat preference typically does not distinguish between the different species within the *Unio crassus* complex.

5.4.10 Thick Shelled Mussel (TSM) Lifecycle and Habitat Preference

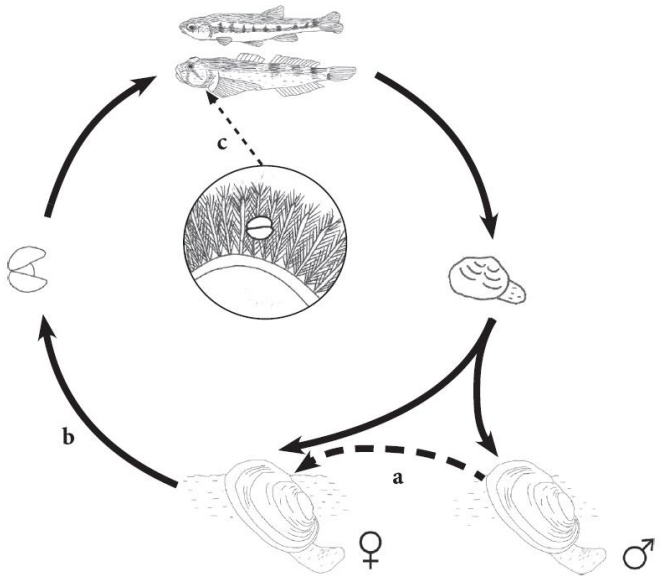
As part of their life cycle, freshwater mussels of the family *Unionidae* depend on a suitable host fish on which their larvae metamorphose into juveniles; this includes TSM. The life cycle of TSM (Figure 22) includes an obligate glochidial larval stage that attaches to the gills of freshwater fish for several days to months.[50] The stage are as follows:

[48] Lopes-Lima el al, (2024) Integrative phylogenetic, phylogeographic and morphological characterisation of the Unio crassus species complex reveals cryptic diversity with important conservation implications. Molecular Phylogenetics and Evolution Volume 195, June 2024, 108046.

[49] Zając, K. Zając, T., and Ćmiel, A. (2018) What can we infer from the shell dimensions of the thick-shelled river mussel *Unio crassus*? Hydrobiologia, 810 (2018), pp. 415-431, 10.1007/s10750-017-3098-2

[50] Lamand, F., Roche, K., Beisel, JN. (2016) Glochidial infestation by the endangered mollusc *Unio crassus* in rivers of north-eastern France: *Phoxinus phoxinus* and *Cottus gobio* as primary fish hosts. Aquatic Conserv: Mar. Freshw. Ecosyst. (2016)

- Between April and June, hermaphroditic individuals release sperm directly into the water (several times during the breeding season). Sperm are then taken downstream by the current and recovered by the female mussel's filtration system.
- Three successive life cycle stages follow fertilization (Figure 22). During the larval stage, proto-glochidia are incubated within the female's marsupial demibranches for 4–6 weeks. After reaching approximately 0.2mm (around May to July), the larvae are released and are passively distributed downstream.
- The secondary parasitic stage begins when the larvae (now called glochidia) attach to a suitable fish host. Although glochidia also commonly attach to the eyes, nose or fins of a fish, only those that use their hooks to attach to the gill arch will encyst and continue development. Glochidia that do not find a suitable host fish die after a few days. Those that do may be disseminated upstream or downstream from the parent by the fish.
- After 3–7 weeks of development (depending on water temperature), the glochidia transform into small bivalves, whereupon they burst the cyst and leave the fish to complete their juvenile and adult stages on the river bottom (Figure 1). At this point, the species becomes a relatively sedentary filter feeders inhabiting the substrate surface, although small-scale displacements are possible to avoid stress (e.g. from reduced water level).



(a) Males release spermatozoids that are taken in by the female to fertilize eggs internally. (b) These eggs develop into glochidia, which are then released into the water column by the female. (c) obligate glochidial phase, in which glochidia attach themselves to a fish's gill for 20 to 50 days, depending on temperature and environmental conditions. Source: Lamant *el al* (2016).

Figure 22 - Diagram illustrating the *Unio crassus* life cycle. Source: Lamant el al (2016)

5.4.11 Host Fish Species

As outline TSM have secondary parasitic life-stage hosting on fish. They are considered to be fairly non-specific, or generalist with regards the species of host fish, being able to host on many different common and resilient species. Primary hosts are typically common and widespread and are suggested to be represented by Minnow, European Bullhead (*Cottus gobio*), Chub, Three-spined Stickleback (*Gasterosteus actuleatus)*, Common Rudd (*Scardinius erythrophthalmus*) and Nase (*Chondrostoma nasus*). [51] [52] [53]

[51] Douda, K,. Horky, P., Billy, M. (2012) Host limitation of the thick-shelled river mussel: identifying the threats to declining affiliate species. Animal Conservation 15: 536–544

[52] Stoeckl, K., Taeubert, J.E., Geist, J. (2014). Fish species composition and host fish density in streams of the thick-shelledriver mussel (Unio crassus) – Implications for conservation. Aquatic Conservation: Marine and Freshwater Ecosystems: DOI: 10.1002/aqc.2470.

[53] Lamand,F., Roche, K., Beisel, J.N. (2016). Glochidial infestation by the endangered mollusc Unio crassus in rivers of north-eastern France. Aquatic Conservation: Marine and Freshwater Ecosystems 26: 445455.

Taeubert *et al* (2012)[54] investigated the host–parasite interaction of different fish species with TSM under artificial and natural conditions. In natural streams, 16 different fish species were assessed for their suitability at TSM hosts, with pronounced differences observed. Of the species assessed in the study, six have been recorded in the Pambukovica dam Biodiversity Study Area (**Error! Reference source not f ound.**). Minnow and chub were assessed as good hosts, due to their high susceptibility to glochidia, wide distribution and its high abundance. The authors concluded that minnow and chub are the are the most important host for TSM in the Danube drainage, despite the fact that some populations exclusively depend on other hosts. The study concluded that TSM was not able to metamorphose on other species recorded in the Biodiversity Study Area including bleak, bitterling and roach. Spirlin, whilst able to be a host was considered a poor host (**Error! Reference source not found.**). Sustainable conservation management of T SM populations is closely linked to the effective management of their host fish populations. In particular, the currently underestimated ecological functions of low-valued fish species such as chub and minnow.[55]

Proschwitz and Wengstrom (2021)[56] reported on 'possible' and 'functional' TSM host in Sweden, where possible host is defined as a fish which contains encysted glochidia and a functional host is defined as a fish that delivers viable juveniles, as defined as excysted juveniles with foot movement. The result for fish recorded in the Biodiversity Study Area as presented in **Error! Reference source not found.**. The authors c oncluded that minnow and common bleak appeared to be the most important hots fish in Sweden.

Table 50 - Suitability of different fish species from the upper Danube drainage and present within the BSA for hosting *U. crassus* as found in this study and the study of Taeubert *et al.* 2012

Scientific name	Common name	In BSA	Suitability (Taeubert et al 2012)	Suitability (Proschwitz and Wengstrom, 2021)
Alburnoides bipunctatus	Spirlin / Schneider	Yes	Poor host	Not assessed
Alburnus alburnus	Common Bleak	Yes	No host	Functional host
Barbatula barbatula	European Stone Loach	Yes	Not assessed	Potential host
Phoxinus phoxinus	Minnow	Yes	Good host	Functional host
Rhodeus sericeus	Amur Bitterling	Yes[57]	No host	Not assessed
Rutilus rutilus	Roach	Yes	No host	Functional host
Squalius cephalus	Chub	Yes	Good host	Potential host

[54] Taeubert, J.E., Martinez, A.M.P., Guma, B., Geist, J. (2012a) The relationship between endangered thick-shelled river mussel (Unio crassus) and its host fishes. Biological Conservation 155 (2012) 94–103

[55] Taeubert, J.E., Guma, B., Geist, J. (2012b) Host-specificity of the endangered thick-shelled river mussel (Unio crassus Philipsson 1788) and implications for conservation. Aquatic Conservation Marine and Fre Hydrobiologia (2021) 848:2869–2890

[56] Proschwitz. T., Wengstrom, N. (2021) Zoogeography, ecology, and conservation status of the large freshwater mussels in Sweden. Hydrobiologia (2021) 848:2869–2890 https://doi.org/10.1007/s10750-020-04351-6

[57] Common bitterling were recorded in the Biodiversity Study Area.

5.4.12 Habitat (Hydrology and Substrate) and Water Quality Requirements

Once disattached from its host fish, TSM is known to favour areas of stable fine sediment deposits, such as silt and sand, in marginal, still-water areas.[58] They have been considered more silt-tolerant that other endangered mussels, such as the freshwater pearl mussel that are susceptible to clogging of interstitial spaces in sediment beds.[59]

According to Tomovic *et al* (2023),[47] in Serbia the distribution of TSM is observed predominantly in the littoral reaches of large lowland rivers (waterbody Types 1 and 2), where fine substrate predominates (psammal/psammopelal (6 µm–2 mm) and in small to medium watercourses (Type 3), where coarse substrate (mesolithal 6–20 cm and microlithal 2–6 cm) predominates, at elevations of up to 500 m. TSM can be characterised as a rheo- to limnophilous species, preferring habitats with slow to moderate water flow.

As part of a TSM reintroduction (phase 1) in Biala River, Southern Polan, Zajac *et al* (2018) studied the relationships between TSM abundance and physical habitat / water quality, to assess the potential of re-introduction sites. Mussel abundance was correlated negatively with the elevation, slope of channel, organic matter contents, and pH (exceeding 8), but correlated positively with silt presence, water conductivity, and concentration of HC02 (bicarbonate/alkalinity), Ca2 (calcium) and NO3 (nitrate). During the subsequent reintroduction (phase 2) for conservation purposes, adult individuals were introduced into one type of functional habitat, marginal channel sectors with stillwater and fine sediment. Despite the initial very high rate of reproduction in some parts of the upper reach of the river, the juveniles were ultimately recruited only in the lower part of the restored range, resulting in a very rapid change in recruitment at a channel slope of 1.8‰. As for abundance in phase 1 of the study, recruitment was positively related to silt content, conductivity, calcium, alkalinity, and negatively to channel elevation and slope, and water pH.

Hydrology and physical characteristics of aquatic habitat are also considered important factors in TSM population health and conservation. Stöckl and Geist (2016)[60] undertook a study examining hydrological and substrate parameters (including shear stress, flow velocity and penetration resistance of substrate) in relation to mussel presence/absence data in six streams (southern Germany) with recruiting and self-sustaining populations to derive information on the hydrological and substrate habitat requirements of the species. The authors concluded that (**Error! Reference source not found.**):

- Hydrological and substrate characteristics of TSM habitat are broader than expected, contrary to the assumption that the species depends on moderate to high flows (>0.3m/s). Streams with low water flow and soft substrate were also identified as suitable habitats.
- Functional characteristics of the substrate, especially stability and areas with low shear stress, seem to be of great importance for the persistence of the species, and monitoring protocols used at present (2016) for habitat assessment of TSM should be updated accordingly.
- Areas with high mussel densities were characterized by low flow velocities, low mean sediment penetration resistances, as well as by low near-bed shear stress compared with non-colonized sites.

Table 51 - Hydrological requirement of TSM in Southern German streams (Source: Stöckl and Geist, 2016)

	Maximum flow velocities (m/s)	Interpretation
Mean flow (m/s)	0.11 - 0.31	Species is tolerant of a wide range of hydrological conditions.
Maximum flow velocities (m/s)	0.22 - 0.95	Species is tolerant of a wide range of hydrological conditions.

[58] Zając, K., Florek, J., Zając, T., Adamski, P., Bielański, W., Ćmiel, A., Klich, M., Lipińska, A. (2018) On the reintroduction of the endangered thick-shelled river mussel Union crassus: The importance of the river's longitudinal profile. Science of the Total Environment 624 (2018) 273–282.

[59] Österling,M.E., Arvidsson, B.L., Greenberg, L.A. (2010). Habitat degradation and the decline of the threatened mussel Margaritifera margaritifera: influence of turbidity and sedimentation on the mussel and its host. J. Appl. Ecol. 47:759–768.

[60] Stoeckl, K., Geist, J. (2016) Hydrological and substrate requirements of the thick-shelled river mussel Unio crassus (Philipsson 1788) Aquatic Conserv: Mar. Freshw. Ecosyst. 26: 456–469 (2016)

	Maximum flow velocities (m/s)	Interpretation
High mussel densities	Areas with high mussel densities were characterized by low flow velocities (<0.3m/s), low mean penetration resistances (0.36 ±0.52 kg/cm^2) as well as by low near-bed shear stress (1.06± 0.33 x 106 N/cm^2) compared with non-colonized sites.	
Maximum near-bed flow velocity at mussel beds	Maximum near-bed flow velocity at mussel beds was 0.33m/s and 0.35m/s at 60% depth. Higher flows with maximum velocities of 0.52m/s and 0.95m/s at 60% depth were measured at non-colonized sites. Mussel density was significantly negatively correlated with near-bed shear forces.	

5.4.13 Water Quality Requirements

As discussed, TSM is a benthic, filter-feeding animal as so is susceptible to any changes of water chemistry, and subtle differences in water chemistry can influence the occurrence of this species. In general, TSM prefers waters which are not eutrophicated and pollution-free. Historically, 2.0 mg/l of nitrate nitrogen was proposed as a threshold for function TSM stream.[61] However, studies German populations indicate that the species avoids higher NO_3 concentrations, with healthy populations inhabiting waters where nitrate levels are below 10 mg/1. Likewise, studies from the Sallingbach River, nitrate nitrogen concentrations averaged between 4.1and 6.5 mg/l in the study sites suggesting is more tolerant to eutrophic habitat conditions than previously thought. Nitrate values for the River Ub are typically well below this upper nitrate threshold, with 1.8 mg/l being the highest value recorded during the baseline (see **Book 3 – Surface Water**).

5.4.14 TSM Summary

Based on literature review, the TSM recorded in the River Ub catchment have the potential to be any of three (*U. crassus* s. str., *Unio nanus* stat. rev., *Unio vicarious* stat. rev) species in the *Unio crassus* complex. Surveys suggest the species is present in low abundance in the study area, having been confirmed using eDNA techniques, but challenging to locate live specimens during subsequent physical surveys.

Despite the conservation status of TMS, it has been shown to relatively tolerant to a wide range of hydrological and water quality conditions. In Serbia the distribution of TSM is observed predominantly in the littoral reaches of large lowland rivers (waterbody Types 1 and 2), where fine substrate predominates (6 µm–2 mm) and in small to medium watercourses (Type 3), such as the River Ub, where coarse substrate (6–20 cm and 2–6 cm) predominates, at elevations of up to 500 m.

Potential hosts for TSM (present within the Biodiversity Study Area) include: Common Bleak, European Stone Loach, Minnow, Roach and Chub. These species are common and considered relatively tolerant to a wide range of habitat and water quality conditions.

5.5 Crayfish

5.5.1 Survey Methodology

The IUCN desk study screening (**Error! Reference source not found.**) identified the potential for presence o f Noble Crayfish *Astacus astacus* (i.e. the published spatial distribution of this species was within a 20km buffer of the Biodiversity Study Area).

During each site visit that included river sampling, a crayfish survey was also undertaken to confirm the presence or absence of native and/or invasive / non-native crayfish species in the River Ub and its tributaries including the noble crayfish. The survey involved manual searching and/or crayfish trapping, depending on

[61] Denic, M., Stoeckl, K., Gum, B., Geist, J. (2013) Physicochemical assessment of Unio crassus habitat quality in a small upland stream and implications for conservation. Hydrobiologia DOI 10.1007/s10750-013-1467-z

the habitats present. The survey covered the River Ub, both upstream and downstream from the Biodiversity Study Area, as well as its tributaries.

5.5.2 Survey Results

While suitable habitats for crayfish including the Stone Crayfish - *Austropotamobius torrentium,* which are protected in Serbia, are present in the River Ub, especially upstream of the dam, no crayfish specimens were recorded in any surveys. Furthermore, evidence of crayfish (e.g. claws or carcasses) were also not recorded.

5.6 Macrophytes

5.6.1 Survey Methodology

As part of the study, the macrophyte assemblage was determined at each site where electric fishing and aquatic macroinvertebrates was undertaken (**Error! Reference source not found.**), i.e. sample sites that e ncompassed both the upstream section of the river and the downstream area of the reservoir dam. Macrophyte surveys in 2024 were conducted simultaneously with aquatic macroinvertebrate surveys in October.

5.6.2 Data Analysis / Assessment Methodology

Data analysis included screening species recorded during surveys against relevant legislation and red lists outlined in Section 1.3 to determine notable species at a national level and/or according to the EBRD PR6 criteria.

5.6.3 Survey Results

The field research in 2023 revealed the absence of aquatic macrophyte species along the Ub River, except at the UB07 site, where only four species were recorded: Broadleaf Bullrush - *Typha latifolia*, Long-leaf Pondweed - *Potamogeton nodosus*, Brooklime - *Veronica beccabunga*, and Reed Sweet-grass - *Glyceria maxima*. All these species are assessed by the IUCN as Least Concern at a global and European scale. Common Bullrush and Long-leaf Pondweed are protected under Serbian legislation.

Presence of green algae was noted, particularly *Cladophora* sp., at the sampling sites UB03, UB05, and UB07 sites, which plays important role in trophic structure of the Ub River (**Error! Reference source not f ound.**).

Table 52 - Macrophytes and algae recorded in the Biodiversity Study Area

No.	Scientific name	Common name	IUCN Europe	IUCN Global	Habitats and species directive / Bern Convention	Serbian legislation
1.	*Typha latifolia*	Common Bullrush	LC	LC	-	
2.	*Potamogeton nodosus*	Long-leaf Pondweed	LC	LC	-	P
3.	*Veronica beccabunga*	Brooklime	LC	LC	-	
4.	*Glyceria maxima*	Reed Sweet-grass	LC	LC	-	
5.	*Cladophora sp*	Green Algae			-	
6.	*Conium maculatum*	Hemlock			-	
7.	*Rorippa amphibia*	Great Yellow-cress	LC	LC	-	
8.	*Epilobium hirsutum*	Great Willowherb		LC	-	P
9.	*Mentha aquatica*	Water Mint	LC	LC	-	
10.	*Oenanthe aquatica*	Fine-leaved Water-dropwort	LC	LC	-	

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

IUCN Least Concern (LC)

In 2024, macrophyte surveys were conducted at the Ub River sampling sites in October. The field research revealed the absence of aquatic macrophyte species along the Ub River due to various hydrological conditions during the summer of 2024, except at the UB 6.5 site, where only four species were recorded with low abundance: Hemlock (*Conium maculatum*), Great Yellow-cress (*Rorippa amphibia*), Great Willowherb (*Epilobium hirsutum*), and Water Mint (*Mentha aquatica*). At UB 6.25, only three species were found, also with low abundance: Hemlock (*Conium maculatum*), Fine-leaved Water-dropwort (*Oenanthe aquatica*), and Water Mint (*Mentha aquatica*). All species were recorded in the riparian zone of the Ub River and have the Least Concern (LC) IUCN European threat status.

The findings from these surveys indicate that the macrophyte community along the Ub River is relatively sparse, with few species present in comparison to other freshwater ecosystems. The presence of a few species such as *Typha latifolia* and *Potamogeton nodosus* suggests that the river may support some aquatic vegetation, although hydrological conditions during the year and other environmental factors likely limit macrophyte growth in many sections. The presence of green algae, particularly *Cladophora* sp., at certain sites is noteworthy, as these organisms contribute significantly to the river's trophic dynamics. Continued monitoring of macrophyte and algae populations will help to assess the long-term health of the river ecosystem, especially in relation to changes in water quality and hydrological conditions.

5.6.4 Protected or Notable Species / Habitats

No macrophytes and algae species observed in the project area meet the threshold as ‘threatened/priority’ species in accordance with EBRD PR6. However, both Great Willowherb (*Epilobium hirsutum*) and Long-leaf Pondweed (*Potamogeton nodosus*) are protected under Serbian legislation.

5.7 Incidental findings

Incidental findings refer to specimens recorded outside the designated survey or timeframe for that particular survey or on a different transect.

5.7.1 Survey Methodology

Bat detectors were deployed to record ultrasonic calls produced by bats for species identification and activity assessment. These detectors function by capturing high-frequency sounds beyond the human hearing range. However, since bat detectors can also record audible and near-ultrasonic frequencies, the software detected and analysed other sounds, including:

- Mammal vocalizations within the lower frequency range (e.g., rodents and small carnivores).
- Orthopteran (cricket and grasshopper) stridulations, which produce sounds in the overlapping frequency range of bat echolocation.

The post-processing software, originally designed for bat call identification, was able to extract, filter, and classify these additional sounds based on spectral patterns, frequency modulation, and temporal characteristics. This allowed for the incidental identification of non-target species, expanding the dataset beyond bats.

The detected species and the abundance of recorded sounds are presented in **Error! Reference source not found.**. These findings provide valuable supplementary data on site biodiversity, particularly for nocturnal and cryptic species that are otherwise difficult to detect through standard survey methods.

5.7.2 Results

Error! Reference source not found. presents the results of a biodiversity survey conducted in different l ocation. The survey recorded various groups of organisms, such as plants, insects, fish, amphibians, birds,

and mammals. The table also provides information on the scientific and common names of the organisms, their conservation status according to the IUCN Red List, and their inclusion in the EU Habitats and Birds Directives.

Table 53 - Incidental findings

Group	Scientific name	Common name	Location	IUCN Europe	IUCN Global	Habitat and species directive / Bern Convention	Bird directive	Serbian legislation
Plants - terrestrial	*Amorpha fruticosa*	False Indigo	Recorded at more locations	-	-	-	-	
	Anthemis ruthenica			-	-	-	-	
	Ballota nigra	Black Horehound		LC	-	-	-	
	Chelidonium majus	Greater Celandine		LC	-	-	-	
	Cruciata laevipes	Crosswort		-	-	-	-	
	Petasites hybridus	Butterbur		LC	-	-	-	
	Ranunculus repens	Creeping Buttercup		LC	-	-	-	
	Silene latifolia	White Campion			-	-	-	
	Symphytum officinale	Comfrey		LC	-	-	-	
Terrestrial insects	*Carabus clatratus*		UB 01	-	-	-	-	
Mussels	*Unio crassus*	Thick-shelled River Mussel	River Dokmirska (nearby the UB 06 point)	VU	EN	HD AII and I, BC R6	-	SP
Aquatic beetles	*Agabus uliginosus*		River Dokmirska (nearby the UB 06 point)	-	-	-	-	
	Hydroporus planus		River Dokmirska (nearby the UB 06 point)	-	-	-	-	
Fish	*Barbatula barbatula*	Stone Loach	UB 03	LC	LC	-	-	
Riparian mammals	*Neomys fodiens*	Eurasian Water Shrew	UB 04	LC	LC	-	-	SP
	Lyristes plebejus		Recorded at more locations	-	-	-	-	

Group	Scientific name	Common name	Location	IUCN Europe	IUCN Global	Habitat and species directive / Bern Convention	Bird directive	Serbian legislation
Terrestrial insects	*Cicada orni*	Ash Cicada		-	-	-	-	
	Cicadatra atra			-	-	-	-	
	Tettigetta dimissa			-	-	-	-	
	Oecanthus pellucens	Italian Tree Cricket		LC	-	-	-	
	Gryllus campestris	Field Cricket		LC	-	-	-	
	Pteronemobius heydenii	Marsh-cricket		LC	-	-	-	
	Pholidoptera griseoaptera	Dark Bush-cricket		LC	-	-	-	
	Tettigonia viridissima	Great Green Bush-cricket		LC	-	-	-	
	Decticus verrucivorus	Wart-biter		LC	-	-	-	
	Papilio machaon	Swallowtail		LC	-	-	-	SP
	Iphiclides podalirius	Scarce Swallowtail		LC	-	-	-	
	Aglais io	European Peacock Butterfly		-	-	-	-	
	Vanessa atalanta	Red Admiral		LC	LC	-	-	
	Orthetrum cancellatum	Black-tailed Skimmer		LC	LC	-	-	
	Sympetrum striolatum	Common Darter		LC	LC	-	-	
	Calopteryx splendens	Banded Demoiselle		LC	-	-	-	
	Calopteryx virgo	Beautiful Demoiselle		LC	LC	-	-	
	Coenagrion puella	Azure Damselfly		-	LC	-	-	

Group	Scientific name	Common name	Location	IUCN Europe	IUCN Global	Habitat and species directive / Bern Convention	Bird directive	Serbian legislation
	Ischnura elegans	Blue-tailed Damselfly		-	LC	-	-	
Amphibians	*Salamandra salamandra*	Fire Salamander	Babinac 2	-	VU		-	
Birds	*Egretta garzetta*	Little Egret	UB07	LC	LC	BC	AI	SP
	Motacilla cinerea	Grey Wagtail	UB05	LC	LC	-	-	SP
	Saxicola rubicola	Stonechat	UB07	LC	-	-	-	
	Emberiza cirlus	Cirl Bunting	UB02	LC	LC	-	-	SP
	Miliaria calandra	Corn Bunting	UB05	LC	LC	-	-	SP
Large mammals	*Canis aureus*	Golden Jackal	UB05	LC	LC	-	-	P
	Vulpes vulpes	Red Fox	Raduša	LC	LC	-	-	P
	Capreolus capreolus	Roe Deer	Gola Glava	LC	LC	-	-	P
	Lepus europaeus	European Hare	Joševa, Dokmir	LC	LC	-	-	P

IUCN Vulnerable (VU), Least Concern (LC), Near Threatened (NT), Data Deficient (DD)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia

Table 54 - Incidental findings by bat detectors

Group	Scientific name	Common name	Location	IUCN Europe	IUCN Global	Habitat and species directive / Bern Convention	Serbian legislation
Mammals	*Crocidura suaveolens*	Lesser White-toothed Shrew		LC	LC	-	P
	Dryomys nitedula	Forest Dormouse		LC	LC	-	SP
	Muscardinus avellanarius	Hazel Dormouse		LC	LC	-	SP
	Rattus norvegicus	Brown Rat		NA	LC	-	
	Sorex minutus	Eurasian Pygmy Shrew		LC	LC	-	P

IUCN Vulnerable (VU), Least Concern (LC), Near Threatened (NT), Data Deficient (DD), Not Applicable (NA)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia

6. Stakeholder Engagement During Data Collection

There are no natural protected sites in the immediate vicinity of the areas designated for the construction of a dam reservoir and irrigation system. The closest Key Biodiversity Areas are Cer Mountain (33 km), Obedska bara (20 km), gorge of the River Gradac (17 km), and Valjevske mountains (20 km). These areas are governed by the government. Hunting and fishing in the site area are established under the general regulation on the establishment of hunting areas on the territory of the Republic of Serbia.

The closest hunting association is “Tamnava” from Koceljevo, which manages the hunting ground “Vlašić” ,5 km from project site, with a total area of 25,742 hectares, of which 22,256 hectares are hunting areas. The association has 417 active members. The hunting species that are constantly bred in the “Vlašić” hunting ground are roe deer, hare, pheasant, and grey partridge. The hunting grounds have 31 stable checks, 125 tree checks, 30 roe deer feeders, 150 pheasant and field partridge feeders, and 30 salt marshes. The association owns a hunting lodge with a usable area of 279 m² and 0.80 hectares of land. The professional service has a manager of the hunting grounds - an expert and a game warden. The hunting association in the Šabacka Kamenica section has been successfully organizing the hunting event, “Kamenička lija,” for more than a decade, which is a popular hunting tourist event in this area.

The fishing area “Kolubara” (Figure 23) encompasses the fishing waters of the rivers Drina, Kolubara, Jablanica, Ljig, Ribnica, Turija, Peštan, and all other tributaries of the mentioned rivers, as well as other natural or artificial fishing waters within the boundaries of the fishing area, except for fishing waters within the boundaries of protected areas. The northern border of the fishing area goes along the western administrative border of the town of Valjevo to the river Ub. The border continues along the right bank of the river Ub to the administrative border with the municipality of Ub and further to the northeastern administrative border of the town of Valjevo. The fishing area “Kolubara” is used for recreational fishing. During the surveys, locals were interviewed and their recollections and claims regarding habitat were recorded.

A local farmers shared a story, during the surveys, about a commercial fishpond, now drained and changed its used to arable land, covering an area of 200 hectares. The former fishpond was located in the vicinity of the River Ub, downstream of the proposed dam (N 44.421322, E 19.804483) and was sourced via a weir located on the River Ub (see fish habitat results Sectio 5.1.2). In the past, the pond was used to breed yprinid fish. However, the area is now mostly agricultural land, with corn and cereals being the primary crops. According to his account, crayfish were once present in the River Ub, but they have not been observed for several years. Similarly, salmonid fish were also present in the past, but not anymore. Over the last several years, the Ub river in upper part has almost completely dried out during the summer, likely affecting aquatic species.

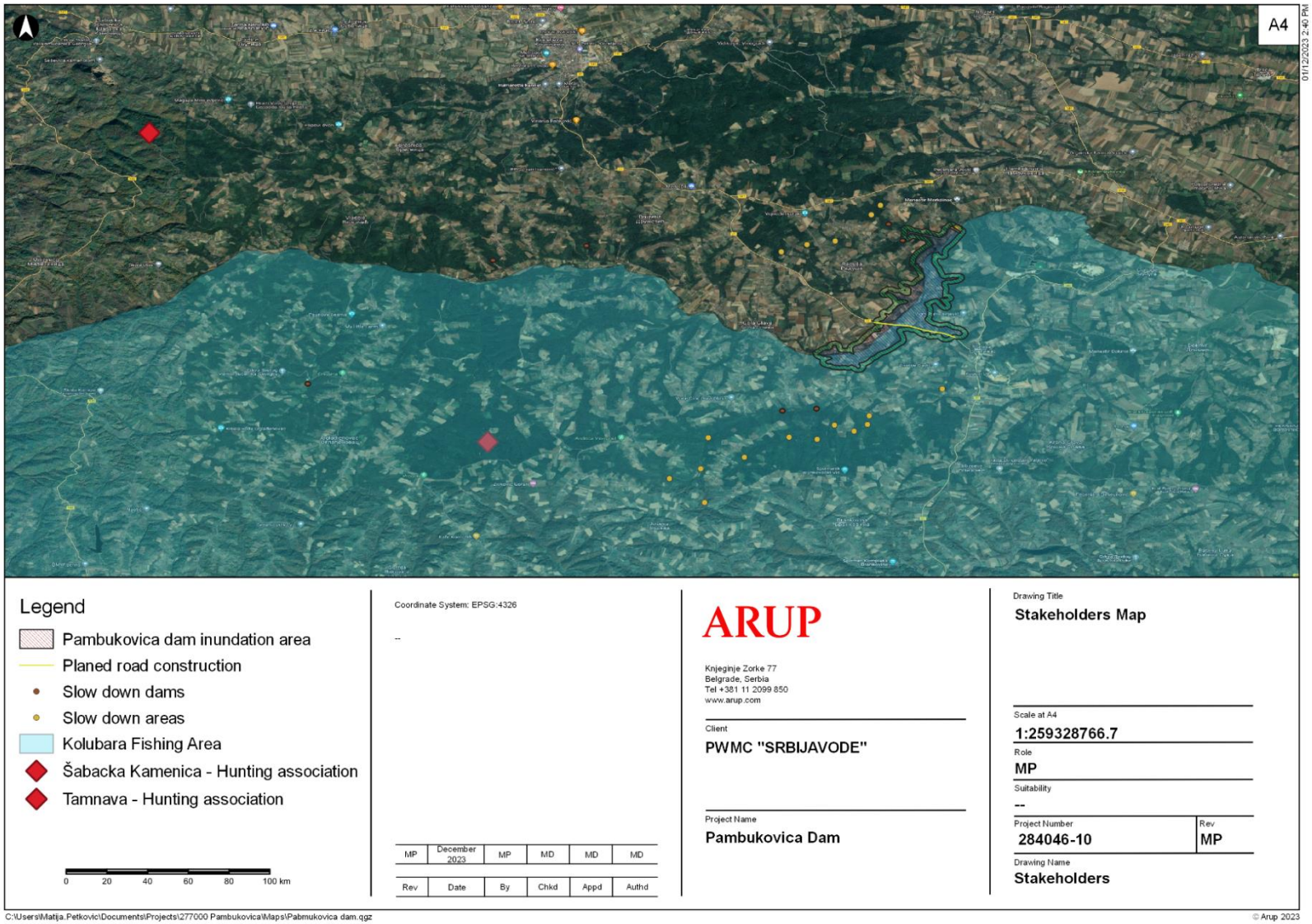


Figure 23 - Stakeholders map

After conducting a survey, it was found that no agricultural, ecological, or similar associations operate in the project area.

Based on the information provided above, it was found that no stakeholders are directly connected or engaged in the project area.

Table 55 - Stakeholder engagement overview

Stakeholder Group	Description	Engagement Level	Contact Success	Collected Information
Hunting Associations	Tamnava" from Koceljevo	Low	Unsuccessful	-
	Hunting association in the Sabacka Kamenica section	Low	Unsuccessful	-
Recreational Fishermen	Local fishermen engaging in recreational fishing	Moderate	Successful	Views and opinions on potential impacts
Local Farmers	Farmers in the project area	High	Successful	Claims and recollections regarding habitat
Water Management Representatives	Representatives of river users (handlers) and rangers present during aquatic survey and electrofishing	High	Successful	Insights into current and historical river use and ecological conditions

7. Critical Habitat (and PBF) Assessment

7.1 Methodology

A key objective of the baseline surveys and desk study literature review was to gather biodiversity information to help identify PBF and/or CH as defined by EBRD. Based on information gathered during the biodiversity baseline, a CHA is undertaken to identify areas of high biodiversity value, which would be sensitive to the Pambukovica Dam Project. The purpose of this step is to determine if any features in the study area qualify as PBF or CH), following EBRD's definitions/criteria (**Error! Reference source not found.**). These features will require attention during the Biodiversity Impact Assessment and mitigation planning, which will form a key part of Project's ESIA. Note, that as per guidance, this is an assessment of the context in which the development is proposed and therefore does not consider specific impacts at this stage of analysis. It supplements the definition of the ecological baseline and answers the basic question, "*how important is the study area for conservation and what PR6 requirements will apply*?".

For a planned development with the potential to generate significant negative impacts on a PFB or CH, a mitigation plan will be required that achieves *no net loss* or a *net gain* of those features in the Project area and its zone of influence.

The methodology for assessment follows the EBRD's Performance Requirement (PR) 6: *Biodiversity Conservation and Sustainable Management of Living Natural Resources* PR6, which is underpinned by Guidance Note 6: *Biodiversity Conservation and Sustainable Management of Living Natural Resources.* [62] This document provides a set of criteria and conditions for identifying PBF and CH, as summarized in **Error! Reference source not found.** below.

Table 56 - Criteria and conditions for identifying priority biodiversity features and critical habitats

Criterion	Priority Biodiversity Feature	Critical Habitat
1. Priority ecosystems		
Threatened ecosystems (a) Habitats listed in Annex 1 of EU Habitats Directive or Resolution 4 of Bern Convention (signatory nations only) (b) IUCN Red-List EN or CR ecosystems	(PR6 para. 12-i) (a) EAAA is habitat type listed in Annex 1 of EU Habitats Directive r Resolution 4 of Bern Convention (b) EAAA[63] < 5% of the global extent of an ecosystem type with IUCN status of CR or EN	(PR6 para. 14-i) (a) EAAA is habitat type listed in Annex 1 of EU Habitats Directive marked as "priority habitat type" (b) EAAA ⩾5% of global extent of an ecosystem type with IUCN status of CR or EN (c) EAAA is ecosystem determined to be of high priority for conservation by national systematic conservation planning
2. Priority species & habitats		
Threatened species (a) Species and their habitats listed in EU Habitats Directive and Birds Directive / Bern Convention (b) IUCN Red List EN or CR species (c) IUCN Red List VU species	(PR6 para. 12-ii) (a) EAAA for species and their habitats listed in Annex II of Habitats Directive, Annex I of Birds Directive, Resolution 6 of Bern Convention	(PR6 para. 14-ii) (a) EAAA for species and their habitats listed in Annex IV of the Habitats Directive (b) EAAA supports ⩾ 0.5% of the global population AND ⩾ 5 reproductive units of a CR or EN species

[62] EBRD (2020) Guidance Note for Performance Requirement 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.

[63] *EAAA = ecologically appropriate area of analysis. See section 7.1.2*

(d) Nationally or regionally (e.g., Europe) listed EN or CR species	(b) EAAA supports < 0.5% of global population OR < 5 reproductive units of a CR or EN species. (c) EAAA supports VU species (d) EAAA for regularly occurring nationally or regionally listed EN or CR species	(c) EAAA supports globally significant population of VU species necessary to prevent a change of IUCN Red List status to EN or CR, and satisfies threshold (b) (d) EAAA for important concentrations of a nationally or regionally listed EN or CR species
Range-restricted species[64]	(PR6 para. 12-ii) (a) EAAA for regularly occurring range-restricted species	(PR6 para. 14-iii) (a) EAAA regularly holds ⩾ 10% of global population AND ⩾ 10 reproductive units of the species[65]
Migratory and congregator species	(PR6 para. 12-ii) (a) EAAA identified per Birds Directive or recognized national or international process as important for migratory birds (esp. Wetlands)	(PR6 para. 14-iv) (a) EAAA sustains, on a cyclical or otherwise regular basis, ⩾ 1 percent of the global population at any point of the species' lifecycle (b) EAAA predictably supports ⩾10 percent of global population during periods of environmental stress

**Quantitative thresholds derived from IUCN Key Biodiversity Area Standard and aligned with International Finance Corporation's (IFC) Guidance Note 6 (rev. 2019)*

An initial CH and PBF Screening was undertaken using the baseline data collected, a review of IUCN Red List data and a literature review. The screening was undertaken in accordance with PR6 Guidance Note 6.

The IUCN Red List of Threatened Species was interrogated (along with additional literature where appropriate) to assess the potential for priority species to be present within 20km of the study area. Species listed as CR, EN and VU on the IUCN Red list were initially screened. Where the known extent (the geographic range) of the species of CR, EN or VU species was identified within 20km of the survey area, these species were included in the screening. VU species identified to be potentially present within 20 km of the study area but with a geographic range that didn't overlap with the study area were not considered further.

In addition to the global and European sources outline in **Error! Reference source not found.** (i.e. IUCN, E U Habitats Directive, EU Birds Directive and the Bern Convention), species recorded were screened against the following national red lists:

- Red Book of Flora of Serbia (1999)
- Red Book of Diurnal Butterflies of Serbia – Lepidoptera: Hesperioidea and Papilionoidea (2003)
- Red Book of Fauna I – Amphibians (2015)
- Red Book of Fauna II – Reptiles (2015).

[64] *For terrestrial vertebrates and plants, restricted-range species are defined as those species that have an extent of occurrence (EOO) less than 50,000 square kilometers (km2). For marine systems, restricted-range species are provisionally being considered those with an EOO of less than 100,000 km2. For coastal, riverine, and other aquatic species in habitats that do not exceed 200 km width at any point (for example, rivers), restricted range is defined as having a global range of less than or equal to 500 km linear geographic span (i.e., the distance between occupied locations furthest apart).*

[65] *The IUCN Key Biodiversity Areas standard cites the following definition for reproductive unit: "the minimum number and combination of mature individuals necessary to trigger a successful reproductive event at a site. Examples of five reproductive units include five pairs, five reproducing females in one harem, and five reproductive individuals of a plant species." Eisenberg, 1977. The Evolution of the Reproductive Unit in the Class Mammalia.*

- Red Book of Fauna of Serbia III – Birds (2018)
- Red Book of Fauna IV – Orthopterans (2018)

Relevant scientific papers were also consulted, some of which were provided by the local biodiversity specialists.

7.1.1 Screening

An initial CH and PBF Screening was undertaken using the baseline data collected, a review of IUCN Red List data and a literature review. The screening was undertaken in accordance with PR6 Guidance Note 6.

The IUCN Red List of Threatened Species was interrogated (along with additional literature where appropriate) to assess the potential for priority species to be present within 20km of the study area. Species listed as CR, EN and VU on the IUCN Red list were initially screened. Where the known extent (the geographic range) of the species of CR, EN or VU species was identified within 20km of the survey area, these species were included in the screening. VU species identified to be potentially present within 20 km of the study area but with a geographic range that didn't overlap with the study area were not considered further (**Error! Reference source not found.**).

7.1.2 Ecologically Appropriate Area of Analysis (EAAA)

For the purposes of this assessment aggregate EAAA's were produced (Figure 24); one specific to Birds and Bats, a second for Amphibians and Reptiles and a third for freshwater ecology.

The spatial extent of the EAAA's was defined based on a) the likely landscape-scale distribution of the ecological features (i.e. the likely local migrations birds / bats /mammals) and b) terrain and ecological context (i.e. the EAAA boundary excludes the Danube to the north and the more mountainous areas to the south and east, as these represent different ecosystems and associated flora/fauna).

For the purposes of this assessment the freshwater ecology EAAA includes the River Ub and its tributaries within the proposed reservoir area; and the River Ub for ~7km upstream and ~11km downstream of the proposed reservoir.

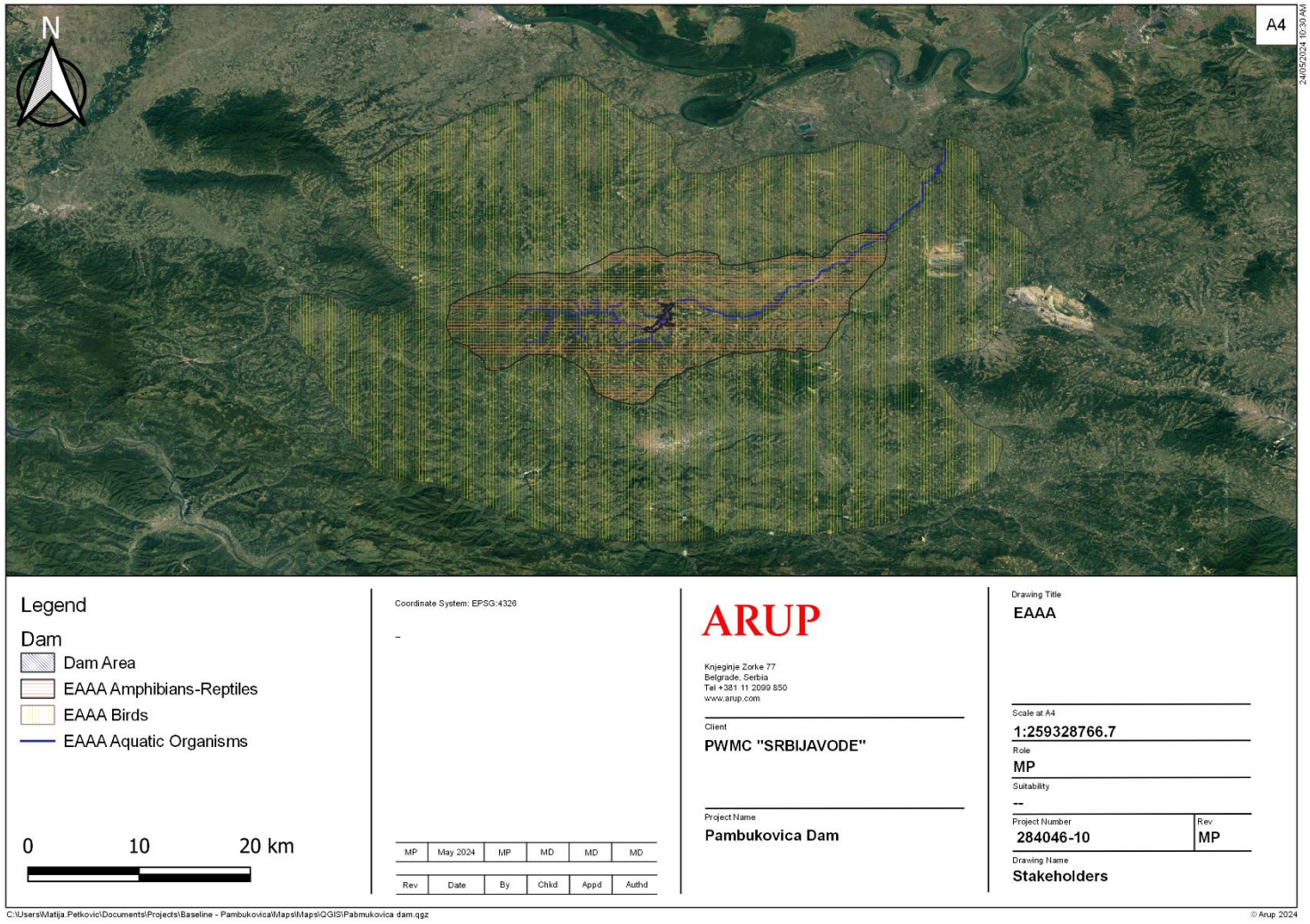


Figure 24 - Ecologically Appropriate Area of Analysis (EAAA)

7.2 CHA Results

7.2.1 Protected Areas

The Project footprint or EAAA does not overlap any protected areas or internationally recognised areas. There are no Legally Protected or Internationally Recognised Areas of Biodiversity Value (as defined by EBRD) in the vicinity of the proposed Project area. Figure 5 - Protected areas and their position regarding the Pambukovica dam shows the Protected Areas surrounding the Pambukovica Dam.

The closest legally protected areas to the Project site are:

- Obedska Bara (Swamp) Nature Reserve and Candidate Emerald Site (CES) – this site is located 19 km north of the Project area and is associated with the River Danube. The site is not hydrologically linked to the Project area as this section of the Danube is located upstream of the confluence where the Ub-Tamnava-Sava catchment enters the Danube.
- Klisura Reke Gradac (Gradac River Gorge) CES, located 18 km south of the Project area and within a different catchment to that of the Project area (Ub-Tamnava-Sava) so is not hydrologically linked.

The Project area is not considered to have significant ecological / functional linkage to any Legally Protected or Internationally Recognised Areas of Biodiversity Value (as defined by EBRD) in the vicinity of the proposed Project area. Based on current project design and mitigation measures, no adverse effects on these areas, or the species for which they are designated, are anticipated.

7.2.2 Criterion 1: Priority ecosystems

Habitat mapping has revealed a mosaic of arable land, modified habitats, and patches of natural and semi-natural habitats within the EAAA (**Error! Reference source not found.**).

Three of the habitat types recorded conform to those listed in Resolution 4 of Bern Convention. None qualify as habitats listed on Annex 1 of EU Habitats Directive or as IUCN Red-List EN or CR ecosystems (**Error! Reference source not found.**). Therefore, PBF is triggered under criterion 1 ‘priority ecosystems’ for Balkan riverine willow scrub (F9.123), *Fagetum moesiace submontanum typicum* woodland (G1.69) and *Quercetum frainetto-cerris* woodland (G1.76811). This does not mean that the other habitats present in **Error! Reference source not found.** are not PBF and/or CH, as this could be triggered based on the individual species, or the assemblage of species, that the habitat supports (see Section 7.2.3).

Table 57 - Total coverage of habitat types recorded within the inundation area with 200m buffer zone

Code	EUNIS Habitat	Area (Hectares)	HD Annex I / CH in survey area	BC R4 / PBF in inundation area with buffer
J4	Transport networks and other constructed hard-surfaced areas	2.94	-	-
J2	Low density buildings	1.82	-	-
I1	Arable land and market gardens	187.143	-	-
E2	Mesic grasslands	17.578	-	-
E7	Sparsely wooded grasslands	21.91	-	-
F9.123	Balkan riverine willow scrub	1.86	-	Yes
G1.69	*Fagetum moesiace submontanum typicum* woodland	29.16	-	Yes
G1.76811	*Quercetum frainetto-cerris* woodland	67.14	-	Yes
G1.C3	*Robinia pseudoacacia* woodland	23.99	-	-
G1.1	Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba*	22.68	-	-

G5	Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. italica*.	9.55	-	-
C3	Littoral zone of inland surface waterbodies	1.8	-	-
C2; C2.31 C3.55	Surface running water comprising Epipotamal streams, Sparsely vegetated river gravel banks	5.07	-	-

7.2.3 Criterion 2: Priority species and their habitats

A IUCN screening indicated the potential presence of 33 ‘threatened/priority species’ as defined by EBRD criteria (EBRD GN6), i.e. species defined as CR, EN or VU according to IUCN within a 20 km buffer of the Biodiversity Study Area (See chapter 2.2). However, the presence of only one species identified during the IUCN screening was confirmed, European turtle dove *Streptopelia turtur*.

Baseline surveys (Arup, 2024) have confirmed the presence of 58 breeding/wandering/migratory bird species, 34 wintering bird species, 25 bat species, 7 reptile species, 8 amphibian species, 86 terrestrial invertebrate species, 57 taxa of aquatic invertebrates, 16 fish species, 35 plant species and 12 riparian and other mammal species. Habitat mapping has revealed a mosaic of arable land, modified habitats, and patches of natural and semi-natural habitats within the project area.

The results have been screened against the International Union for Conservation of Nature’s (IUCN) Red List categories of CR, EN, or VU, Annex II and IV of the Habitats Directive, Annex I of the Birds Directive, Resolution 6 of the Bern Convention, any Serbian Red List, and against Serbian lists for "Strictly Protected" and "Protected" species. Of the species recorded, a number meet the criteria for 'threatened/priority' species (as defined by EBRD PR6) and were taken forward to be assessed in the CHA. Priority species recorded are as follows:

- Birds (4): Middle Spotted Woodpecker *Dendrocoptes medius,* Little Egret *Egretta garzetta,* Red-backed Shrike *Lanius collurio,* Grey-headed Woodpecker *Picus canus* and European Turtle Dove *Streptopelia turtur*. Based on the data available to date, Turtle Dove, Grey-headed Woodpecker and Red-backed Shrike are known to breed in the project area.
- Bats (25): all species of bat recorded are considered as ‘priority species’ according to EBRD guidance.
- Reptiles (5): Common Wall Lizard *Podarcis muralis,* European Green Lizard *Lacerta viridis*, Sand Lizard *Lacerta agilis*, Aesculapian Snake *Zamenis longissimus,* Dice Snake *Natrix tessellata*.
- Amphibians (5): Yellow-beilled Toad *Bombina variegate*, European Green Toad *Pseudepidalea viridis*, Common Spadefoot Toad *Pelobates fuscus*, Greek Stream Frog *Rana graeca* and Fire Salamander *Salamandra salamandra.*
- Fish (2): Balkan Loach *Cobitis elongata* and Spined Loach *Cobitis taenia*
- Aquatic invertebrates (4): dragonflies *Aeshna viridis, Ophiogomphus cecilia* and *Stylurus flavipes*, and the Thick-shelled Mussel *Unio crassus.*

These species are assessed against the EBRD criteria with respect to triggering PBF and/or CH in **Error! R eference source not found.**.

Table 58 - Critical Habitat (and Priority Biodiversity Feature) Assessment – Criterion 2

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
Birds													
Dendrocoptes medius (Middle Spotted Woodpecker)	LC	LC	-	BD AI, BC R6	✓						This species is listed on Annex I of the Birds Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species was recorded on three occasions during surveys within woodland. The species is restricted to mature deciduous forest and prefers mixed oak (*Quercus*), on which it depends in large parts of its range, and hornbeam (*Carpinus*) in primeval forest. Old open orchards bordering deciduous woodland are also used, but are of dwindling importance. In the south it occupies beech, mixed oak-beech and oak forest and beech forest in north-east Anatolia and the Caucasus. Breeding begins from mid-April to the beginning of May. The species is non-migratory.[66] Woodland habitat with the EAAA is considered to represent PBF for this species.	-	Yes
Egretta garzetta (Little Egret)	LC	LC	SP	BD AI, BC R6	✓						This species is listed on Annex I of the Birds Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species of small heron was noted on a single occasion as an incidental survey finding (i.e. not during bird specific surveys) during aquatic ecology surveys at River Ub Site 7. It inhabits fresh, brackish or saline wetlands and shows a preference for shallow waters (10-15 cm deep) in open, unvegetated sites where water levels and dissolved oxygen levels fluctuate daily, tidally or seasonally, and where fish are concentrated in pools or at the water's surface.[67] Habitats frequented include the margins of shallow lakes, rivers, streams and pools, open swamps and marshes, flooded meadows, flood-plains, lagoons, irrigation canals, aquaculture ponds	-	Yes

[66] BirdLife International. 2018. *Leiopicus medius. The IUCN Red List of Threatened Species 2018*: e.T22681114A132055069. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22681114A132055069.en.

[67] BirdLife International. 2016. Egretta garzetta. The IUCN Red List of Threatened Species 2016: e.T62774969A86473701. https://dx.doi.org/10.2305/IUCN.UK.2016-3.RLTS.T62774969A86473701.en.

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											saltpans and rice fields. The species is a highly opportunistic feeder, taking mainly small fish, aquatic and terrestrial insects and crustaceans, as well as amphibians, molluscs. Aquatic and riparian edge habitats with the EAAA are considered to represent PBF for this species.		
Lanius collurio (Red-backed Shrike)	LC	LC	SP	BD AI, BC R6	✓						This species is listed on Annex I of the Birds Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species was recorded in all surveys using scrub. High-quality habitats for this species tend to feature mosaic-like grassy vegetation with alternating areas of tall and short growth and bare areas, with perches. In agricultural areas this species occupies neglected overgrown patches, heaths, open downs, overgrown orchards and gardens, hedgerows, and scrub along railways or roadsides. It is found also in temporary steppe-like habitats, such as military training areas, burned forests, forest clearings and spruce (*Picea*) plantations. It is an opportunistic feeder, feeding mostly on insects and other invertebrates as well as small mammals, birds, amphibians and reptiles.[68] The species is migratory, wintering in eastern and southern Africa[69] and is considered likely to be breeding in the EAAA. Suitable habitat within the EAAA is therefore considered to represent PBF for this species.	-	Yes
Picus canus (Grey-headed Woodpecker)	LC	LC	SP	BD AI, BC R6	✓						This species is listed on Annex I of the Birds Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species was recorded on two occasions during surveys within woodland. This species occupies a wide range of habitats, using open country with many copses, in not over-dense forest, floodplain-forest, parks, orchards and gardens. It is associated	-	Yes

[68] BirdLife International. 2017. Lanius collurio (amended version of 2016 assessment). The IUCN Red List of Threatened Species 2017: e.T22705001A110988087. https://dx.doi.org/10.2305/IUCN.UK.2017-1.RLTS.T22705001A110988087.en. Accessed on 27 March 2024.

[69] Lefranc, N.; Worfolk, T. 1997. Shrikes: a guide to the shrikes of the world. Pica Press, Mountfield, U.K.

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											mostly with deciduous trees, but locally in pine-oak (*Pinus-Quercus*) woodland, or more open coniferous montane forest with larch (*Larix*). In Europe it is found in lowlands and hills up to 1,700 m and non-breeders up to 2,000 m.[70] The species is non-migratory although some local post-breeding movements occur.[71] Woodland habitat with the EAAA is considered to represent PBF for this species.		
Streptopelia turtur (European Turtle Dove)	VU	VU	P				✓				This species is assessed as Vulnerable by IUCN at a global and European scale and is assessed under criterion 2c for PBF and 2c for CH. This species was recorded on three occasions during surveys within woodland and scrub. The species breeds from western Europe through central Asia to south-central Siberia and northern China. The species uses hedges, borders of forest, groves, spinneys, coppices, young tree plantations, scrubby wasteland, woody marshes, scrub and garrigue, all with agricultural areas nearby for feeding. It uses a wide variety of woodland types. It tolerates humans but does not breed close to towns or villages. It breeds at low altitudes not exceeding 500 m in the temperate zone and up to 1,000-1,300 m in Mediterranean areas.[72] It mainly feeds on the ground taking seeds and fruits of weeds and cereals, but also berries, fungi and invertebrates. It is strongly migratory, wintering south of the Sahara from Senegal east to Eritrea and Ethiopia.[73] When assessed under criterion 2c due to its VU status, there is no reason to believe that the EAAA supports a globally significant population (⩾ 0.5% of the global population AND ⩾ 5	-	Yes

[70] BirdLife International. 2021. Picus canus (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T22726503A166432665. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22726503A166432665.en.

[71] Winkler, H. and Christie, D.A. 2015. Grey-faced Woodpecker (Picus canus). In: del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. and de Juana, E. (eds), Handbook of the Birds of the World Alive, Lynx Edicions, Barcelona.

[72] BirdLife International. 2021. Streptopelia turtur (Europe assessment). The IUCN Red List of Threatened Species 2021: e.T22690419A166232970. https://dx.doi.org/10.2305/IUCN.UK.2021-3.RLTS.T22690419A166232970.en.

[73] Tucker, G.M. and Heath, M.F. 1994. Birds in Europe: their conservation status. BirdLife International, Cambridge, U.K.

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											reproductive units) and therefore it does not qualify as CH for this species. However, suitable habitat within the EAAA is considered to represent PBF for this species under criterion 2c.3		
Bats[74]													
Common Serotine (*Eptesicus serotinus*)	LC	LC	SP LC	HD AIV	✓						All species of bats are listed on Annex IV of the Habitat Directive (as *Microchiroptera all species*) and are assessed under criterion 2a for PBF and CH. The presence of 17 species has been confirmed during surveys (see column 1) in a variety of habitats, commuting, foraging and potentially roosting throughout the River Ub corridor, woodlands, grasslands and neighbouring arable land parcels. Further insight from survey results is provided below.	Yes	-
Savi's Pipistrelle (*Hypsugo savii*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Alcathoe Bat (*Myotis alcathoe*)	DD	DD	DD	HD AIV	✓							Yes	-
Brandt's Bat (*Myotis brandtii*)	LC	LC	SP DD	HD AIV	✓							Yes	-
Daubenton's Bat (*Myotis daubentonii*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Whiskered Bat (*Myotis mystacinus*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Natterer's Bat (*Myotis nattereri*)	LC	LC	SP NT	HD AIV	✓							Yes	-
Leisler's Bat (*Nyctalus leisleri*)	LC	LC	SP LC	HD AIV	✓							Yes	-

[74] Ministry of Environment and Spatial Planning Republic of Serbia (2007) National report on the implementation of the agreement on the conservation of bats Europe, www.eurobats.org

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
Common Noctule (*Nyctalus noctula*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Kuhl's Pipistrelle (*Pipistrellus kuhlii*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Nathusius' Pipistrelle (Pipistrellus nathusii)	LC	LC	SP LC	HD AIV	✓							Yes	-
Common Pipistrelle (*Pipistrellus pipistrellus*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Soprano Pipistrelle (*Pipistrellus pygmaeus*)	LC	LC	SP DD	HD AIV	✓							Yes	-
Brown Long-eared Bat (*Plecotus auritus*)	LC	LC	SP NT	HD AIV	✓							Yes	-
Grey Long-eared bat (*Plecotus austriacus*)	LC	LC	SP LC	HD AIV	✓							Yes	-
European Free-tailed Bat (*Tadarida teniotis*)	LC	LC	SP DD	HD AIV	✓							Yes	-

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
Parti-coloured Bat (*Vespertilio murinus*)	LC	LC	SP LC	HD AIV	✓							Yes	-
Western Barbastelle Bat (*Barbastella barbastellus*)	NT	VU	SP VU	HD AII AIV, BC R6	✓		✓				These individual species of bat are listed on Annex II and Annex IV of the Habitats Directive. They are also assessed as Near Threatened (global) and VU (Europe) by IUCN. These species are therefore assessed under criterion 2a and 2c for PBF and CH. The further presence of an additional eight species has been confirmed during surveys (see column 1) in a variety of habitats, commuting, foraging and potentially roosting throughout the River Ub corridor, woodlands, grasslands and neighbouring arable land parcels. Field survey results have shown that the findings from the automated detector surveys align with the activity transect surveys, reinforcing the conclusions drawn about bat activity in the study area. Bat activity was highest at locations near the River Ub riparian corridor and lower at woodland sites further from the river. The highest bat activity was recorded at the road crossing, particularly among pipistrelle species, likely due to the presence of an underpass facilitating safe movement and commuting. The north of site exhibited the greatest species diversity, emphasizing its ecological importance, while the young eastern woodland recorded the lowest bat activity, suggesting less favorable habitat conditions in this area. These findings underscore the critical role of riparian corridors and man-made structural features in supporting diverse and abundant bat populations.	Yes	-
Schreiber's Bent-wing Bat *(Miniopterus schreibersii)*	NT	NT	SP LC	HD AII AIV, BC R6	✓							Yes	-
Bechstein's Bat (*Myotis bechsteinii*)	NT	VU	SP NT	HD AII AIV, BC R6	✓		✓					Yes	-
Long-fingered Bat (*Myotis capaccinii*)	VU	VU	SP LC	HD AII AIV, BC R6	✓		✓					Yes	-
Geoffroy's Bat (*Myotis emarginatus*)	LC	LC	SP NT	HD AII AIV, BC R6	✓							Yes	-
Mediterranean Horseshoe Bat (*Rhinolophus euryale*)	NT	VU	SP NT	HD AII AIV, BC R6	✓		✓					Yes	-
Greater Horseshoe Bat (*Rhinolophus ferrumequinum*)	LC	LC	SP LC	HD AII AIV, BC R6	✓							Yes	-

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
Lesser Horseshoe Bat (*Rhinolophus hipposideros*)	LC	LC	SP NT	HD AII AIV, BC R6	✓							Yes	-
Reptiles													
Podarcis muralis (Common Wall Lizard)	LC	LC	-	HD AIV	✓						Five species of reptiles recorded during the field surveys that are listed on Annex IV of the Habitats Directive (column 1) are assessed under criterion 2a for CH and PBF. Areas within the EAAA provide a significant matrix of suitable habitats including arable margins, woodlands and aquatic marginal habitats. Due to the presence of these reptile species, recorded in suitable habitat during the field surveys, optimal habitats within the EAAA is considered to represent CH for these species.	Yes	-
Lacerta viridis (European Green Lizard)	LC	LC	-	HD AIV	✓								
Lacerta agilis (Sand Lizard)	LC	LC	-	HD AIV	✓								
Natrix tessellata (Dice Snake)	LC	LC	SP	HD AIV	✓					`			
Zamenis longissimus (Aesculapian Snake)	LC	LC	SP	HD AIV	✓								
Amphibians													
Bombina variegata (Yellow-beilled Toad)	LC	-	SP	HD AII, AIV	✓						Of the recorded amphibians, two mentioned here are listed in Annex II and IV of the Habitat Directives. River and riparian habitats are considered their primary habitats, while recordings on arable land and road networks were only outside the dry period of the year.	Yes	-
Pelobates fuscus	LC		SP	HD AIV	✓								

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
(Common Spadefoot Toad)											Areas within the EAAA provide a significant matrix of suitable habitats including arable margins, woodlands and aquatic marginal habitats. Due to the presence of these amphibian species, recorded in suitable habitat during the field surveys, optimal habitats within the EAAA is considered to represent CH for these species Further assessment of the survey data with local specialists will be undertaken during preparation of the ESIA to determine which habitat types tigger CH for these species of amphibian.		
Rana graeca Greek Stream Frog	LC	LC	SP	HD IV	✓								
Salamandra salamandra Fire Salamander	VU	LC			✓						This species is assessed as VU by IUCN at a global and European scale and is assessed under criterion 2c for PBF and 2c for CH. This species is associated with wet cool deciduous, mixed, or rarely, coniferous forests with well shaded brooks and small rivers. Within the mountain forest belt, the species can be found in woodlands, glades and forest edges, rocky slopes, dense bush, and herbaceous vegetation. The species prefers microhabitats covered with dense leaf-litter and moss. It does tolerate some habitat modification, and has even been found in gardens. When assessed under criterion 2c due to its VU status CH is not triggered, there is no reason to believe that the EAAA supports a globally significant population (⩾ 0.5% of the global population AND ⩾ 5 reproductive units) and therefore it does not qualify as CH for this species. However, suitable habitat within the EAAA is considered to represent PBF for this species under criterion 2c.	-	Yes
Fish													
Cobitis elongata Balkan Loach	LC		SP	HD AII, BC R6	✓				✓		This species is listed on Annex II of the Habitats Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species also endemic to the Balkans and so is assessed under criterion 2r for PBF and CH. This species was recorded during electric fishing surveys of the River Ub, within the EAAA at site UB9 and UB12. This species inhabits moderate to fast-flowing stretches of shallow rivers. On	-	Yes

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											sandy banks and shores, sometimes on rock bottom with submerged vegetation. The species is not known to enter small streams, large rivers or river stretches without current.[75] With respect to 2r, the IUCN published estimated extent of occurrence is 291270 km^2 and whilst restricted to the Balkans (Bosnia and Herzegovina; Bulgaria; Croatia; Montenegro; North Macedonia; Romania; Serbia; Slovenia) its global range is greater than 500 km linear geographic span (i.e. the distance between occupied location furthest apart) and so does not qualify as restricted-range according to EBRD. Given that riverine habitat suitable for this species is abundant in the EAAA and on a precautionary basis this species could be present throughout, the rivers in the EAAA are considered to represent PBF for this species.		
Cobitis taenia Spined Loach	LC		SP	HD AII, BC R6	✓						This loach (benthic fish) species is listed on Annex II of the Habitats Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a as a potential PBF trigger. This species was recorded (eDNA record only) during surveys at one site (UB 7) on River Ub. This species inhabits a variety of watercourse types, from small lowland streams to large river system, in channels, ditches, backwaters and lakes on sand bottom. This species is able to inhabit very degraded streams especially if siltation is a problem.[76] Spawns in April-July, at temperatures above 18°C. Eggs are spawned in dense vegetation. Larvae are negatively phototactic (avoid light), hiding under vegetation and in debris until beginning of exogenous feeding. River Ub Site 7 is not typical of the streams within the EAAA, as this site is located lower down within the Irrigation Zone approximately 15 km downstream of the proposed dam. Further	-	Yes

[75] Freyhof, J. & Kottelat, M. 2008. *Cobitis elongata. The IUCN Red List of Threatened Species 2008*: e.T5031A11108572. http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T5031A11108572.en

[76] Freyhof, J. 2013. *Cobitis taenia. The IUCN Red List of Threatened Species 2013*: e.T5037A11109311. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T5037A11109311.en

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											research, survey and assessment work is required to define the sections of river/tributaries that trigger PBF for this species.		
Barbus balcanicus (Balkan Barbel / Large-spot Barbel / Danube Barbel)	LC	LC	P	HD AII, BC R6	✓			✓			This species is included (originally as Barbus meridionalis) in Annex II of the European Union Habitats Directive and Resolution 6 of the Bern Convention and is assessed under criterion 2a and 2r as a potential PBF trigger. This species was recorded at numerous site in the study area. This species inhabits fast to moderately-flowing premontane and montane streams and small rivers with gravel bottom. Given that riverine habitat suitable for this species is abundant in the EAAA and on a precautionary basis this species could be present throughout, the rivers in the EAAA are considered to represent PBF for this species With respect to 2r, the IUCN published estimated extent of occurrence is 400613 km^2 and its global range is greater than 500 km linear geographic span (i.e. the distance between occupied location furthest apart) and so not does qualify as restricted-range according to EBRD.	-	Yes
Aquatic macroinvertebrates													
Aeshna viridis (Green Hawker)	LC	NT	-	HD AIV							These three dragonfly species are listed on Annex IV of the Habitats Directive and are assessed under criterion 2a as a potential PBF or CH trigger. These species is assessed as Least Concern (Global) and Near Threatened (Europe) by IUCN. *Aeshna viridis* (IUCN LC/NT) was recorded was recorded in its flying form during terrestrial invertebrate surveys and in its aquatic form in the River Ub (site UB 7). *Ophiogomphus cecilia* (IUCN LC) was recorded its aquatic form in the River Ub (UB 5) and the Ogladjenovačka tributary. *Stylurus flavipes* (IUCN LC*)* was recorded at two sites on the River Ub (UB 1 and UB 2) and the Jasenovac tributary. Whilst River Ub Site 7 is not typical of the river within the main project area, as this site is located lower down within the Irrigation Zone approximately 15 km downstream of the proposed dam, on a precautionary all three dragonfly species could be present throughout the EAAA.	Yes	-
Ophiogomphus cecilia (Green Snaketail)	LC	-	P	HD AIV, BC R6									
Stylurus flavipes River Clubtail	LC	LC	-	HD AIV, BC R6									

Species	Status				CH / PBF Assessment Criteria						Assessment	CH	PBF
	IUCN (Global)	IUCN (Europe)	National Status	EU Designation	2a	2b	2c	2d	2r	2m			
											Based on the above, habitats within the EAAA suitable for this species (River Ub and tributaries and riparian edge habitat) are considered to represent CH. Assessment, with local specialists will be undertaken during preparation of the ESIA to determine whether CH is triggered by this species in line with GN6.		
Unio crassus Thick-shelled River Mussel	EN	VU	SP	HD AII, IV, BC							The thick-shelled river mussel presence was confirmed at all sites sampled of the River Ub; this species is assessed as VU (in Europe) and EN (globally) according to IUCN. It is also listed in Annex II and IV of the EU Habitats Directive and Resolution 6 of the Bern Convention and is strictly protected by Serbian legislation, specifically the decree on the proclamation and protection of strictly protected and protected wild species of plants, animals, and fungi. It should be noted that the life-cycle of the thick-shelled river mussel, like most freshwater mussels, has a temporary obligate parasitic life stage (glochidia) on fish. Glochidia live on the gills of host fish which included common coarse fish that have been recorded in the Biodiversity Studt Area. Based on the above, habitats within the EAAA suitable for this species (River Ub and tributaries including the in-channel riparian edge mud habitats) are considered to represent CH.	Yes	-

IUCN Vulnerable (VU) or Least Concern (LC)

EU Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora Annex I-IV

BD A - Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds (Codified version)

BC - Convention on the conservation of European wildlife and natural habitats, revised annex I of resolution 6 (1998) of the standing committee to the Bern convention

Decree on proclamation and protection of strictly Protected and Protected wild species of plants, animals and fungi ("Official Gazette of the Republic of Serbia", No. 5/2010, 47/2011, 32/2016 and 98/2016) [in Serbian]: SP – strictly protected (wild species of plants, animals and fungi are wild species that have disappeared from the territory of the Republic of Serbia or its parts, returned to reintroduction programs, extremely endangered, endangered, relict, locally endemic, stenoendemic, internationally significant and protected wild species, of special importance for conservation of biological diversity of the Republic of Serbia; P – protected species (wild species of plants, animals and fungi in order to preserve biological diversity, natural gene pool, i.e. species that have special significance from ecological, ecosystem, biogeographical, scientific, health, economic and other aspects for the Republic of Serbia)

7.3 CHA Summary

7.3.1 Criterion 1: Priority ecosystems

None of the habitats recorded conform to descriptions of those listed in Annex 1 of the EU Habitats Directive, but some are listed in Resolution 4 of the Bern Convention. However, none qualify as IUCN Red List EN or CR ecosystems. Therefore, Balkan riverine willow scrub, *Fagetum moesiace submontanum* typicum woodland, and *Quercetum frainetto-cerris* woodland are listed as PBF.

7.3.2 Criterion 2: Priority species and their habitats

PBF and/or CH is likely triggered under Criterion 2 due to the presence of multiple 'priority species' as assessed in **Error! Reference source not found.**.

Figure 25, Figure 26 and **Error! Reference source not found.** show the estimated direct habitat losses associated with the reservoir footprint. Habitat that are potentially PBF and CH are indicated and total 62.31 hectares.

For a planned development with the potential to generate significant negative impacts on a PFB or CH, a mitigation plan will be required that achieves *no net loss* or a *net gain* of those features in the Project area and its zone of influence. The potential construction and operations phase impact are assessed in light of mitigation (including loss-gain analysis) in the Biodiversity Impact Assessment Section 8).

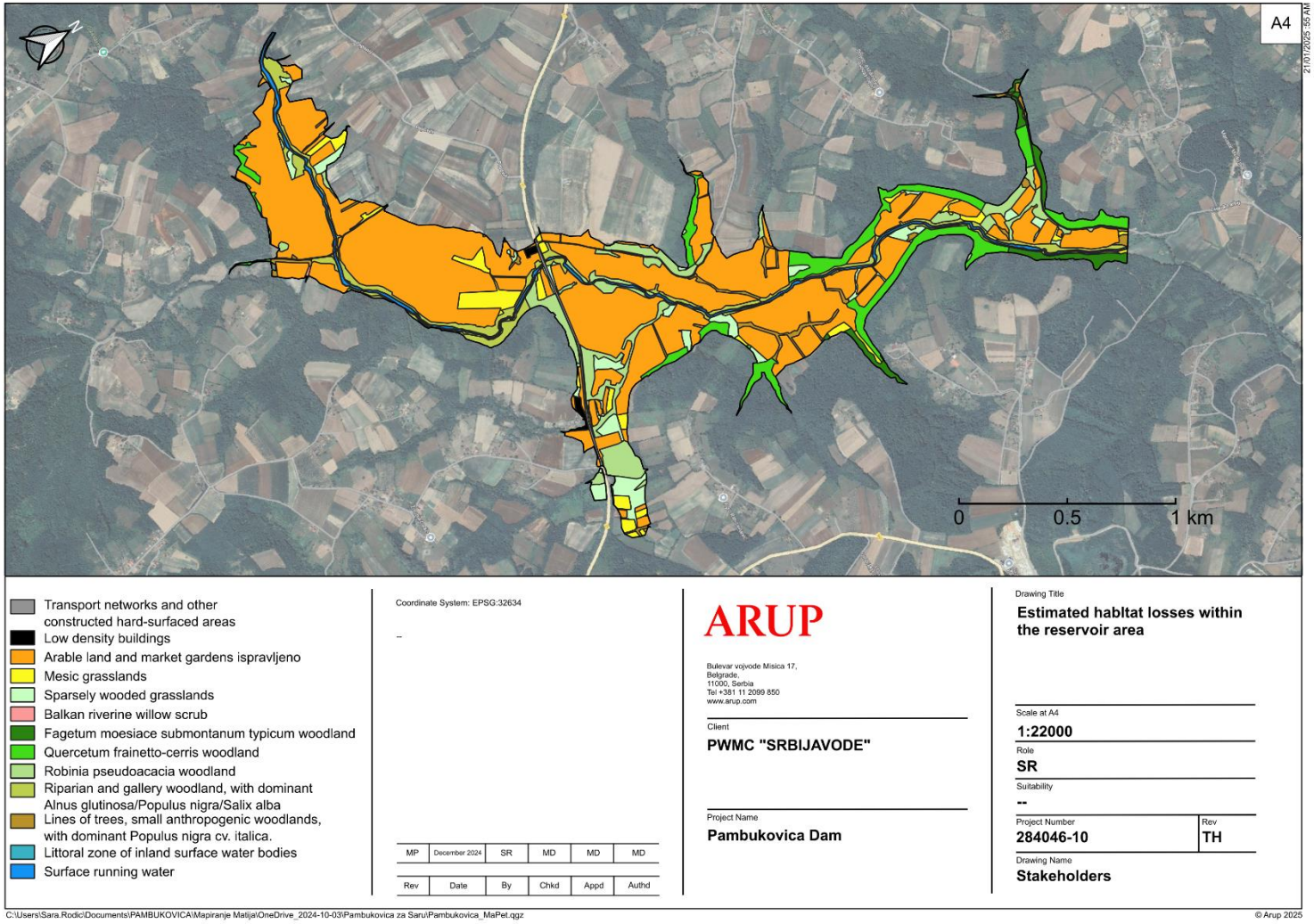


Figure 25 –Direct habitat loss/change within the footprint of the proposed reservoir

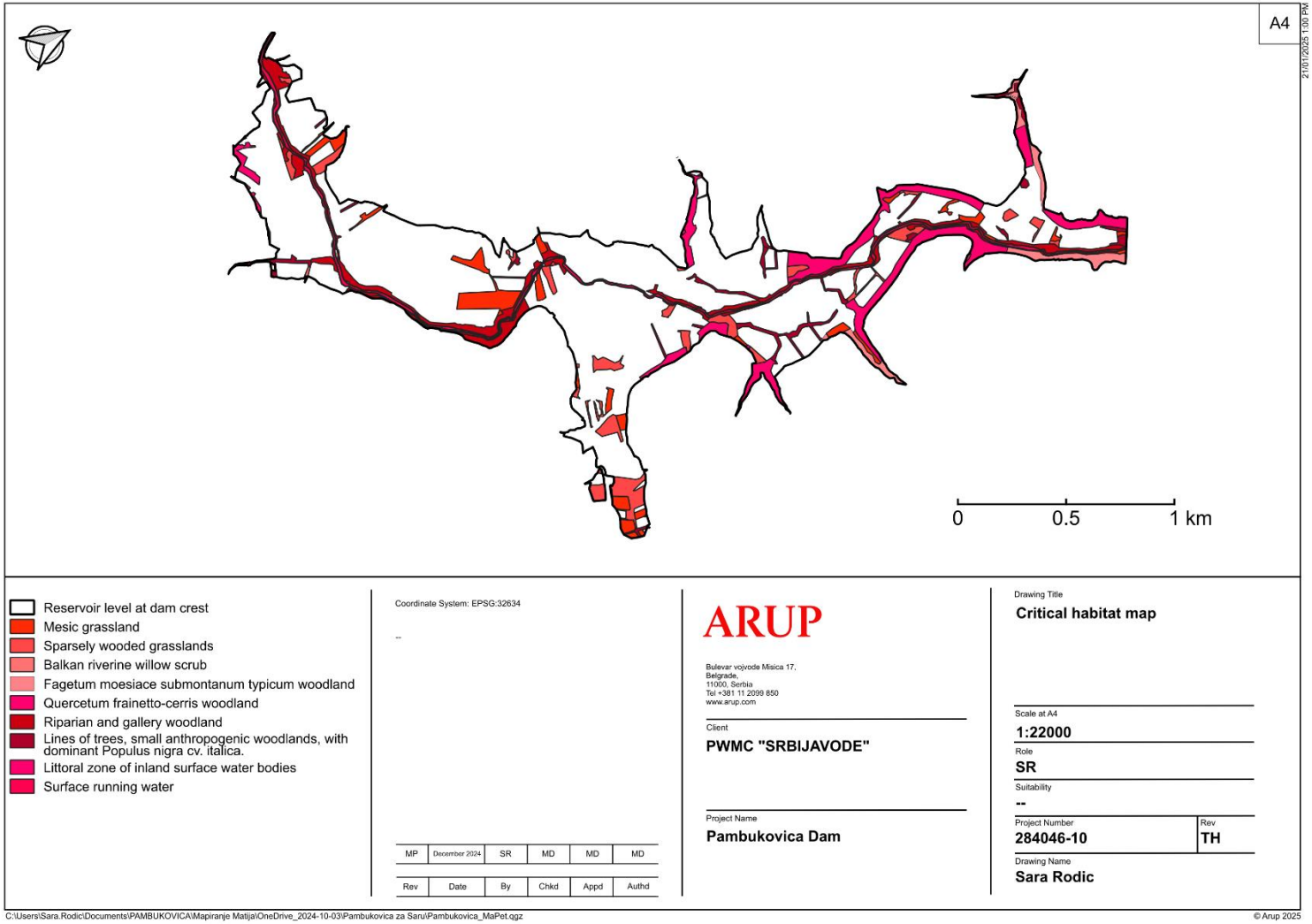


Figure 26 - Critical habitat map

Table 59 - Direct habitat loss/change within the footprint of the proposed reservoir

Code	EUNIS Habitat	Estimated Area (Hectares) lost	Potential PBF / CH	Potential PBF / CH loss
J4	Transport networks and other constructed hard-surfaced areas	1.93	No	-
J2	Low density buildings	0.63	No	-
I1	Arable land and market gardens	125.83	No	-
E2	Mesic grasslands	8.28	Yes	8.28
E7	Sparsely wooded grasslands	9.19	Yes	9.19
F9.123	Balkan riverine willow scrub	0.07	Yes	0.07
G1.69	*Fagetum moesiace submontanum typicum* woodland	4.14	Yes	4.14
G1.76811	*Quercetum frainetto-cerris* woodland	17.18	Yes	17.18
G1.C3	*Robinia pseudoacacia* woodland	15.93	No	-
G1.1	Riparian and gallery woodland, with dominant *Alnus glutinosa/Populus nigra/Salix alba*	12.33	Yes	12.33
G5	Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. italica*.	4.54	Yes	4.54
C3	Littoral zone of inland surface waterbodies	1.71	Yes	1.71
C2: C2.31 C3.55	Surface running water, comprising Epipotamal streams Sparsely vegetated river gravel banks	4.87	Yes	4.87
	Total	206.63	-	62.31

8. Biodiversity Impact Assessment

8.1 Impact Assessment Methodology

This chapter outlines the methodology used to assess the potential impacts associated with the construction and operation of the Project. The methodology aligns with international standards for environmental and social impact assessments (ESIA) and other chapter of the incorporates field and desk data, expert evaluations, and best practices in biodiversity conservation.

8.1.1 Definitions

Direct vs Indirect Impacts – a direct impact is any change to the environment, whether adverse or beneficial, wholly or partially, resulting directly from an environmental aspect related to the project. An indirect impact may affect an environmental, social or economic component through a second order impact resulting from a direct impact.

Magnitude Criteria - the assessment of impact magnitude was undertaken by categorising identified impacts of the Project as beneficial or adverse. Then impacts are categorised as 'major', 'moderate', 'minor' or 'negligible' based on consideration of parameters such as:

Duration of the impact – ranging from 'well into operation' to 'temporary with no detectable impact'.

Spatial extent of the impact – for instance, within the site boundary, within district, regionally, nationally, and internationally.

Reversibility – ranging from 'permanent thus requiring significant intervention to return to baseline' to 'no change'.

Likelihood – ranging from 'occurring regularly under typical conditions' to 'unlikely to occur'.
Table below presents generic criteria for determining impact magnitude (for adverse impacts)

Table 60 - General criteria for determining impact magnitude

Impact	Criteria
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change
Minor	Detectable but small change to the specific conditions assessed.
Negligible	No perceptible change to the specific conditions assessed

8.1.2 Sensitivity criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria used to determine sensitivity of receptors are outlined in Table below.

Table 61 - Generic criteria used to determine sensitivity of receptors

Impact Sensitivity	Criteria
High	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes
Medium	Receptor with little capacity to absorb proposed changes

Impact Sensitivity	Criteria
Low	Receptor with some capacity to absorb proposed changes
Negligible	Receptor with good capacity to absorb proposed changes

8.1.3 Impact Evaluation

The significance of impacts were evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the impact evaluation matrix in **Error! Reference source not found.**. P otential impacts evaluated as
Major and Moderate were considered to be 'significant', and Minor and Negligible as 'not significant'.

Table 62 - Impact Significance Matrix

		Magnitude			
		Major	Moderate	Minor	Negligible
Sensitivity	High	**Major**	**Major**	**Moderate**	**Negligible**
	Medium	**Major**	**Moderate**	**Minor**	**Negligible**
	Low	**Moderate**	**Minor**	**Negligible**	**Negligible**
	Negligible	**Minor**	**Negligible**	**Negligible**	**Negligible**

8.2 Screening of Potential Impacts

A full description of the construction and operations phases of the Project is presented in **Book 2 – Project Description**. The project will involve construction of a 27.5m high dam on the River Ub, to be located approximately 21km upstream of its confluence with the Tamnava River, which is approximately 15km west of the settlement of Ub. The retention area of the considered profile is characterized mainly by hilly terrain. The width of the river valley is variable, ranging from 100 meters to over 600 meters. At the location of the proposed dam, the width of the river valley is about 150 meters. The retention would mostly inundate agricultural land. A small percentage of the inundation area will cover natural and semi-naturel habitats, approximately 33,99%. This is discussed further in Biodiversity Impact Assessment (Section 8). The size/area of the inundation area would vary over time based on the operating rules and storage capacity for flood defence.

In addition to the dam construction, the Project will involve development of an irrigation network of approximately 2,225ha. The Project can therefore be split into two phases:

- Phase 1 - Construction of Pambukovica dam. For construction of the dam, and before impoundment, a 900m long section of the State Road No.21 will need to be raised above the maximum water level of the reservoir, and additional services located in the reservoir footprint relocated. Phase 1 will complete with the impoundment of the river and formation of the reservoir. Design of the dam has been prepared up to the level of Design for the Construction Permit (PGD) as defined in national legislation. It is anticipated that the vegetation clearance upstream of the dam will be required in advance of reservoir commissioning and the River UB will be diverted around the works area during the construction of the dam construction. Note that the construction phase is considered to include all enabling works, including activities such as vegetation clearance, land preparation, and compound construction. No invasive works will be undertaken during the pre-construction phase.

- Phase 1 – Operation of Pambukovica dam. The detailed operating rules for the reservoir are detail in **Technical Assessment Report Appendix 7 – Operational Rules**. Under Serbian legislation there is a requirement to deliver a seasonal minimum flow (Qe) which has been evaluated at 68 l/s for cold season (Oct-Mar) and 102 l/s for warm season (Apr-Sep). The warm season is higher than the cold season to

support an important period - the beginning of fish spawning.[77] This national condition is considered appropriate as all fish species recorded in the Project area are summer-spawning fish. The Serbian minimum flow of maximum 102 l/s will be delivered either via the environmental flow pipe or irrigation supply pipe. The maximum capacity of the environmental flow pipe is 200 l/s. However, E flows downstream of the reservoir will typically far exceed the Serbian minimum flow requirements, as additional water is required to be released to maintain the Phase 1 target reservoir level of 138.5 masl. The release of additional water to maintain the target reservoir level will be delivered through the bottom gate outlet. Modelled E flows representing a dry, normal and wet year are described in the Section 8.2.2. Periodic sediment flushing from the dam may be required. The frequency of sediment flushing activities will be dependent on sediment accretion levels which will be monitored using bathymetry during the operations phase. In years where sediment flushing is required, it will be timed to minimise impacts to downstream biodiversity. Sediment flushing would likely occur in winter/spring (Feb-April) making use of the high spring river levels to carry and dissipate the sediment effectively, whilst also avoiding excess sediment during the summer fish spawning and egg incubation periods.

- Phase 2 - Construction of an irrigation system within Ub Municipality is now planned to begin in parallel with finalisation of Phase 1 works. Irrigation works will involve construction of the key facilities of the irrigation system distribution network which include pump stations, pressure pipelines and the tanks for daily balancing of the inflow. The rest of the distribution network infrastructure is planned to be developed to full capacity in the subsequent two years. Development of the secondary distribution network is planned concurrently with the primary distribution network.

- Phase 2 – Operation of Pambukovica dam. Delivery of the Serbian minimum flow for Phase 2 will be consistent with that described above for Phase 1. However, as is the case for Phase 1, E Flows downstream of the reservoir will typically far exceed the Serbian minimum flow, as additional water is required to be released to maintain the Phase 2 target reservoir level of 145.5 masl. The release of additional water to maintain the target reservoir level will be delivered through the draw down outlet. Modelled daily E flows representing a average, wet and dry year are described in the Section 8.2.2. Periodic sediment flushing from the dam may be required. The frequency of sediment flushing activities will be dependent on sediment accretion levels which will be monitored using bathymetry during the operations phase. In years where sediment flushing is required, it will be timed to minimise impacts to downstream biodiversity. Sediment flushing would likely occur in winter/spring (Feb-April) making use of the high spring river levels to carry and dissipate the sediment effectively, whilst also avoiding excess sediment during the summer fish spawning and egg incubation periods.

For the purpose of this impact assessment and the screening of potential impact pathways, the riverine environment has been split into four zones. The zone above the dam and reservoir impoundment is Zone 0; the dam inundation area of the dam is Zone 1; directly below the dam is Zone 2 and further below is Zone 3.

Table 63 - Aquatic Biodiversity Impact Zones (River Ub)

Zone	Zone Description
Zone 0	Above proposed inundation area
Zone 1	Reservoir / Inundation area
Zone 2	Downstream of proposed dam, to the confluence of two tributaries (Dokmirca and Bukovica Rivers)
Zone 3	Ub River downstream of Dokmirca and Bukovica Rivers, inclusive of town of Ub, to the confluence with Tamnava River

[77] ON THE METHOD AND MEASUREMENT CRITERIA FOR DETERMINING MINIMUM SUSTAINABLE FLOW demo.paragraf.rs/demo/combined/Old/t/t2023_11/SG_096_2023_006.htm

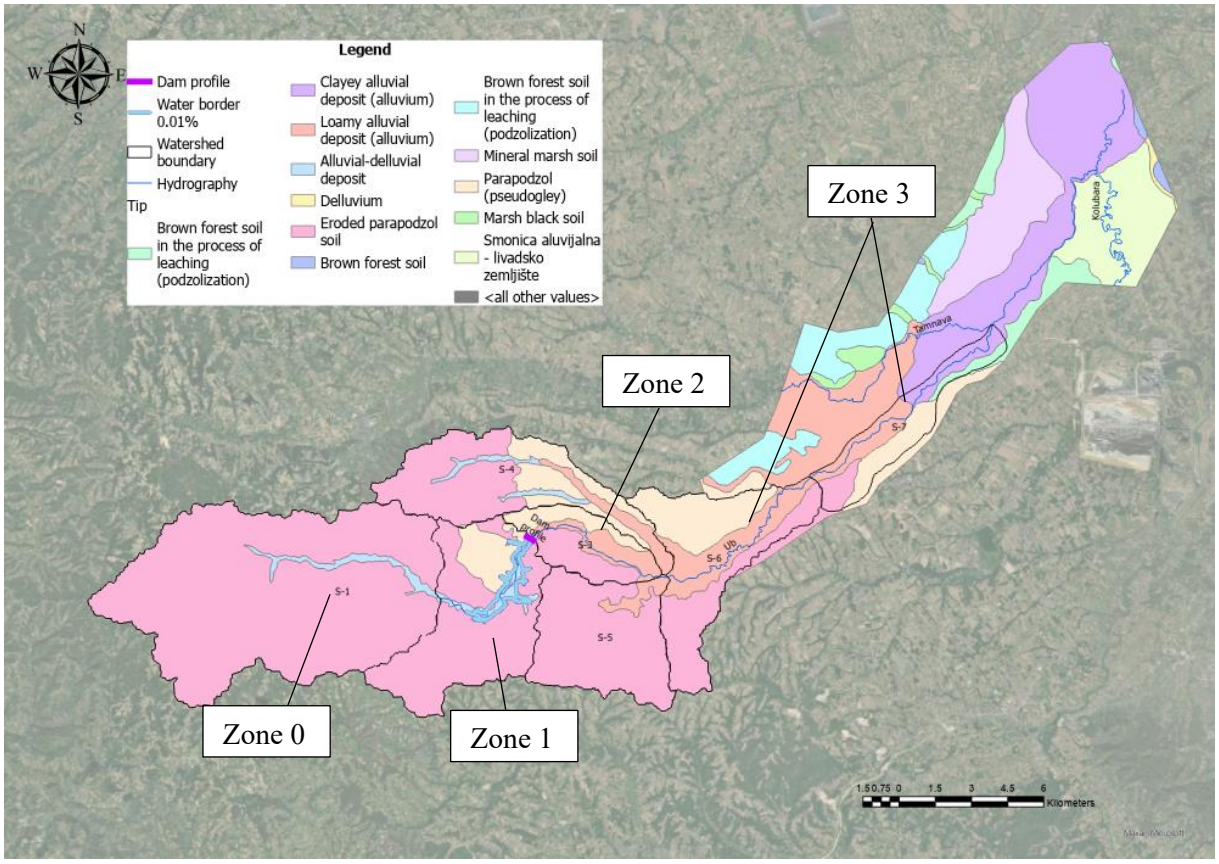


Figure 27 – Aquatic Biodiversity Impact assessment zones

The screening of potential impacts for the Pambukovica Dam project aims to identify and assess key environmental effects that may arise during both the construction and operation phases. This process ensures that potential risks to biodiversity, water resources, and surrounding ecosystems are understood and appropriately managed through targeted mitigation measures.

8.2.1 Construction Impacts

During the construction phase, the primary environmental impacts are associated with habitat loss, habitat and species disturbance through noise and vibration, pollution of land and water, the introduction and/or spread of invasive species, as well as severance and limited movement of wildlife due to habitat fragmentation and construction activities.

Direct habitat loss/change/fragmentation

The most significant anticipated impact of the Project relates to the permanent loss / change of habitats within the land required for construction of dam and associated infrastructure. There will also be habitat loss associated with the construction of seven sediment traps on Babinac, Joševa, Jasenovac, Medvednjak, and Oglađenovačka rivers. The traps will be 2 to 3 m with underlain tooth and ridge berm and construction is planned as part of the overall Pambukovica Dam Project, as part of Phase 1. PWMC Srbijavode confirmed that the plan is to construct sediment traps in parallel with the construction of the dam. Completion is planned before start of reservoir operation.

Of the total area of land within the footprint of the proposed Phase 2 target reservoir level, the majority (79.79 ha or 61.53 % of the footprint) is arable lands; *Robinia pseudoaccacia* woodlands equates to 10.81 ha and 8.34% of the footprint; existing road equates to 1.07 ha and 0.80 % of the footprint; low density building equates to 0.07 ha and 0.05% of the footprint. These habitats are not considered to qualify as either PBF or CH due to the lack of floral and habitat diversity and associated resources these habitats offer for notable mobile species.

However, the remaining land is considered to qualify as CH based in its suitability to support, and the confirmed presence of, a number of species of conservation value (particularly those listed on Annex IV of the Habitats Directive). The following areas of CH, are to potentially be lost as a result of the Project:

- *Fagetum moesiace submontanum typicum* woodland (EUNIS habitat code G1.69) - 1.82 ha
- *Quercetum frainetto-cerris* woodland (EUNIS habitat code G1.76811) - 9.47 ha
- Riparian and gallery woodland, with dominant *Alnus glutinosa*/*Populus nigra*/*Salix alba* (EUNIS habitat code G1.1) - 8.55 ha
- Mesic grasslands (EUNIS habitat code E2) - 5.08 ha
- Sparsely wooded grasslands (EUNIS habitat code E7) – 4.93 haLines of trees, small anthropogenic woodlands, with dominant *Populus nigra* cv. *Italica* (EUNIS habitat code G5) – 3.11 ha

Additionally, there is 6.17 ha of aquatic habitats that fall within the footprint of the proposed reservoir:

- Littoral zone of inland surface waterbodies (EUNIS habitat code C3) - 1.30 ha
- Surface running water (EUNIS habitat code C2) - 4.87 ha or 5.2 km of river lenght
    - Epipotamal streams (EUNIS habitat code C2.31)
    - Sparsely vegetated river gravel banks (EUNIS habitat code C3.55)

The potential impacts of direct habitat loss/change have been assessed pre and post mitigation in Section 8.

Loss of habitat for faunal species

In the absence of mitigation, the habitat loss/change described above could have direct impacts to bat populations and indirect impacts to other faunal species within the Project site, due to a reduction in roost sites, habitat extent, quality, diversity, and connectivity associated with the loss of woodland, wetland, riparian, and river habitats. This could include impacts on aquatic river species such as fish, aquatic invertebrates, and amphibians, which are particularly sensitive to changes in flow regime, water quality, and sedimentation during construction. The alteration of these habitats could disrupt breeding, feeding, commuting and migration patterns. This could also have an indirect impact on species through increased risk of predation and competition, as habitat fragmentation forces species into smaller, less suitable areas. Generally, loss of habitat results in a reduction in the area's carrying capacity and displacement of species into the wider landscape.

Species mortality and injury

Species mortality or injury can occur during the construction of the dam and habitat clearance in the inundation area, and though reservoir commissioning and inundation. Less mobile species, or animals that are hibernating or have young, are likely to be most vulnerable to direct mortality due to vegetation clearance during the construction phase. For aquatic river species, such as fish, aquatic invertebrates (including TSM), and amphibians, mortality or injury can occur from habitat disturbance, sedimentation, and sudden changes in water flow during in-stream construction activities. Additionally, aquatic species may be injured or killed if construction activities cause sudden changes in water quality, temperature, or oxygen levels.

There is also potential for mortality or injury due to collision with vehicles during construction. Animal groups that are particularly susceptible and are at risk from collision are mammals (including bats) and birds.

There is potential for faunal species, particularly bats, mammals, amphibians, reptiles, birds, terrestrial invertebrates, and aquatic species, to be accidentally killed or injured during vegetation removal, earthworks, and in-water construction activities.

Disturbance of faunal species

Changes associated with the construction of the dam (including the creation of the reservoir, changes to water flow, and associated infrastructure such as spillways and access roads), increased noise and vibration from construction activities, and altered light conditions during both construction and operation have the potential to create barrier effects for faunal species (terrestrial and aquatic) and significantly alter the environment for floral species (terrestrial and aquatic).

As described in the **Book 2 – Project Description**, material for constructing the retaining body of the embankment is to be sourced from the excavation within the construction area (dam location). The remaining material for the retaining body is planned to be sourced from borrow pits of terrace and alluvial material, located on both the left and right banks of the river within the reservoir area, up to 1,000 m distance (i.e. with the expropriation area). If this material does not meet the required specifications, an alternative is proposed, which involves using crushed stone (with specified particle size distribution) from the Čučuge quarry and sandy material from the "Kopovi Ub" company landfill. The quarry is located approximately 5.5 km from the dam site. Information at the moment suggest that this quarry not currently active.

Degradation / pollution of habitats

The construction of the Pambukovica Dam has the potential to result in various forms of habitat degradation and pollution. Excavation, land clearing, and earthworks will lead to soil erosion and increased sedimentation in nearby water bodies, potentially altering aquatic habitats and reducing water quality. Additionally, the use of heavy machinery and construction materials poses a significant risk of chemical spills and leaks, which could contaminate both terrestrial and freshwater ecosystems. Dust and airborne pollutants generated from construction activities may further degrade air quality and affect nearby vegetation, while in-stream construction works can disturb sediment deposits, leading to increased turbidity and a reduction in light penetration, which is crucial for aquatic life. Changing river habitat to lake may represent habitat loss by some aquatic species that prefer flowing water conditions.

Introduction of Invasive / non-native species

The construction phase of the Pambukovica Dam poses a risk of introducing invasive / non-native species, which can significantly impact both terrestrial and aquatic ecosystems. The movement of construction materials, machinery, and personnel from various locations increases the likelihood of unintentionally introducing invasive / non-native species. Soil, equipment, and water used during construction can serve as carriers for non-native plant seeds and aquatic organisms.

Terrestrial habitats are particularly vulnerable to invasive / non-native plant species that thrive in disturbed areas such as cleared land and access roads, outcompeting native vegetation and reducing biodiversity. In aquatic environments, construction activities like dredging and water extraction can introduce invasive / non-native species, disrupting the natural balance of the Ub River and threatening native fish and invertebrates.

The increased human presence may also introduce invasive / non-native species, such as rodents and invasive / non-native insects, which can alter local food webs and introduce new pathogens.

To mitigate these risks, biosecurity measures such as cleaning and inspecting construction equipment, using certified weed-free materials, and monitoring for invasive / non-native species should be implemented. Staff training and adherence to best practices are crucial to preventing accidental introductions and minimizing ecological impacts.

8.2.2 Operations-phase Impacts

The operational phase of the dam presents long-term environmental changes, particularly due to altered river hydrology and flow regimes, habitat fragmentation, and changes in water quality. Changes in sediment transport, water temperature, and dissolved oxygen levels can significantly impact aquatic ecosystems and downstream habitats. Additionally, ongoing maintenance and water management practices, such as the introduction of non-native species, may further affect local biodiversity.

A key aspect of these environmental changes is the variability of the dam's water level, which depends on factors such as seasonal rainfall, operational protocols, and water demand. Managed to balance flood control, water supply, and ecological needs, these fluctuations influence aquatic habitats, water quality, and resource availability for various species. Understanding these dynamics is essential for assessing biodiversity impacts and developing effective mitigation strategies.

Changes in river Ub hydrology and fluvial geomorphology

An assessment of the potential for hydrological, fluvial geomorphological and water quality changes during operation are assessed in the **Book 3 – Surface Water**. During the operations phase of the dam, significant changes will occur in the hydrology and fluvial geomorphology of the Ub River. The construction of the dam will alter water flow patterns, including changes in river discharge, flow velocities, and sediment transport processes. These alterations could result in a change to the river's natural dynamic processes, including sediment deposition and erosion, which play a critical role in maintaining habitat diversity and quality for aquatic species.

The creation of the reservoir will lead to changes in the hydrological regime downstream of the dam, potentially disrupting the ecological balance of downstream habitats. Changes in water depth and velocity can also impact fish migration, reproduction, and the health of aquatic communities. Additionally, the river's altered morphology may affect the distribution and composition of riparian vegetation, potentially leading to the loss of vital habitats for terrestrial species, including bird species dependent on the riverine habitat. The magnitude of these changes on the river's ecosystem depends on the degree of alteration to natural hydrological and geomorphological processes.

Phase 1 Operation - Figure 28, Figure 29, Figure 30 show the modelled annual hydrographs for the River Ub downstream of the proposed dam in a hypothetical average year, dry year and wet year 'with' and 'without' the project during Phase 1 of the operations phase.

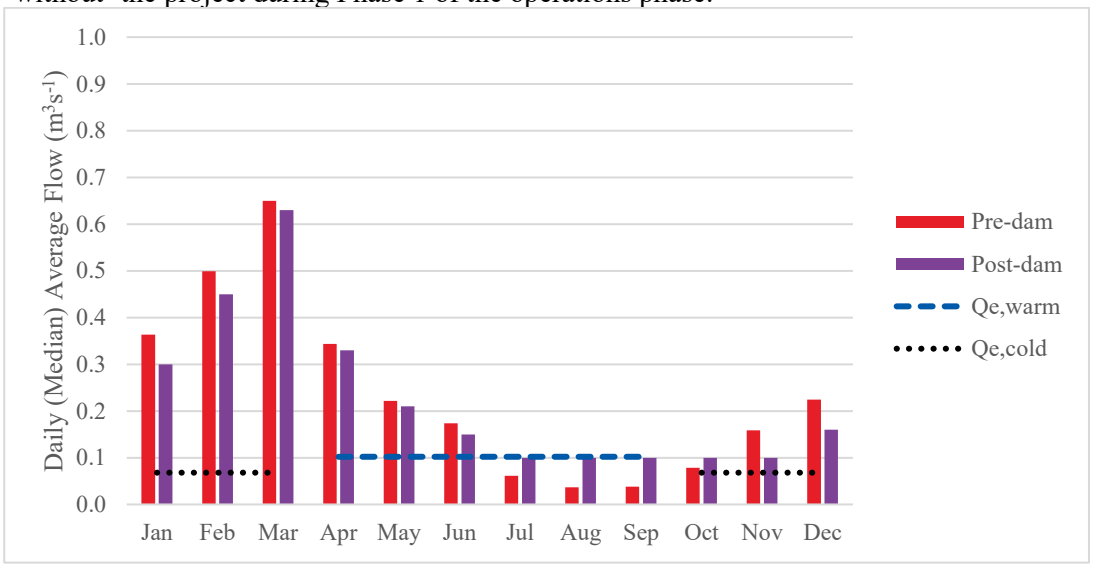


Figure 28 – Hypothetical average year monthly median (q50) daily average flow at Pambukovica dam estimated from observed data (scaled from Ub station, red) and modelled with scheme (purple)

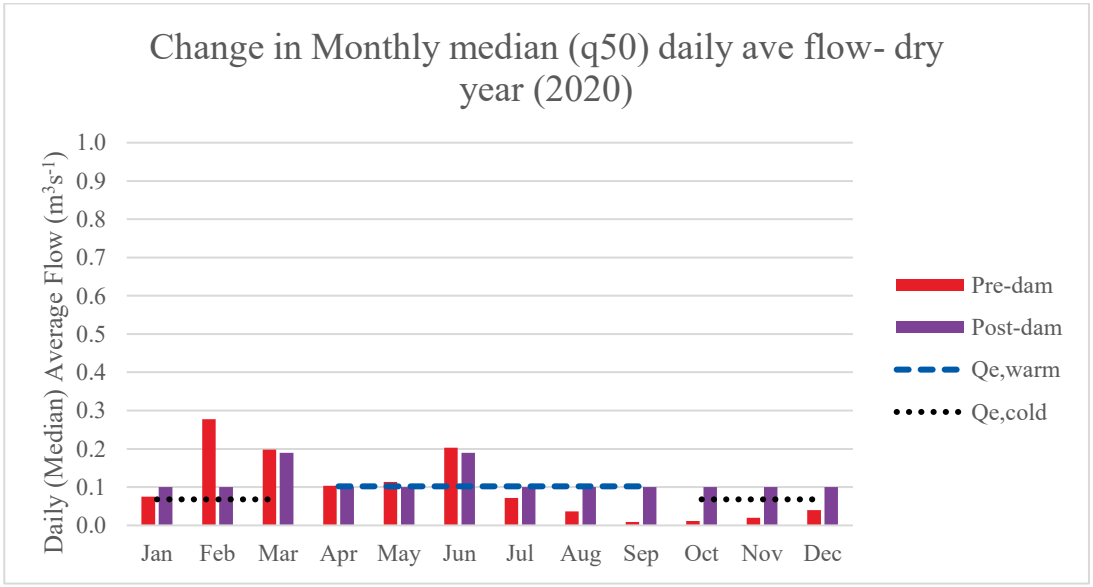


Figure 29 - Dry year (2020) monthly median (q50) daily average flow at Pambukovica dam estimated from observed data (scaled from Ub station, red) and modelled with scheme (purple)

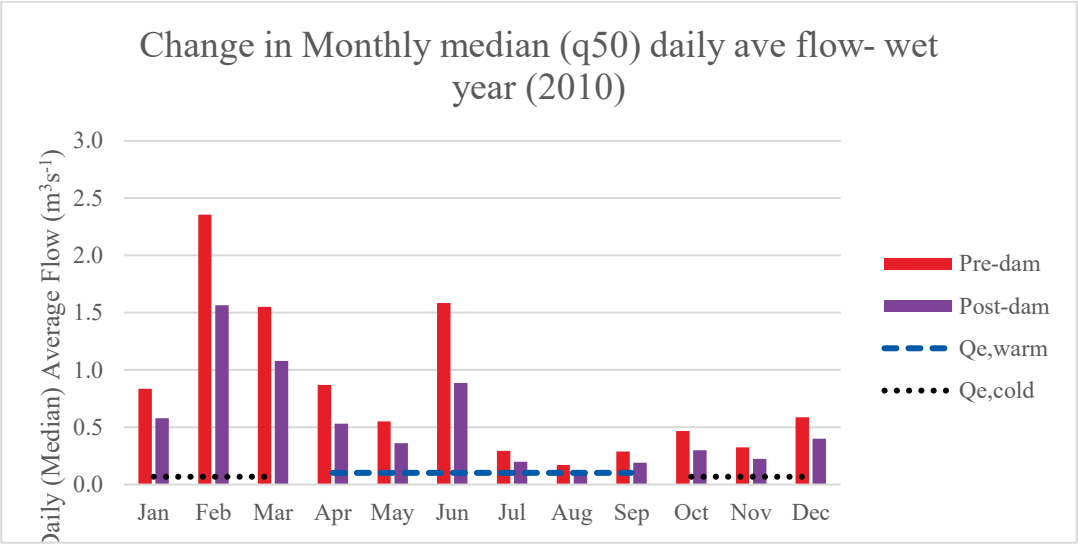


Figure 30 - 1991- 2023 Monthly median (q50) daily average flow at Pambukovica dam estimated from observed data (scaled from Ub station, red) and modelled with scheme (purple)

From a hydrological perspective, these plots demonstrate the following for Phase 1 of operation:

- A minor reduction in monthly average flows during winter and spring, associated with storage in the reservoir.
- Monthly flows will mimic that of the baseline (albeit reduced) maintaining a nature-like hydrological regime, consisting of high flows and low flows in the required seasons. This is crucial to support and maintain the life-cycle of sensitive aquatic and riparian ecology downstream.
- In both the modelled 'average' and 'dry' year scenarios the operations phase flow will be higher than that under the baseline scenario for some months between July and December (depending on the year), delivering drought resilience for the River Ub downstream. For example, the operations-phase E Flow in an average year (Figure 28) will be higher than the baseline scenario in the months of July, August and September.

In addition, the storage in the reservoir for the retention of flood water will also result in a reduction in the magnitude of downstream flood events in the River Ub. Stored water will be released at a slower rate following a storm event which change the flood hydrology of the river downstream of the proposed dam. This may offer resilience to aquatic receptors that historically suffered adverse effects from major floods.

Phase 2 Operation – During the year the Serbian minimum flow (Qe) will need to be maintained whilst accommodating for the use of the reservoir storage for flood mitigation and irrigation. The Serbian minimum flow of maximum 102 l/s will be delivered either via the environmental flow pipe or irrigation supply pipe However, Phase 2 operations (E Flow) downstream of the reservoir typically far exceed the presented Serbian minimal flow, as additional water is required to be released to maintain the Phase 2 target reservoir level of 145.5 masl. The release of additional water to maintain the target reservoir level will be delivered through the bottom gate outlet.

The Serbian minimal flow (Qe) for the warm season and cold season, and the E Flow (purple line: outflow to river) and baseline scenario (red line: inflow to dam) in an average year (Figure 31), wet year (Figure 32) and wet year (Figure 33) is shown below for Phase 2. The reservoir storage volume (indicated by the blue line) considers an irrigation demand of 4.2 4.2Mm^3 per year, split over June-August, with higher demand assumed in July and August (see Technical Assessment Report Appendix 7 – Operational Rules). From a hydrological perspective, these plots demonstrate the following for Phase 2 of operation:

- For the representative **average year (2007)** both the irrigation demand and downstream Serbian minimum flow will be met through drawdown of the reservoir (indicated by the blue line). The E Flow to the River Ub downstream of the dam (purple line: outflow to river) matches the natural baseline regime (red line: inflow to dam), other than for a short period in October / December where reservoir filling

occurs. With the exception of this period of filling, daily flows will maintain a natural hydrological regime, consisting of high flows and low flows in the required seasons. This is crucial to support and maintain the lifecycle of sensitive aquatic and riparian ecology downstream.

- For the representative **wet year (2005)** both the irrigation demand and downstream Serbian minimum flow will be met through drawdown of the reservoir (indicated by the blue line). The E Flow to the River Ub downstream of the dam (purple line: outflow to river) matches the natural baseline regime (red line: inflow to dam), other than for a short periods in June to September where reservoir filling occurs. With the exception of this period of filling, daily flows will maintain a natural hydrological regime, consisting of high flows and low flows in the required seasons. This is crucial to support and maintain the lifecycle of sensitive aquatic and riparian ecology downstream
- For the representative **dry year (2020)** both the irrigation demand and downstream Serbian minimum flow will be met through drawdown of the reservoir. However, the reservoir storage would not fully recover to target level during Autume / winter and further recharge in January February of the following year would be required. However, water availability is high at this time of year (indicated by the peaks on the lefthand side of the graph) and recharge to target is expected to be quick. Once the reservoir target level is achieved E flows would again mimic the natural regime. This is crucial to support and maintain the lifecycle of sensitive aquatic and riparian ecology downstream
- In dry years the E Flow will be higher than that under the baseline scenario, as a result of delivery of the Serbian minimum flow, delivering drought resilience for ecosystems along the Ub, Tamnava and Kolubara Rivers downstream. This can be seen in Figure 29 (2020 - representative dry year) where the operations-phase flows downstream of the dam (purple line: outflow to river) is higher than the natural baseline regime (red line: inflow to dam) between the months June and October.

In addition, the storage in the reservoir for the retention of flood water will also result in a reduction in the magnitude of downstream flood events in the River Ub. Stored water will be released at a slower rate following a storm event which change the flood hydrology of the river downstream of the proposed dam.

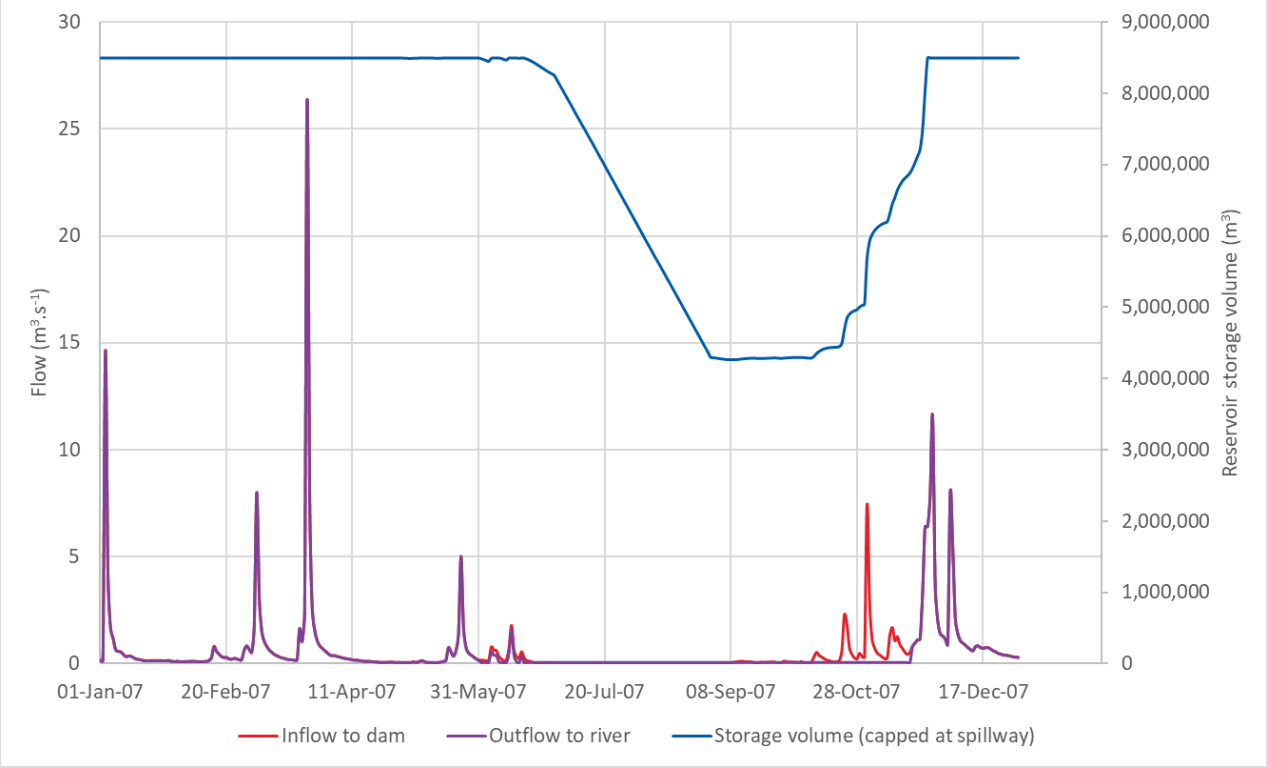


Figure 31 – Example average year (2007) daily flow into Pambukovica dam, out of the dam to Ub RIver and the change in stored water volume within the dam, when capped at the spillway

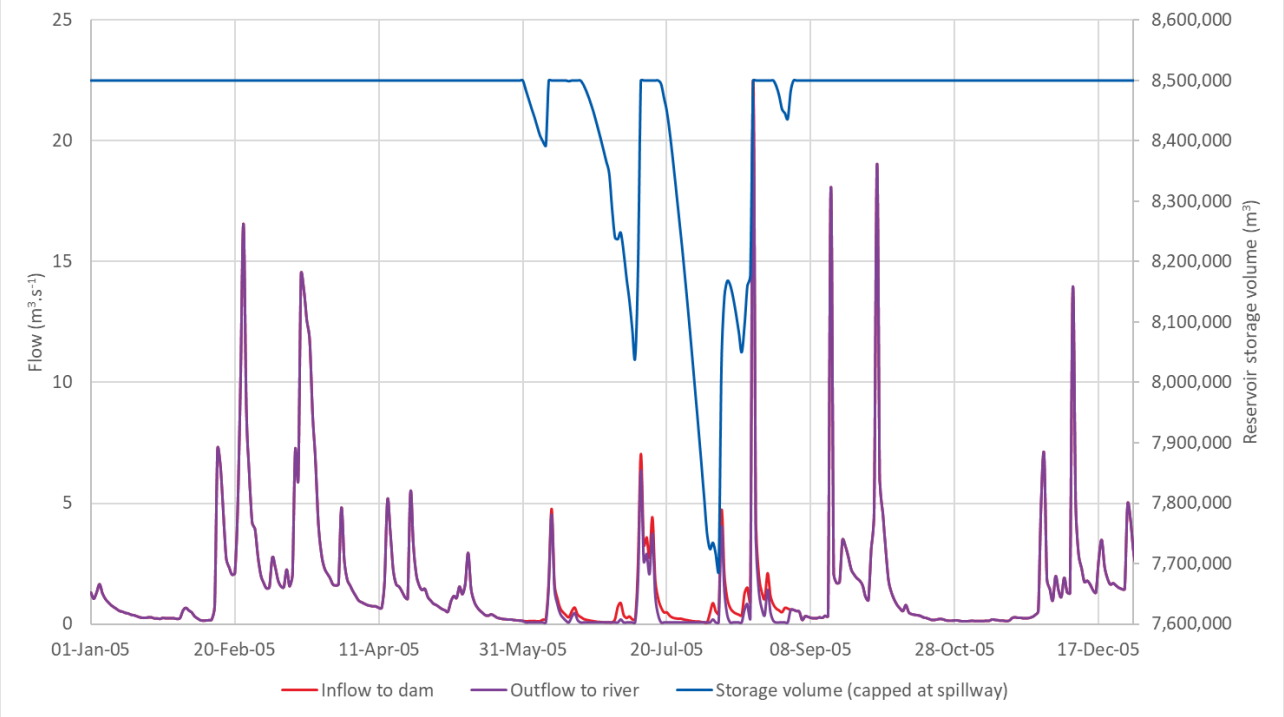


Figure 32 – Example wet year (2005) daily flow into Pambukovica dam, out of the dam to Ub River and the change in stored water volume within the dam, when capped at the spillway

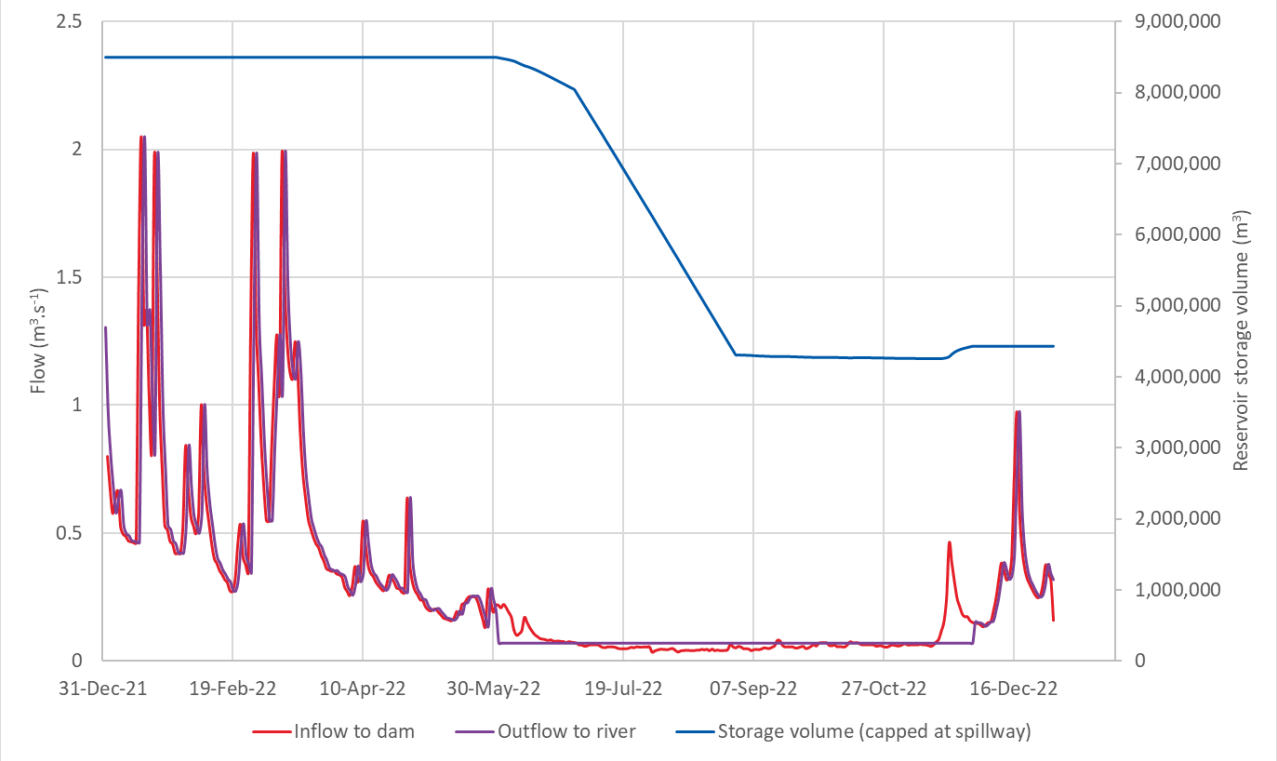


Figure 33 – Example dry year (2020) daily flow into Pambukovica dam, out of the dam to Ub River and the change in stored water volume within the dam, when capped at the spillway

There will also be a change immediately upstream of the dam, from a flowing lotic river environment to a lentic reservoir environment. This change will render the habitat sub-optimal or unsuitable for certain aquatic species, that required riverine habitat. The potential for hydrological, fluvial geomorphological and water quality changes during operation are assessed in the **Book 3 – Surface Water**. This information has been used to underpin the assessment of biodiversity impacts.

Habitat severance – fish/mussel

The project involves the construction of a 27.5m high dam on the River Ub which will not have a fish pass. Therefore, the permanent structure will sever the river to fish movement, in both upstream and downstream directions. This will affect fish migration, and mussel species that depend on the fish assemblage for the 'parasitic' stage of their life-cycle. Changes in river discharge downstream of the dam, if too severe, may also affect migration of fish that rely on sufficient water depth and velocities to enable migration between specific river habitats (e.g. spawning, feeding, and nursery areas).

It should be noted that none of the fish present in the project area are considered to be catadromous or anadromous migrants. The local fish species do migrate but on a local scale, and whilst the severance of the river will have a negative impact on the migration through the dam area, suitable habitats for fish exist upstream and downstream of the inundation area. This is demonstrated by the fish habitat mapping (Appendix A.3) and the length/area of catchment upstream which is extensive (see **Book 3 – Surface Water)**. In terms of the drought and its effect on the severity of Project severance risk, the River Ub is known to suffer from drought in summer months. However, habitats downstream will receive higher than baseline (pre-Project) flows in drought conditions, due to the E Flow / Serbian minimum flow. Habitats upstream of the inundation area will remain unaffected by the Project as the impact of drought on the riverine habitat would not change. However, some mobile fish species using upstream habitats would have the potential to migrate downstream into the reservoir (their natural response in drought conditions), which would act a drought refuge, before returning to upstream riverine habitats following the drought. However, the fact remains that the dam will lead to severance can lead to population fragmentation and reduced genetic diversity within the isolated (upstream and downstream) populations.

During operation habitat severance may also occur as a result of the proposed seven sediment traps on Babinac, Joševa, Jasenovac, Medvednjak, and Oglađenovačka rivers. In the absence of mitigation, or design measure that facilitate free passage of fish, there is potential for fish migration to be affected.

Fish Entrainment and interaction with dam operating infrastructure

During operation the is potential for fish residing in the reservoir to become entrained into the dam infrastructure (i.e. the irrigation and E Flow pipe) or become swept downstream through water releases through the bottom gate outlet and/or spillway. This can lead to displacement of fish into the downstream environment, or result in injury, mortality, through contact with dam infrastructure or pressure changes. This impact is assessed in light of proposed mitigation in Section 8.5.

Drought and Flood Resilience – fish/mussel and other aquatic receptors

A potential positive impact of the project relates to increased drought resilience. Delivery of the E flow (which include the Serbian minimum flow) downstream of the dam, during periods of drought, has the potential to deliver more water to the river downstream compared to the baseline scenario. This is because water will be stored in the reservoir ensuring the Serbian minimum flow can be released during the low flow / drought conditions, delivering drought resilience both during Phase 1 and Phase 2. The reservoir itself will also offer a refuge for some aquatic species living in the riverine habitats upstream of the inundation area, including fish, during periods of drought. Aquatic and aquatic-dependant species could move downstream into the reservoir to take refuge when the river upstream is in drought conditions, before returning back upstream to the river when the drought ends. Increased drought resilience is considered a key benefit of the scheme and is considered to offset some adverse effects expected for aquatic receptors (e.g. habitat severance and loss of riverine habitat).

There is also potential benefit for aquatic receptors resulting from the reservoirs storage capacity during extreme 'ecologically damaging' floods. The reservoir is designed to store water, reducing the magnitude of flood events and safeguarding human communities downstream, including in the town of Ub (see **Technical Assessment Report Appendix 7 – Operational Rules**). However, a reduction in the magnitude of major storm events may also provide ecological resilience to aquatic communities, for example as a result decreased loss of young-of-year fish, and reduced loss of mature fish during floods that become stranded and unable to find their way to the main river channels as flood waters recede.

The potential for hydrological, fluvial geomorphological and water quality changes during operation are assessed in the **Book 3 – Surface Water.**

Change in resources / habitat for fauna – landscape change from river valley to open water habitat

During the operation phase of the dam, the transformation of the river valley into an open water reservoir will result in significant changes to the resources and habitats available for fauna. Aquatic species that depend on flowing river habitats may be displaced or experience reduced habitat quality as the dynamic, fast-moving water is replaced with a more stable and stagnant reservoir environment. This shift may disrupt the existing feeding, breeding, and migration patterns for species such as fish, amphibians, and aquatic invertebrates.

Similarly, terrestrial species that relied on river valley habitats, such as riparian zones, wetlands, and floodplains, may be forced to adapt to new environments or move to other areas. The loss of these habitats, which often provide critical resources like food, shelter, and roosting/nesting sites, may result in reduced species populations or even localized extinctions for some specialized fauna. The landscape change from a river valley to an open water habitat will alter ecological dynamics, potentially leading to a decrease in biodiversity if suitable compensatory habitats are not provided.

Notwithstanding the above, the addition of open water habitat (and associated riparian habitats) will also bring biodiversity benefits for a number of species groups such as birds, bats and amphibians. Increased open water and riparian habitat is considered a key benefit of the scheme and is considered to offset some adverse effects expected for aquatic dependant receptors.

Species displacement and/or mortality due to reservoir releases causing increase river levels

During the operation phase of the dam, there is potential for periodic flooding downstream associated with reservoir releases. If poorly managed reservoir releases have the potential to result in displacement and/or mortality. Aquatic species, such as fish and amphibians, may be displaced as their habitats are periodically submerged or altered by changes in water depth. This can disrupt their breeding, feeding, and migratory behaviours. Terrestrial species, including mammals, birds, and reptiles, may also be affected by the flooding of riparian and terrestrial habitats, forcing them to relocate or leading to potential mortality if they are unable to escape the rising waters. The frequent inundation of these areas can degrade or permanently alter habitats, reducing the availability of food and shelter. These impacts are particularly significant in areas with sensitive or specialized species that depend on stable environmental conditions. It should be noted that many of these effects exist with, and without, the reservoir their nature may change as a result of the modification.

Disturbance of flora/ Disturbance of terrestrial fauna – habitat severance

During the operations phase of the dam, habitat severance with regards to the reservoir impoundment areas may affect movements of riparian mammals.

Degradation / pollution of habitats

During the operational phase of the Pambukovica Dam, the primary concerns related to habitat degradation and pollution will stem from routine maintenance activities, potential dam leakage, changes in river water quality as result reservoir water releases and sediment flushing activities. The release of water from the dam, if not properly managed, may lead to fluctuations in water quality, including temperature changes, nutrient enrichment (particularly during the early phase of reservoir development) and changes in dissolved oxygen concentration in the River Ub, which could adversely affect aquatic organisms. In particular, temperature pollution caused by the release of water from layers that are either warmer or colder than the natural temperature of the Ub River could give rise to ecological impacts. Such temperature variations can disrupt the life cycles of aquatic species, alter metabolic rates, and affect breeding patterns, potentially leading to shifts in species distribution and community structure. Furthermore, accidental discharges of pollutants from maintenance operations, such as lubricants and cleaning agents, pose a risk to surrounding environments. Proper monitoring and mitigation measures will be necessary to ensure that the dam's operation does not result in long-term degradation of the aquatic and terrestrial habitats downstream.

The potential for hydrological, fluvial geomorphological and water quality changes during operation are assessed in the **Book 3 – Surface Water**.

8.3 Mitigation and Monitoring

8.3.1 Construction

Mitigation would be implemented in order to mitigate for potential impacts of the construction phase as described in the Biodiversity Impact Assessment: Construction (**Error! Reference source not found.**), and t he Actions in Biodiversity Management Plan (**Error! Reference source not found.**). Construction phase monitoring and mitigation of the water environment is captured in the Water Environment Monitoring and Management Plan (WEMPP). This document contains elements that are considered in the Biodiversity Impact Assessment in relation to aquatic receptors.

8.3.2 Operation

Mitigation, including embedded / design mitigation would be implemented in order to mitigate for potential impacts of the operation phase as described in Biodiversity Impact Assessment: Operation (**Error! R eference source not found.**), and the Actions in Biodiversity Management Plan (**Error! Reference source not found.**). Operations phase monitoring and mitigation of the water environment is captured in the WEMMP. This document contains elements that are considered in the Biodiversity Impact Assessment in relation to aquatic receptors.

8.4 Biodiversity Impact Assessment: Construction

Table 64 - Biodiversity Impact Assessment – Construction

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
Terrestrial Habitat (CH): • Mesic grasslands • Sparsely wooded grasslands • Balkan riverine willow scrub • *Fagetum moesiace submontanum typicum* woodland • Querc*etum frainetto-cerris* woodland • Riparian and gallery woodland • Lines of trees, small anthropogenic woodlands	Direct habitat loss, change, and fragmentation due to dam construction, inundation, and associated facilities. Permanent loss of critical habitats within the construction footprint.	**Major**	All non-arable or urban terrestrial habitats within the study area have been assessed as CH due to the confirmed presence of a number on species of conservation value including species and habitats listed on Annex IV (species) and Annex 1 (habitats) of the Habitats Directive. Some habitats, namely, Balkan riverine willow scrub, *Fagetum moesiace submontanum typicum* woodland and *Quercetum frainetto-cerris* woodland also trigger Priority Biodiversity Feature as they are listed on listed in Resolution 4 of Bern Convention, however, for the purposes of this assessment and the offset strategy these habitats are considered to qualify as CH. Terrestrial CH extend across of the study area (Figure 26 and **Error! Reference source not found.**). These habitats provide essential ecological functions and support species of conservation, making them particularly vulnerable to the impacts. Overall, the project will result in the impact of 32,96 hectares of (non-arable) terrestrial habitats that are considered to qualify as CH. The vegetation clearance required for the project inundation area footprint (based on 145m water level) includes (CH) habitats: Woodlands: • *Fagetum moesiace submontanum* typicum woodland (EUNIS code G1.69) – 1.82 ha • *Quercetum frainetto-cerris* woodland (EUNIS code G1.76811) – 9.47 ha • Riparian and gallery woodland, dominated by *Alnus glutinosa*, *Populus nigra*, and *Salix alba* (EUNIS G1.1) – 8.55 ha • Lines of trees, small anthropogenic woodlands, with dominant *Populus nigra cv. Italica* (EUNIS G1.1) – 3.11 ha Grasslands: • Mesic grasslands (EUNIS code E2) – 5.08 ha • Sparsely wooded grasslands (EUNIS code E7) – 4. 93 ha There is potential for construction material to be sourced from the Čučuge quarry and sandy material from the "Kopovi Ub" company landfill, if insufficient material is present within the expropriation area. The quarry is located approximately 5.5 km from the dam site. Information suggests that this quarry not currently active. It is assumed that further excavation of the quarry would not increase the quarry footprint, that may impact potential natural / CH habitats, and that natural / CH surrounding the quarry will be avoided. However, should material need to be sourced from the quarry, or other areas outside the expropriation area, a biodiversity risk assessment	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			of the site and its surroundings will need to be undertaken by a suitable qualified biodiversity specialist, in line with **BMP Action 1** *Habitat Management, Enhancement and Offset Plan* and **BMP Action 5** Sensitive Site Clearance Strategy. **Avoidance of CH -** Measures to avoid CH loss have been taken into account as part of the project design to date and ensuring avoidance of CH is maximised will continue as the project design develops. For construction, CH will be avoided wherever possible; this includes setting up exclusion zones and buffers to protect sensitive areas, based on detailed pre-construction surveys and habitat mapping carried out (**BMP Action 1** *Habitat Management, Enhancement and Offset Plan*). Whilst loss of CH will be avoided (see above) where possible and the impacts to the species for which it was assigned will be minimised through species-specific measures and sensitive site clearance (see species specific measures below), there will loss of woodland habitat and grassland that will need to be offset to provide nesting and roosting habitats for birds and bats. This, along with the specie-specific measures, is considered a key component of part the Net Gain Strategy. Further details the approach to identifying on-site and offsite habitat offset opportunities is described in the *Habitat Management, Enhancement and Offset Plan* (**BMP Action 1**). **Net Gain Strategy** - To compensate for the loss of 34.26 hectares of CH (see above) and achieve the required Net Gains, sufficient areas of 'like for like' habitat will need to be created. In line by EBRD guidance, loss-gain analysis using the Quality Hectares (Qha) approach has been undertaken to calculate the amount of offset required and ensure a material net gain will be achieved. This method reflects both the quantity and quality of the features to define a Qha valuation for both the habitats 'lost' and 'gained' through habitat creation and enhancement. Losses and gains were calculated according to the following equations where quality (Q) is expressed as a coefficient (0-1) multiplied by the area (hectares), providing the unit of measure Qha: Project Losses = Area of Project Impact (ha) x Habitat Quality (Q) Project Offset = Area Restored and/or Created (ha) x Habitat Quality (Q) Suitable land for compensation has been identified (see Figure 35 and **Error! Reference source not found.**) as part of BMP Action 1 (*Develop and implement a Habitat Management, Enhancement and Offset Plan*). The aim of this plan is to both reduce the area of land required for construction and deliver the required habitat gains (including compensatory habitats) in a way that supports the species for which the CH was designated (i.e. bats, mammals, amphibians, reptiles, birds, terrestrial invertebrates and fish). It should be noted that urban or arable / farm land will be required for compensatory habitat, as all other natural habitats within the study area likely qualify as CH. Further development and implementation of the *Habitat Management, Enhancement and Offset Plan* (**BMP Action 1**) through pre-construction, construction and operation, will be undertaken by a suitably qualified ecologist. The plan will detail methods to ensure the introduction and spread of alien species is managed during	

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			construction and operation and ensure that a holistic approach to habitat creation is taken, whereby opportunities to enhance existing habitats and connect them to the surroundings and newly created habitats are realised. The success of the habitat creation will be monitored according to the *Ecological Monitoring Plan* (**BMP Action 2**). This plan will cover monitoring of mitigation / habitat creation sites, as well as the routine construction and operations phase monitoring to assess impacts.	

Freshwater Habitat (CH):
 	
• Littoral zone of inland surface waterbodies
 	
• Surface running water, comprising
 	
Epipotamal streams and
 	
Sparsely vegetated river gravel banks
	Direct habitat loss/change (Zone 1) and fragmentation
	
	Potential restriction of aquatic species movement due to construction activities and poor design of watercourse crossings.
		Major	Riverine habitats associated with the River Ub have been assessed as CH due to the confirmed presence of a number on species of conservation value including, fish (Balkan Loach *Cobitis elongata*, Spined Loach *Cobitis taenia* and *Barbus balcanicus* Balkan Barbel) and aquatic invertebrates; dragonflies *Aeshna viridis*, *Ophiogomphus cecilia* and *Stylurus flavipes* and the Thick-shelled Mussel *Unio crassus*. Potential impacts to individual aquatic species/groups are assessed in the relevant section below.
			
			Lotic riverine aquatic habitats upstream of the proposed dam (Zone 1) that will be replaced by stillwater (lentic) habitat total 4.98 ha (~5.3 km river length). These habitats play a crucial role in maintaining aquatic biodiversity and ecosystem functions, making them highly sensitive to potential impacts. Aquatic habitats within the proposed reservoir inundation area (based on 145m water level) are:
			
			• Littoral zone of inland surface waterbodies (EUNIS code C3) – 1.3 ha
			  • Surface running water (EUNIS code C2) – 5.3km, comprising
			  • Epipotamal streams (EUNIS code C2.31)
			  • Sparsely vegetated river gravel banks (EUNIS code C3.55)
			
			The potential impacts of this shift in habitat type (Zone 1) and other effect of the dam in term of species severance are assessed for fish and aquatic invertebrates separately below in the Fauna (aquatic) section.
			
			The construction of the dam and associated activities will result in direct habitat loss and fragmentation of freshwater habitats, including the littoral zone of inland waterbodies and surface running waters. Construction activities and poorly designed watercourse crossings (temporary and/or permanent) may also restrict the movement of aquatic species, posing a high impact on biodiversity.
			
			To mitigate these impacts, it is needed to:
			
			Net Gain Strategy – There will be a loss of surface running waters / river habitat (C2.31 and C3.55) (5.3km) and littoral zone (1.3 ha), which will become open water reservoir habitat following reservoir commissioning; this loss of river habitat cannot be offset on a 'like-for-like area/length' basis and this impact will be offset through enhancement/restoration of existing river habitat, rather than creation of new river length.
			
			Loss of surface running waters habitats shall be offset through enhancement/restoration of existing river habitat upstream and downstream of the proposed dam. This will be delivered through a combination of increased drought and ecological flood resilience in the Ub catchment downstream of the dam (afforded by the reservoir storage capacity and delivery of the Serbian minimum flow in periods of drought), and the Actions set out in the
				Minor

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			Aquatic Enhancement Plan **(Action 7**) of the Biodiversity Management Plan. Actions set out in the *Aquatic Enhancement Plan* **(Action 7**) will be delivered upstream and downstream of the proposed dam. Opportunities in the vicinity of the dam (i.e. within the expropriation area and upstream catchment) will be prioritised, however Srbijavode has identified significant areas of ecologically-connected (via river/riparian corridor) land adjacent to River Tamnava (immediately downstream of the Ub-Tamnava confluence to upstream of the Kolubara River) to deliver offsite offsets downstream of the dam (see *Aquatic Enhancement Plan***,** for further details). Riverine enhancements will be delivered in a co-ordinated manner with the terrestrial offset. It should however be noted that many of the species utilising the river habitat are adaptable to still water environments, and there is potential for species-level gain for CH triggers species living upstream and downstream of the proposed reservoir, through increased resilience from summer droughts and damaging flood events. This is discussed further for fish and TSM separately under Fauna (aquatic) in Table 65 - Biodiversity Impact Assessment – Operation. To mitigate losses in riverine habitat, there will be significant gains (224.62 %) in 'Littoral zone of inland surface waterbodies' associated with the marginal areas of the reservoir. The riparian area of the reservoir will also be planted with trees/woodland which will help to connect the riparian zone upstream and downstream of the reservoir. The marginal reservoir habitat will not be a 'like for like' replacement of the riparian river habitat, particularly for aquatic species. The success of vegetation structure of the marginal area will depend on gradient and reservoir operation. During Phase 1 where reservoir levels are likely to be fairly consistent (at 138.5 masl) the vegetation structure may develop well from the local seed bank. Under phase 2 the nature of the reservoir margin and its vegetation structure will depend on operation and the degree of water level fluctuation. There will be significant gains (386.37 %) in 'Surface standing waters' associated with the development of the reservoir itself. It is likely that high value habitats, such as reed bed, that will colonise at the upstream end of the reservoir, where sediment are deposited as the River Ub meets the impounded reservoir water. Loss-gain analysis for aquatic habitats, using the Quality Hectares (Qha) approach, has been undertaken (see Figure 35 and **Error! Reference source not found.**). This will be implemented as part of **BMP Action 1**. The success of the habitat creation will be monitored according to the Freshwater Ecology Monitoring Plan (**BMP Action 3**). This plan will cover monitoring of aquatic habitat creation sites, as well as the routine construction and operations phase monitoring of individual species/receptors to assess impacts. **Diversion of the River Ub around the construction works** - During the summer of the first construction year, when the water level of the Ub river and existing watercourses is low, and before the river diversion and the start of major dam works (second construction year), the riverbed will be regulated downstream of the dam for about 800m. The purpose of this regulation is to allow the diverted river flow from the diversion gallery to be smoothly accepted during the construction period. Separation of the construction zone and the river through via the proposed diversion will enable the pollution risk form construction to be better manged. **Pollution / Sediment control measures** - During construction, sediment and accidental spills of chemical (inc. fuels and oils) and pollution associated with pouring of concrete could have a significant impact on the aquatic	

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			environment. However, as the dam will be constructed in a dry riverbed environment, using coffer dams/diversions which will reduce the likelihood that a pollution event would affect the downstream river environment. Other mitigation, such as silt curtains, sediment ponds, and diversion channels will be used to minimise the impacts of construction on downstream water quality and aquatic habitats. These activities will be captured in the *Pollution Control Strategy* (**BMP Action 6**). **Watercourse crossings** - poorly designed watercourse crossings have the potential to restrict the movement fish (PBF) and riparian species during the construction phase. Any temporary and permanent watercourse crossings will be constructed to allow the free movement of fish and other riparian species, preventing habitat fragmentation. To offset the describe losses in river habitat an *Aquatic Enhancement Plan* **(Action 7)** will be developed and implemented. This will be implemented as part of sediment control measures proposed for upstream rivers. These include; double living wicker, afforestation in/or adjacent to the river, Ilofilters (forest grass belts) and improved agricultural practices and prohibition on poor agricultural practices to redcuce bank erosion and sediment ingress. The **removal of solid waste** (including plastics and fly-tipped material) will be removed at key locations where it forms around logjams. The benefit of removing natural material (logjams) will be assessed by a suitable qualified freshwater ecology. The reservoir itself will also likely collect solid water that will be removed and disposed of cleansing downstream section of the River Ub.	
• Amphibians	Species accidental injury or mortality during construction Potential indirect effects such as predation due to habitat fragmentation.	**Major**	**Amphibian:** five amphibia of conservation value were recorded in the study area; Yellow-beilled Toad (*Bombina variegate)*, European Green Toad (*Pseudepidalea viridis)*, Common Spadefoot Toad (*Pelobates fuscus*), Greek Stream Frog (*Rana graeca*) and Fire Salamander (*Salamandra salamandra*). The presence of these amphibian species necessitates the implementation of targeted conservation and mitigation measures to minimize construction impacts and ensure compliance with relevant biodiversity protection frameworks. Construction activities associated with the dam project pose a significant risk to amphibians. The primary concerns include accidental injury or mortality due to site operations and flooding habitat during reservoir commissioning, as well as indirect impacts such as increased predation risks resulting from habitat fragmentation. To address these challenges: - **Establishing buffer** around sensitive habitats to minimize direct disturbance from construction activities. To minimize direct disturbance from construction activities, including the development of access roads, a buffer zone will be established around sensitive habitats. This measure also aims to preserve ecological connectivity and prevent the isolation of species in fragmented or island-like habitats due to construction works and machinery movement. A 50-meter buffer will be maintained around wetland and riparian habitats to support	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			species movement between the river and adjacent ponds. This mitigation items from part of the **BMP Action 5** *Sensitive Site Clearance Strategy.* - **Timing construction** and reservoir commissioning activities to avoid critical life stages for wildlife and migration periods. Work near aquatic habitats should be avoided from March to June (amphibian breeding) in line with **BMP Action 5** *Sensitive Site Clearance Strategy.* - **Ecological monitoring** of species activity pre- and post-construction to detect any adverse effects and enable adaptive management measures (**BMP Action 2** *Ecological Monitoring Plan: Terrestrial*). - **Wildlife rescue and relocation** at risk of being trapped or injured by construction activities or flooded during reservoir commissioning, will be undertaken in line with **BMP Action 5** *Sensitive Site Clearance Strategy.* - **Habitat compensation** through the creation or restoration of similar habitats in nearby locations to offset the loss of habitat within the construction footprint: • Targeted planting of native vegetation to enhance habitats, including aquatic plants around the reservoir area to improve breeding conditions. • Enhancement of the aquatic habitat by maintaining water quality and ensuring suitable around the reservoir. • The reservoir itself will also off breeding opportunities for amphibians. The habitat compensation items form part of **BMP Action 1** *Habitat Management, Enhancement and Offset Plan* and **BMP Action 5** *Sensitive Site Clearance Strategy.*	
• Reptiles	Species accidental injury or mortality during construction Potential indirect effects such as predation due to habitat fragmentation.	**Major**	**Reptiles** identified as conservation priorities include the Common Wall Lizard (*Podarcis muralis*), European Green Lizard (*Lacerta viridis*), Sand Lizard (*Lacerta agilis*), Aesculapian Snake (*Zamenis longissimus*), and Dice Snake (*Natrix tessellata*), which are sensitive to habitat fragmentation and human disturbances. The presence of these species necessitates the implementation of targeted conservation and mitigation measures to minimize construction impacts and ensure compliance with relevant biodiversity protection frameworks. Construction activities associated with the dam project pose a significant risk to reptiles. The primary concerns include accidental injury or mortality due to site operations, as well as indirect impacts such as increased predation risks resulting from habitat fragmentation. To address these challenges: - **Establishing buffer** around sensitive habitats to minimize direct disturbance from construction activities. This includes maintaining corridors for species movement between habitats. Connectivity corridors will be preserved for reptile. This mitigation items from part of the **BMP Action 5** *Sensitive Site Clearance Strategy.*	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			- **Timing construction** activities to avoid critical life stages for wildlife and migration periods. - **Ecological monitoring** of species activity pre- and post-construction to detect any adverse effects and enable adaptive management measures (**BMP Action 2** *Ecological Monitoring Plan: Terrestrial*). - **Wildlife rescue and relocation** for reptiles at risk of being trapped or injured by construction activities, will be undertaken in line with **BMP Action 5** *Sensitive Site Clearance Strategy.* - **Habitat compensation** through the creation or restoration of similar habitats in nearby locations to offset the loss of habitat within the construction footprint. Creation of refugia (wood piles and stone piles using material from vegetation clearance) to provide safe shelters during and after construction. The habitat compensation items form part of **BMP Action 1** *Habitat Management, Enhancement and Offset Plan* and **BMP Action 5** *Sensitive Site Clearance Strategy.*	
Woodland birds	Species accidental injury or mortality during construction; potential indirect effects such as predation due to habitat fragmentation. Disturbance/displacement of bird species within the local vicinity and the wider project footprint.	**Major**	Construction activities pose a significant risk to woodland birds, including species such as the Middle Spotted Woodpecker (*Dendrocoptes medius*) and Grey-headed Woodpecker (*Picus canus*), which depend on mature deciduous forests for nesting and foraging. Risks include the direct loss of cavity-bearing trees, disturbance during the breeding season, and long-term habitat fragmentation. To address these challenges: **Sensitive site clearance** – Buffer zones of 50–500 meters will be established around active nest trees, subject to species sensitivity. Corridors of remaining woodland will be maintained where possible to ensure connectivity. Site clearance will be phased from the central area outward, to allow for gradual displacement and minimize abrupt habitat loss (BMP, Action 5). **Timing of construction** – All tree clearance will be conducted outside the bird breeding season (March–August). If works are unavoidable during this period, pre-clearance surveys will be undertaken by a qualified ecologist within 48 hours before felling. If an active nest is found, clearance will be postponed until fledging has occurred. For early nesters, surveys should begin from February (**BMP, Action 5**). **Habitat compensation** – To offset loss of mature nest trees, artificial nest boxes targeting woodpecker species will be installed on retained trees or nearby structures prior to clearance. Habitat enhancement and restoration will be initiated before construction begins to provide alternative nesting opportunities (**BMP, Action 1**). **Nesting compensation** – A sufficient number of cavity-type nest boxes will be installed in suitable woodland areas, facing adjacent habitat patches. Box design and placement will reflect species-specific preferences (**BMP, Action 5**). **Ecological monitoring** – Bird activity and nest box occupancy will be monitored during construction. Where significant impacts are identified, mitigation will be adjusted (BMP, Action 2).	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
Shrubland/Grassland birds			Species such as the European Turtle Dove (*Streptopelia turtur*) and Red-backed Shrike *(Lanius collurio*) inhabit open grasslands and field margins with scattered shrubs. They are at risk from habitat loss due to clearance, disturbance from noise and machinery, and reduced breeding success due to fragmentation. To address these challenges: **Sensitive site clearance** – Hedgerows and shrub patches will be preserved where feasible to maintain foraging and nesting structure. Phased clearance will reduce abrupt displacement. Buffer strips will be maintained to allow for movement between habitat patches (**BMP, Action 5**). **Timing of construction** – Vegetation clearance in shrub and grassland habitats will occur outside the breeding season (March–August). If unavoidable, a pre-clearance survey by a competent ecologist will be conducted no more than 48 hours prior to works. If nests are found, clearance will be deferred until the nesting attempt concludes (**BMP, Action 5**). **Ecological monitoring** – Breeding activity and habitat use by target species will be tracked through the construction period. Mitigation will be adapted based on observed impacts, and broader conservation actions will be implemented where required (**BMP, Action 2**).	
Riparian/Wetland birds			The Little Egret (*Egretta garzetta*), which depends on wetlands and riparian zones for nesting and foraging, is vulnerable to habitat degradation caused by changes in hydrology, sedimentation, and construction disturbance near aquatic habitats. To address these challenges: **Timing of construction** – In-river or near-water works will be scheduled to avoid the nesting period of wetland birds. Any vegetation clearance in these areas during March–August will require pre-clearance surveys by an ecologist. If active nests are located, works will be postponed until chicks have fledged (BMP, Action 5). **Habitat compensation** – Wetland enhancement will be undertaken, including shallow ponds, reedbed planting, and bank stabilization with native species. These areas will serve as alternative habitat and foraging grounds (BMP, Action 1). **Nesting compensation** – Raised nest structures suitable for egrets will be installed near suitable waterbodies, in accordance with habitat preferences and known local use (BMP, Action 5). Ecological monitoring – Waterbird usage of riparian and constructed wetland habitats will be monitored. Where significant decline or disturbance is observed, further mitigation (e.g., increased buffers or off-site conservation) will be applied (**BMP, Action 2).**	
• Bats	Species accidental injury or mortality during construction;	**Major**	All **Bat** species recorded in the project area are considered priority species.	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
	potential indirect effects such as prey availability and higher energy expenditure. Disturbance/displacement of bat species within the local vicinity and the wider project footprint.		The presence of these species necessitates the implementation of targeted conservation and mitigation measures to minimize construction impacts and ensure compliance with relevant biodiversity protection frameworks. Construction activities associated with the dam project pose a significant risk to bats. The primary concerns include accidental injury or mortality due to site operations, as well as indirect impacts such as increase in energy expenditure due to having to fly for longer times to reach alternative foraging grounds and roost sites resulting from habitat fragmentation. To address these challenges the following is prescribed: **Sensitive site clearance** – Buffer zones around sensitive habitats to minimize direct disturbance from construction activities. This includes maintaining corridors to enable bat species movement between neighbouring habitats. In addition to establishing a 50m buffer around identified bat roosting sites at construction stage (where buffers cannot be applied and where the loss of roost sites cannot be avoided, tree felling or building demolition will be timed to avoid bats. Roost exclusion might also be required at an appropriate time of the year **(BMP, Action 5)**. Additionally, site clearance will be phased, starting within the central area of the site with a view of moving the clearance outwards towards/ towards the site peripheries in order to displace species towards retained suitable habitats **(BMP, Action 5)**. Efforts to **microsite sediment traps** to minimise vegetation clearance and potential impacts on protected species (micrositing to be informed by an experiences ecologist) **(BMP, Action 5)**. **Timing of construction** activities, including vegetation clearance, should be undertaken whilst avoiding critical life stages for bats. Specifically, the maternity (between Late April and Early August) and hibernation (October to March) periods. If winter vegetation clearance / demolition cannot be avoided, buildings and trees will be inspected in the summer and any roosts present would need to be excluded and compensated for prior to the hibernation period **(BMP, Action 5)**. **Habitat compensation** through the creation or restoration of habitats lost will be managed and mitigated (in the long-term) through the Management Plan (**BMP, Action 1**) which will aim to achieve a net gain for terrestrial and riparian habitats by connecting / enhancing existing and newly created habitats. Furthermore, areas cleared during construction for temporary use will be progressively restored, as soon as practically possible and in agreement with the landowner (e.g., aiming production of a stable vegetative cover to minimize erosion, dust) **(BMP, Action 1)**. A series of **roost compensation** measures will be implemented as part of the ecological mitigation strategy for the dam project. Roost compensation will be targeted to the roosting preference of bat species present onsite. For both crevice and cavity dwelling species bat boxes will be installed within adjacent retained habitats prior to any vegetation clearance. Additionally, where feasible confirmed bat roosts located during the pre-felling inspections will be translocated to within adjacent retained woodland habitat (BMP, Action 1 and Action 5). Veteranisation (i.e. creating roosting features in living trees) will be prescribed to compensate for the loss of potential roost features within trees that will be lost. Veteranisation will be implemented within targeted areas of	

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			retained woodland to the proposed reservoir, as advised by a bat ecologist prior to implementation **(BMP, Action 1 and Action 5)**. **Ecological monitoring** of bat activity during pre-construction and construction to detect any adverse effects and enable adaptive management/mitigation measures to be implemented (BMP, Action 2). Additional conservation measures for bats species will be developed if the results of ongoing monitoring shows that bats are being significantly affected. Other measures will include support to bat conservation off-site through raising awareness at the local level in cooperation with local qualified Non-governmental Organisations **(BMP, Action 2)**.	
• Other mammals	Species accidental injury or mortality during construction; potential indirect effects such as predation due to habitat fragmentation.	**Major**	**Other mammals** The presence of these species necessitates the implementation of targeted conservation and mitigation measures to minimize construction impacts and ensure compliance with relevant biodiversity protection frameworks. Construction activities associated with the dam project pose a significant risk to terrestrial fauna, including amphibians, reptiles, mammals, and birds. The primary concerns include accidental injury or mortality due to site operations, as well as indirect impacts such as increased predation risks resulting from habitat fragmentation. To address these challenges: **Establishing buffer** around sensitive habitats to minimize direct disturbance from construction activities. This includes maintaining corridors for species movement between habitats. To minimize disturbance to mammals during construction activities, including the development of access roads, a buffer zone will be established around sensitive habitats. This measure is intended to maintain habitat connectivity and ensure that mammals are not isolated in fragmented or island-like patches due to machinery movement and site works. A 50-meter buffer will be maintained around woodland which are likely used as feeding or transit habitats by local mammal species. **Ecological monitoring** of species activity pre- and post-construction to detect any adverse effects and enable adaptive management measures. **Wildlife rescue and relocation** efforts for amphibians, reptiles, and mammals at risk of being trapped or injured by construction activities. **Habitat compensation** through the creation or restoration of similar habitats in nearby locations to offset the loss of habitat within the construction footprint.	**Moderate**
Aquatic species	Injury or mortality during construction Lack of continuity during construction	**Major**	Several aquatic species present within the project area are protected under national and international legislation and serve as triggers for CH/PBF. **Notable Fish** species of conservation concern include the Balkan Loach (*Cobitis elongata*), Spined Loach (*Cobitis taenia*) and Balkan Barbel (*Barbus balcanicus),* which are sensitive to habitat alterations such as changes in water flow, sedimentation, and water quality. These species rely on riverine habitats with suitable	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
	(river diversion) and habitat severance Potential disruption of breeding, spawning, and foraging areas, along with reduced connectivity between aquatic habitats. Changes in hydrological regime Changes in water quality, including increased sedimentation and risk of pollution event		substrate and water conditions for feeding and reproduction. In addition to these PBF species a number of common and not-notable species play a key role in life-cycle of TSM as hosts – these include likely to include Common Bleak, European Stone Loach, Minnow, Roach and Chub. These species all require gravel to spawning on. **Aquatic macroinvertebrates**, which play roles in nutrient cycling and ecosystem health and are of conservation concern include the Green Hawker (*Aeshna viridis*), River Clubtail (*Stylurus flavipes*), and Green Snaketail (*Ophiogomphus cecilia*). **Thick-shelled River Mussel** (*Unio crassus*), a priority species, is sensitive to changes in hydrology, water quality and sedimentation. The construction period could give rise to elevated siltation and risk of pollution incidents. The construction of the dam and associated infrastructure presents significant risks to aquatic fauna, including fish, mussels, and riparian species. Key concerns include accidental harm or mortality, habitat fragmentation, and disruptions to critical life processes such as breeding, spawning, and foraging. Construction activities may also lead to increased sedimentation, which can degrade water quality and reduce habitat suitability. To minimize these impacts, it is needed to: **Watercourse crossings** - temporary and permanent watercourse crossings should be constructed to allow the free movement of fish and other riparian species, preventing habitat fragmentation. This will be achieved by incorporating culverts installed well below bed level, or bridges that maintain natural flow conditions, using substrate that mimics natural riverbeds, and ensuring appropriate water depth and velocity for species migration. Additionally, maintaining riparian vegetation around crossings will help stabilize banks, reduce sediment runoff, and provide essential habitat for aquatic and semi-aquatic species. Design of watercourse crossings is captured in **BMP Action 1** *Habitat Management, Enhancement and Offset Plan*. **Sediment control** measures such as the use of silt barriers, water treatment systems, or sedimentation ponds to reduce water turbidity and protect aquatic species from sedimentation impacts (**BMP Action 6)**. Hazardous materials will be dealt with according to best practice, including proper storage, transportation, and disposal to minimize the risk of accidental spills. **Timing of construction activities** in river should avoid critical life stages for species, such as spawning. The fish species in the project area are typically gravel-bed summer spawners. **Relocation of species –** Where instream works or dewatering are required, they will be carried out under the supervision of a suitably qualified Ecological Clerk of Works (ECoW). Fish and TSM translocation would take place prior to dewatering in order to move fish from impacted areas to suitable habitat elsewhere. Netting and/or electric fishing techniques would be used, under the appropriate Serbian licenced and consent (**BMP Action 5**).	

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			Impoundment – prior to reservoir impoundment, TSM will be translocated to suitable sites upstream or downstream of the reservoir. This will be done under the appropriate Serbian licence, by a suitable qualified mussel specialist (**BMP Action 5**). **Post-construction habitat restoration** including replanting riparian vegetation, improving flow conditions, and creating artificial spawning grounds to support aquatic species (**BMP Action 5)** **Water quality monitoring** will be undertaken in lione with the requirements of the to assess the success of sediment control and water quality measures. Water quality monitoring commitment are described in the WEMMP of the Water Chapter. Water environment monitoring protocol will be designed in conjunction with **BMP Action 3** Freshwater Ecology Monitoring Plan.	
• Fish	Injury or mortality during construction Lack of continuity during construction (river diversion) and habitat severance Potential disruption of breeding, spawning, and foraging areas, along with reduced connectivity between aquatic habitats. Changes in hydrological regime Changes in water quality, including increased sedimentation and risk of pollution event	**Major**	Construction activities such as river diversion, in-stream works, and sediment disturbance pose significant risks to fish species, particularly those of conservation concern such as the Balkan Loach (*Cobitis elongata*), Spined Loach (*Cobitis taenia*), and Balkan Barbel (*Barbus balcanicus*). These species are highly sensitive to habitat fragmentation, flow alteration, increased turbidity, and pollution events, especially during spawning periods. Gravel substrate and clean, well-oxygenated water are critical to their reproduction. To address these challenges: **Watercourse crossings** – Temporary and permanent structures (e.g., culverts and bridges) will be designed to preserve longitudinal connectivity, using bed-level installation allow unhindered fish passage and maintain hydrological conditions (BMP, Action 1). Surrounding riparian vegetation will be retained or restored to support bank stability and minimize sediment input. **Sediment and pollution control** – Silt curtains, sedimentation ponds, and water filtration systems will be used during in-stream works to limit turbidity. Hazardous materials will be managed to avoid accidental pollution, including spill response protocols and secure on-site storage (BMP, Action 6). **Timing of construction** – In-stream works will be scheduled to avoid critical spawning periods. Fish in the project area generally spawn in gravel beds during summer; construction during this time will be avoided to prevent disruption to reproductive cycles. **Relocation of species** – Prior to any dewatering fish will be translocated from impacted areas to suitable habitat. (BMP, Action 5). **Monitoring** – Water quality monitoring will be conducted regularly to evaluate the effectiveness of mitigation measures, in line with the WEMMP and **BMP Action 3 (Freshwater Ecology Monitoring Plan).**	**Minor**
• Mussels	Injury or mortality during construction	**Major**	The Thick-shelled River Mussel (*Unio crassus*), a species of high conservation concern, is particularly sensitive to changes in hydrology, sediment load, and pollution. Its lifecycle relies on a parasitic life-stage where fish	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
	Lack of continuity during construction (river diversion) and habitat severance Potential disruption of breeding, spawning, and foraging areas, along with reduced connectivity between aquatic habitats. Changes in hydrological regime Changes in water quality, including increased sedimentation and risk of pollution event		hosts (e.g., Common Bleak, Roach, Minnow), making it vulnerable to the same stressors that affect these species. To address these challenges: **Watercourse integrity** – Flow continuity will be maintained at all times to prevent habitat fragmentation. Crossings will be designed to retain natural flow conditions and minimize changes to sediment deposition patterns (**BMP, Action 1**). **Pollution and sediment control** – Works will implement sediment containment (e.g., silt curtains, filtration) and strict hazardous material handling procedures to prevent degradation of water quality, which is critical for mussel survival and feeding (BMP, Action 6). **Timing and supervision** – Mussel habitat will be surveyed before in-stream activities, with mitigation timed to avoid peak sensitivity periods. **Translocation** – Prior to dewatering or reservoir impoundment, mussels will be translocated to secure upstream or downstream sites with suitable hydrological conditions. (BMP, Action 5). **Post-construction restoration** – Mussel-supporting habitats will be restored through the reintroduction of clean substrates and flow improvement downstream. Riparian planting will also reduce sediment input in the long term (BMP, Action 5). **Monitoring** – Mussel populations will be monitored post-translocation to assess survival and establishment success. Water quality data from BMP Action 3 will inform adaptive management.	
• Riparian species		**Major**	Riparian and aquatic macroinvertebrate species such as the Green Hawker (*Aeshna viridis*), River Clubtail (*Stylurus flavipes*), and Green Snaketail (*Ophiogomphus cecilia*) are key indicators of ecosystem health. These taxa are susceptible to changes in sediment levels, bank disturbance, and riparian vegetation loss. Green snaketail (*Ophiogomphus cecilia*) – Requires clean, fast-flowing water, making a lake environment unsuitable. However, gravel-bed riverine habitats suitable for this species are widespread upstream and downstream of the proposed dam. Downstream habitat will become more resilient to drought as a result of the Serbian minimum flow to be releases in summer; in drier periods/years this minimum flow will be greater than the baseline scenario. Actions outlined below (for during construction) and proposal set out in Action 7 Aquatic Enhancement Plan will deliver gains for this species. To address these challenges: **Protection of riparian zones** – Existing riparian vegetation will be retained wherever feasible. Where disturbance is necessary, rapid replanting with native species will be undertaken post-construction to restore shading, stabilize banks, and provide habitat continuity (BMP, Action 1).	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			Sediment and flow control – During construction, sedimentation will be minimized through control measures like settling ponds and erosion barriers. These efforts will protect the clean substrate conditions needed for macroinvertebrate colonization (BMP, Action 6). **Timing of works** – Construction activities affecting riparian margins and water edges will avoid periods of adult emergence and larval development for dragonflies and other sensitive species. **Monitoring** – Macroinvertebrate diversity and abundance will be surveyed pre- and post-construction to assess ecosystem function recovery. Monitoring will inform any additional enhancement needs (BMP, Action 3).	

8.5 Biodiversity Impact Assessment: Operation

Table 65 - Biodiversity Impact Assessment – Operation

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
Terrestrial Habitat: • Mesic grasslands • Sparsely wooded grasslands • Balkan riverine willow scrub • *Fagetum moesiace submontanum typicum* woodland • Quercetum frainetto-cerris woodland • Riparian and gallery woodland • Lines of trees, small anthropogenic woodlands	Long-term habitat alteration and fragmentation due to altered hydrology, vegetation changes, and human presence. Possible encroachment of invasive species in restored areas.	**Moderate**	- **Post-construction habitat restoration** to ensure long-term stability and resilience of habitats affected by operational changes (**BMP, Action 1**). - **Invasive species management** to control and eradicate non-native species that may invade newly restored or sensitive habitats. - **Regular monitoring** of habitat quality, flora, and fauna health to ensure that restoration efforts are successful and to identify any emerging threats (**BMP, Action 2**). - **Adaptive management (see also chapter** Error! Reference source not found.**)** to implement necessary a djustments based on monitoring results, such as further restoration or enhancements to habitats.	**Minor to Moderate**
Freshwater Habitat: • Littoral zone of inland surface waterbodies • Surface running water, comprising Epipotamal streams and Sparsely vegetated river gravel banks	Changes in water flow, water quality, and habitat conditions due to the dam and associated structures in operation. Potential for reduced water availability or water quality degradation.	**Major**	- **Water quality monitoring** to assess impacts on aquatic species and riparian habitats, ensuring that water parameters such as pH, temperature, and sediment levels remain within acceptable thresholds (**BMP, Action 3**). - **Flow management strategies** to maintain eE flows that support aquatic life, including seasonal variability in flow to mimic natural conditions. - Riparian vegetation management to stabilize banks and improve water filtration, helping to protect water quality. - Silt control through regular maintenance of sedimentation basins and any necessary dredging to prevent habitat degradation.	**Minor**
• Amphibians	Long-term impacts due to habitat fragmentation, reduced movement corridors, and potential disturbance from	**Moderate**	Amphibians - **Wildlife monitoring** to track the health and populations of key species, particularly those that are most sensitive to operational impacts. The risk of mortality during reservoir filling and during the cold season should be addressed through the translocation of recorded individuals prior to water level rise. This is	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
	operational activities such as noise, light, and human presence.		especially important during the hibernation and cold period, when species are less able to escape rising water. - **Noise and light mitigation** through the use of low-impact lighting, sound barriers, and careful management of operational activities near sensitive wildlife areas. - **Habitat restoration** to enhance fragmented areas, improving movement corridors and ensuring access to necessary resources like food and - **Adaptive management** strategies to address unforeseen impacts through ongoing monitoring and timely interventions	
• Reptiles	Long-term impacts due to habitat fragmentation, reduced movement corridors, and potential disturbance from operational activities such as noise, light, and human presence.	**Moderate**	Reptiles - **Wildlife monitoring** to track the health and populations of key species, particularly those that are most sensitive to operational impacts. The risk of animal mortality during reservoir filling, particularly for reptiles, should be addressed through the translocation of recorded individuals prior to water level rise. This is especially important during the hibernation period, when species are less able to escape rising water. - **Noise and light mitigation** through the use of low-impact lighting, sound barriers, and careful management of operational activities near sensitive wildlife areas **(BMP, Action 5).** - **Habitat restoration** to enhance fragmented areas, improving movement corridors and ensuring access to necessary resources like food and shelter **(BMP, Action 1**). - **Adaptive management** strategies to address unforeseen impacts through ongoing monitoring and timely interventions.	**Minor**
• Birds	Long-term impacts due to habitat fragmentation, reduced movement corridors, and potential disturbance from operational activities such as noise, light, and human presence.	**Moderate**	- **Wildlife monitoring** to track the health and populations of key species. If nesting bird species are identified and mitigation is not feasible, translocation should be considered to avoid impacts. Reservoir filling should be scheduled outside the nesting period whenever possible to minimize disturbance. **- Noise and light mitigation** through the use of low-impact lighting, sound barriers, and careful management of operational activities near sensitive wildlife areas (**BMP, Action 5**). - **Habitat restoration** to enhance fragmented areas, improving movement corridors and ensuring access to necessary resources like food and shelter (see **Error! Reference source not found.**). - **Adaptive management** strategies to address unforeseen impacts through ongoing monitoring and timely interventions (**see chapters 8.3 and 8.7**).	**Minor**
• Bats	Long-term impacts due to habitat fragmentation, reduced movement corridors, and potential	**Moderate**	**Monitoring of compensatory measures** during construction and operational periods will be implemented to assess their effectiveness (**BMP, Action 2**). If maternity/breeding (May–July) or hibernating (October–April) bats are identified within the reservoir area and mitigation is not feasible, translocation measures	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
	disturbance from operational activities such as noise, light, and human presence.		should be considered. To avoid disturbance and mortality, reservoir filling should be scheduled outside the hibernation and maternity (breeding) periods. To mitigate **noise and light** impacts, low-impact lighting, sound barriers, and careful management of operational activities near sensitive wildlife areas will be implemented. Additionally, night-time work (from sunset to sunrise) should be avoided in sensitive areas for bats whenever possible, as bats are nocturnal and can be affected by artificial lighting (**BMP, Action 5**). Operational lighting plans should be developed in consultation with a bat ecologist, as the detailed design is currently unavailable. A sensitive lighting strategy should be completed upon provision of this design. **Habitat restoration and enhancements** will be managed and monitored to ensure that all new habitats reach the condition of the existing habitats through the implementation of a Management Plan (BMP, Action 1), which will aim to achieve a net gain for terrestrial and riparian habitats by connecting / enhancing existing and newly created habitats. Ultimately, improving and promoting commuting and foraging activities, while ensuring access to necessary resources like food and roosting opportunities.	
• Other mammals	Long-term impacts due to habitat fragmentation, reduced movement corridors, and potential disturbance from operational activities such as noise, light, and human presence.	**Moderate**	Other mammals - **Wildlife monitoring** to track the health and populations of key species, particularly those that are most sensitive to operational impacts.(BMP, Action 2) - **Noise and light mitigation** through the use of low-impact lighting, sound barriers, and careful management of operational activities near sensitive wildlife areas. (BMP, Action 5) - **Habitat restoration** to enhance fragmented areas, improving movement corridors and ensuring access to necessary resources like food and shelter (see **Error! Reference source not found.**). - **Adaptive management** strategies to address unforeseen impacts through ongoing monitoring and timely interventions.	**Minor**
• Fish • Mussels • Riparian species	Lack of continuity (barrier effect of dam) and habitat severance	**Moderate**	The project involves construction of a **27.5 m dam that will not have a fish pass**. Therefore, the permanent structures will sever the river to fish movement. All species recorded in the study area (Error! Reference s ource not found.**)** are indicative of gravel bed streams, but many can also inhabit stillwater environments. Spawning typically occurs on gravel substrate, with some species more adaptable, spawning on gravel and/or vegetation. All fish in the project area are late spring/summer spawning species. No species present are cold water / winter spawners (e.g. trout). Whilst some species may make minor migrations from larger rivers to tributaries, or from lakes/reservoirs into rivers to spawn (**see** Error! Reference source not found.) **none are considered to migrate large d istances and would typically be described as 'resident' or 'non-migratory' fish. Resident fish are fish species that complete all stages of its life cycle within freshwater and frequently within a local area**. Most notable species of conservation value recorded are the loaches: Balkan loach, spined loach and golden	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			spined loach. These are small, benthic (bottom dwelling) species and are non-migratory. None of the fish in the river are considered to be catadromous or anadromous (i.e. sea-going migrants). These species have been record both in the River Ub upstream and downstream of the reservoir and in tributaries. Whilst the proposed dam will sever connectivity in the River Ub, creating a barrier to migration for fish. Habitats suitable to support the life-cycles of the fish assemblage (including spawning and nursery habitats) are present both upstream and downstream of the dam (see Section 5.1.2). It is therefore considered that the fish population of the River Ub can be adequately supported, both upstream and downstream of the dam, and a fish pass is therefore not critical to the health of the fish community. There may however be a genetic impacts of severing fish/mussel population. Genetically, dams represent barriers to migration, causing the fragmentation of fish populations by changing their gene flow dynamics. Fragmentation reduces the effective size and genetic diversity of populations. <u>Monitoring and mitigation would include:</u> Develop and implement a Freshwater Ecology Monitoring Plan (**BMP Action 3**) Fish stocking as required and/or period trap and transport of fish from downstream of the reservoir to upstream (**BMP Action 3**) Improving fish passage and this increasing connectivity for fish in the lower River Ub (**BMP Action 7**). This could be achieved by fish passage improvements / creation of a fish pass at redundant weir (formerly for the purpose of a fishery) that is acting as a barrier to all fish species (see Figure 13 Section 5.1.2).	
	Fish Entrainment and interaction with dam operating infrastructure	**Moderate**	During operation there is potential for fish residing in the reservoir to become entrained into the dam infrastructure (i.e. the irrigation and E Flow pipe) or become swept downstream through water releases through the bottom gate outlet and/or spillway. This can lead to displacement of fish into the downstream environment, or result in injury, mortality, through contact with dam infrastructure or pressure changes. Safeguarding fish in reservoirs needs to be balanced with the operation risk mesh screen present. This topic was discussed with dam design technical experts in a design call. It was discussed that the design of the gate bottom outlet, irrigation pipe and E Flow pipe will be subject to detailed design and fish screening will be considered as part of this. It was agreed that a fish screening arrangement (mesh size and type to be determined) would be considered as part of detailed design. Discussions highlighted that screening of the bottom gate outlet is likely not feasible due to the size of the flows this needs to pass, however, screening of the irrigation and E Flow is viable. During discussions, it was noted that the design will likely be updated such that a greater range of flows could be passed via the E Flow pipe (i.e. typical River Ub flows) and that the bottom gate outlet would only be used to pass flood events. This means that the bottom gate outlet will normally be closed and as such fish screening will be located on the E Flow pipe and irrigation pipe only. Fish screening will minimised the risk of fish injury / mortality during low/normal flow conditions. Fish may be displaced via the bottom gate outlet during flood events; it is considered that some may be damaged	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			/ die during bottom gate displacement, whilst other may survive but be displace in the River Ub. This may have some benefit with respect to fish that survive helping to maintain the genetic diversity either side of the dam.	
	Changes in hydrological regime	**Moderate**	The creation of the reservoir will lead to changes in the hydrological regime downstream of the dam. This has the potential to disrupting the ecological balance of downstream habitats. Changes in water depth and velocity can also impact fish migration, reproduction, and the health of aquatic communities. Additionally, the river's altered morphology may affect the distribution and composition of riparian vegetation, potentially leading to the loss of vital habitats for terrestrial species, including bird species dependent on the riverine habitat. The magnitude of these changes on the river's ecosystem depends on the degree of alteration to natural hydrological and geomorphological processes. Figure 28, Figure 29 and Figure 30 (Section 8.2.2) show the modelled annual hydrographs for the River Ub downstream of the proposed dam in a hypothetical average year, dry year and wet year 'with' and 'without' the project during Phase 1 of the operations phase. From a hydrological perspective, Phase 1 of operation will result in: • A minor reduction in monthly average flows during winter and spring, associated with storage in the reservoir. • Monthly flows will mimic that of the baseline (albeit slightly reduced) maintaining a nature-like hydrological regime, consisting of high flows and low flows in the required seasons. This is crucial to support and maintain the life-cycle of sensitive aquatic and riparian ecology downstream. • In both the modelled 'average' and 'dry' year scenarios the operations phase flow will be higher than that under the baseline scenario in drier month, as a result of the Serbian minimum flow, delivering drought resilience for the River Ub downstream. In addition, the storage in the reservoir for the retention of flood water will also result in a reduction in the magnitude of downstream flood events in the River Ub. Stored water will be released at a slower rate following a storm event which change the flood hydrology of the river downstream of the proposed dam. This may offer resilience to aquatic receptors that historically suffered adverse effects from major floods. From a hydrological perspective, Phase 2 of operation will result in: • In dry years the E Flow will be higher than that under the baseline scenario, as a result of delivery of the Serbian minimum flow, delivering drought resilience for ecosystems along the Ub, Tamnava and Kolubara Rivers downstream.	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			• A natural hydrograph downstream in the River Ub for most of the year with the exceptions of breif periods where deviation form the baseline occurs for reservoir filling. Reservoir following periods have been shown to be short are shot as the reservoir has been sjow to fill to Phase 2 target levels quickly. • The E Flow is considered to be nature-like with natural fluctuation (based on River Ub inflows) and suitably high flushing flows to 'cleanse' downstream habitats for fish and TMS populations. • The severity of extreme flood event that may be detrimental to aquatic system, through washout of juvenile fish and mussels, will also be tempered when the dam operated as a flood defence asset. <u>Monitoring and mitigation would include:</u> **BMP Action 3**: Develop and implement a Freshwater Ecological Monitoring Plan **Environmental flow monitoring** - the E flow (including delivery of the Serbian minimum flow) is to be monitored through a flowmeter located on the discharge pipework. Flow release data will be made public and logged providing an e flow audit trail. Downstream E Flow releases can be compared to River Ub flows upstream of the dam allowing the deviation from 'natural' pre-dam conditions to be calculated and disclosed (**WEMMP Action 2)** To demonstrate that the E flow, including Serbian minimum flow commitments are met, the flow monitoring will be disclosed publicly (for example, on the Project website) (**WEMMP Action 2).**	
	Changes in water quality (nutrient and physico – chemical inc. temperature and DO)	**Major**	Water quality within the reservoir is likely to change to some extent compared to baseline (riverine). This will be most apparent in the initial years (2 to 5 years) as a result of decomposition remnant vegetation within the inundation area. Eutrophication occurs when there is an excessive development of primary and secondary producers (algae, macrophytes, zooplankton) resulting in the depletion of oxygen within the reservoir area and subsequent algal blooms. Eutrophication is caused by a multitude of factors but can be attributed principally to excess nutrients (N and P) entering a water body, encouraging the growth of algae and plants. It is considered likely that changes such as temperature stratification, dissolved oxygen concentration would be minimal after year 5 and so would not have a significant impact on fauna or flora. In severe cases water releases from the reservoir high in nutrients and/or low in dissolved oxygen could lead to anoxia in the River Ub adversely effecting the fish and TSM pollution. However, both the fish assemblage and TSM are considered relatively tolerant to changes in water quality (see Section 5.2.6 for further detail on fish habitat requirements and Section 5.4.12 for TSM habitat preference). Monitoring and mitigation would include:	**Moderate**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			Fish and aquatic species monitoring to track population health, breeding success, and movement patterns, adjusting management strategies as needed (**BMP Action 3**). This will include monitoring for aquatic invertebrate, a good indicator of water quality. **Water quality monitoring** to assess impacts on aquatic species and riparian habitats, ensuring that water parameters such as chlorophyl, temperature, oxygenation, conductivity, pH, and nutrients levels remain within acceptable thresholds according to the Surface Water Quality regulations of Serbia (No. 50/2012) (**WEMMP Action 3**) **Adaptive Water Quality management** - eutrophication of the reservoir will need to be monitored through applying the OECD limits for trophic state. In the event that the reservoir is eutrophic then adaptive management principles should apply to improve water quality of E Flow prior to downstream release. Adaptive management could include the of an artificial mixer in the reservoir. Reservoir mixers offer a cost-efficient way to reduce stratification of the reservoir water column resulting in more uniform temperature and dissolved oxygen throughout a water column. This can minimise or eliminates incidence of Blue Green Algae and oxidising metallic ions (**WEMMP Action 3**).	
	Changes in sediment regime downstream of the dam (inc. period flashing).	**Moderate**	The damming of the Ub River will retain sediment from the surrounding catchment within Zone 0 and Zone 1, which would normally travel to downstream ecosystems. Downstream of the proposed dam there are two major tributaries which provide additional sediment to the Ub River within lower reaches of Zone 2 (Dokmirca and Bukovica Rivers). However, there are no major tributaries in the upper part of zone 2 to deliver sediment to River Ub habitats and as such there is a risk of sediment starvation. Beyond the weir within Zone 3 the channel has been significantly modified within Ub town into a trapezoidal concrete channel which does not promote sediment accumulation. Periodic sediment flushing from the dam may be required and is considered to beneficial for aquatic biodiversity if implemented sensitively. The frequency of sediment flushing activities will be dependent on sediment accretion levels which will be monitored using bathymetry during the operations phase. In years where sediment flushing is required, it will be timed to minimise impacts to downstream biodiversity. Sediment flushing would likely occur in winter/spring (Feb-April) making use of the high spring river levels to carry and dissipate the sediment effectively, whilst also avoiding excess sediment during the summer fish spawning and egg incubation periods. The aquatic receptors are considered to be fairly tolerant of sediment. The fish species supported by the River Ub are gravel-spawners, but are otherwise considered fairly adaptable see Section 5.2.6 for further detail on fish habitat requirements). TSM have been considered more silt-tolerant that other endangered mussels, such as the freshwater pearl mussel that are susceptible to clogging of interstitial spaces in sediment beds. Likewise, the fish species present within the project area (including host fish for TSM). The starvation of silt (as a result of the dam) is consider a risk for TSM, whose abundance has been shown to correlate positive with silt presence (see	**Minor**

Receptor	Potential Impact Description	Impact Significance (pre-mitigation)	Assessment (mitigation)	Residual Impact Significance
			Section 5.2.6 for further detail on fish habitat requirements and Section 5.4.12 for TSM habitat preference). However, silt will be transported downstream during flood events, where the bottom gate outlet will be open. Sediment flushing will also enable the transfer of silt downstream. Monitoring and mitigation would include: **Sediment monitoring** - as part of the management and monitoring measures for the Ub River suspended sediment and bedload should be monitored annually at strategic locations within zone 0-3 (pre-construction through to operations). Turbidity is also to be monitored following a high flow event and sediment flushing. **Sediment translocation** - in accordance with sediment connectivity management measures accumulated sediment should be translocated to the mainstem Ub River within Zone 2 to compensate for sediment storage in the reservoir (**WEMMP Action 5**: Develop and implement an Ub River Connectivity Strategy). This action is covered under **WEMMP Action 4**: Develop and monitor upstream restoration measures and **Action 6:** Develop and implement a Sediment Monitoring and Management Strategy. Sediment traps will likely contain a wide range of clast sized that can be strategically placed in riparian areas (as part of routine maintenance) where it will be naturally re-introduced to the River Ub during periods moderate to high flood events. **Sensitivity time sediment flushing** activities also will deliver finer sediments.	
Aquatic Invasive Species	Proliferation in the reservoir environment	**Moderate**	Chinese Pond Mussel (*Sinanodonta woodiana*), Topmouth Gudgeon (*Pseudorasbora parva*) and Prussian Carp (*Carassius gibelio*) have all been recorded in the Biodiversity Study Area. The spread of these species within the project area, and to other sites (e.g. on plant / equipment) will be manged / minimised during construction via **BMP Action 4** - Develop and implement an Introduction / Spread of Invasive and Non-Native Species (INNS) Management Plan. However, there is potential for INNS to proliferate in the reservoir event during operation. Topmouth Gudgeon have been recorded upstream and downstream of the proposed dam and are extremely invasive. They breed successfully in large numbers, can out-compete native fish and predate on invertebrates and the eggs and larvae of other fish. They are better suited to stillwater environments, compared to rivers, where they are less successful. Prussian Carp are also well suited to stillwater environments and have been recorded upstream and downstream of the dam to can be expected to inhabit the reservoir. Chinese Pond Mussel was recorded well downstream of the proposed reservoir area (UB07 only) so can be assumed absent from the reservoir area. The management of Topmouth Gudgeon and Prussian Carp during operation is considered unfeasible.	**Moderate**

8.6 Phase 2 Impact Biodiversity Assessment: Irrigation

The Biodiversity Impact Assessment (**Error! Reference source not found.** and **Error! Reference source no t found.**) focusses on construction and Phase 1 (flood reduction) and Phase 2 (flood reduction) dam operation. Analysis of the potential aquatic impacts of Phase 2 of operation has relied on assumptions about irrigation demand (assumed to be 4.2Mm^3 per year - see Technical Assessment Report Appendix 7 – Operational Rules). The analysis suggests that Phase 2 E Flow presented will be sufficient to support the biodiversity receptors downstream, however this should be confirmed through further modelling in advance of commissioning Stage 2, particularly if the anticipated irrigation demand changes. During Phase 2 reservoir level management will need to balance flood risk reduction downstream, with reservoir storage for the purposes of irrigation and delivering an natural flow regime downstream in the River Ub. Monitoring set out in the BMP and WEMMP (pre-construction, construction and Phase 1 operation) will inform the assessment of Phase 1 impacts, but will also form the baseline for Phase 2 (irrigation) impacts.

8.7 Biodiversity Management Plan

Table 64covers the Project Biodiversity Management Plan (BMP). The BMP will be an iterative document that will be updated and amended as the project proceeds from loan approval, through pre-construction and into operation. The BMP is a publicly disclosed document.

Table 66 - Biodiversity Management Plan

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
Action 1 Develop and implement a Habitat Management, Enhancement and Offset Plan	Vegetation clearance / Habitat loss Introduction / spread of INNS	The **No Net Loss/Net Gain Strategy** has been developed to cover construction, and operation phases of the project, ensuring that habitat loss and vegetation clearance are minimized to the greatest extent possible. The plan has been designed to deliver and demonstrate Net Gains for Critical Habitat (CH), with calculations based on the EBRD GN6 Quality Hectares approach to ensure habitat replacement and enhancement on a 'like for like' basis. The Habitat Management, Enhancement and Offset Plan will be an iterative document that will evolve throughout the Project life-cycle under the oversight of a suitable qualified biodiversity specialist. Efforts have been made to avoid unnecessary vegetation clearance, with a clear distinction between areas that must be cleared due to reservoir flooding and those that can be preserved through careful planning and mitigation measures. Replanting and the formation of new habitats, in line with the offset strategy, will commence before vegetation removal to ensure that the newly established habitats have time to develop and effectively replace the lost ones. The project has committed to preserving habitats wherever feasible, restricting clearance only to areas essential for reservoir flooding and infrastructure development. The **Net Gain Strategy** (see chapter 8.8) has been designed to compensate for the unavoidable habitat losses, ensuring the creation and enhancement of equivalent habitats in suitable locations to maintain ecological integrity and biodiversity value. A total of 34.26 ha of terrestrial critical habitat will be lost due to reservoir flooding. A total of 42.27 ha is required to offset this according to the Quantity Hectares Loss-Gain analysis. Within the remaining, non-flooded expropriated land, riparian woodland loss will be mitigated by converting *Robinia pseudoacacia* woodland (2.99 ha) and arable land (14.03 ha) into native riparian/gallery woodlands, resulting in a net gain of 8.57 ha of these habitats. To offset the remaining 24.41 ha of CH, additional land beyond the expropriation zone will be required. Opportunities in the vicinity of the dam will be prioritised for habitat creation, however Srbijavode has identified significant areas of ecologically-connected (via river/riparian corridor) land adjacent to River Tamnava (immediately downstream of the Ub-Tamnava confluence to the confluence with the Kolubara) to deliver offsite offsets downstream of the dam. The extent of the land available to Srbijavode for offsite habitat offset is provided in Appendix **Error! Reference source not found.**. Land available for offsite (habitat creation / enhancement) includes a total of approximately 32.4 hectares (10.30 ha, 18.29 ha, and 3.85 ha in the Brović, Piroman	Pre-construction phase: • HMP developed and approved: Months 1–6 pre-construction • Habitat restoration initiated: Month 6 onward • Offset land secured and restoration launched: before clearance (Months 6–12) Operation phase: • Monitoring and adaptive management: Ongoing throughout operation	Project-affected area and identified offset sites in adjacent catchment; priority on riparian zones and slopes above reservoir.	Lead: Project Biodiversity Specialist / Ecological Consultant Support: EPC Contractor, Local Forestry Department, Offset Landowners, Independent Monitoring Authority

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		and Veliko Polje sub-municipalities respectively). This land is located immediately adjacent to the Tamnava River; the total length of river channel within this zone is approximately 10km. The land is all adjacent to the Tamnava River within three sub-municipalities: Brović (red), Piroman (green) and Veliko Polje (yellow). Work is ongoing to assess the baseline condition of this habitat and select the most appropriate areas to implement habitat creation/enhancement area measures. To inform the draft Habitat Management, Enhancement and Offset Plan, the following Tasks have been proposed or are completed: 1. PWMC Srbijavode to map areas within 10, 20, 30km from the project area and areas within the Ub to Sava watershed closest to the project (within their ownership and jurisdiction). **Timescale:** Pre-disclosure **Status:** Completed - The extent of the land available to Srbijavode for offsite habitat offset is provided in Appendix A.9. This land is in additional to available land with the expropriation area. 2. Undertake a review of mapped areas, confirmation of availability and desktop based, high-level, suitability assessment. Defining prioritisation for future on-site survey to determine suitability. **Timescale:** Pre-disclosure **Status:** Completed – a desk-top review of the land for offsite habitat offset (Appendix A.9) has been undertaken. The land is located adjacent to River Tamnava between the river channel and the flood embankment. This land is predominant a mix of meadows, grassland and shrubs, with patches of broadleaved woodland. Some of this area was visited as part of the aquatic biodiversity / otter surveys; they are subject to anthropogenic impacts such as mowing, fly-tipping of house-hold and agricultural litter, and proliferation of invasive species (e.g. black locust *Robinia pseudoacacia* and tree of heaven *Ailanthus altissima*). Based on current information (note follow up site visits are planned – see below), the land available is considered suitable to deliver the required habitat enhancement / creation, which consists of the following habitat types: Mesic grasslands, Sparsely wooded grasslands, *Fagetum moesiace submontanum typicum woodland* and *Quercetum frainetto-cerris* woodland. Grassland habitats will be created/enhanced through altered management (adjusted grazing/crop regimes and/or cutting practices). Woodland creation is considered			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		viable in these areas, which is evidenced by the presence of existing woodland of this typology within this zone (i.e. between the river and the flood embankment). Habitat types will confirmed and mapped, along with the current condition of the habitats during the proposed site visits and ground-truthing (see below). The land identified for habitat enhancement / offset is considered functionally and ecologically linked for the species triggered the CH/PBF (i.e. bats and bats). Being adjacent to the river also enables this land to be used to deliver the requirements of Action 7 Aquatic Enhancement Plan (see Action 7 below). 3. Undertake biodiversity surveys (confirmation of degradation and habitat mapping) of the mapped areas to determine suitability for offset. **Timescale:** During-disclosure period **Status:** To be completed. This task will involve mapping the habitat according to EUNIS categories to align with the baseline studies. The condition of the habitat will be assessed, which will feed into the site selection process (i.e. identification of the most suitability areas to deliver the offsite enhancements). This opportunity mapping will include terrestrial and riparian habitats and feed into both BMP Action 1 and BMP Action 7 Aquatic Enhancement Plan (see Action 7 below). Data will feed into an update of the Loss-Gain analysis (see Task 4 below) 4. Develop draft methodology for delivering offset based on the selected areas and requirements set out in the ESIA (mitigation needed in each of the selected areas) with timeline for offset implementation and cost estimate. **Timescale:** During-disclosure period **Status:** To be completed. Based on the findings of Task 3. The Loss-Gain analysis will be updated using the Quality Hectare approach; this will include both on-site and off-site areas that will be mapped. 5. Finalisation of the draft Habitat Management, Enhancement and Offset Plan and submission to Lenders for approval. **Timescale:** During-disclosure period **Status:** To be completed, based on Tasks 1-4 set out above. Offset & Restoration Strategy: • Convert steeper plots to *Fagetum moesiace submontanum typicum* or *Quercetum frainetto-cerris* woodland for soil stability. • Use flatter arable land for targeted habitat restoration.			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		• Replace *Robinia pseudoacacia* with *Alnus glutinosa*, *Populus nigra*, and *Salix alba* to enhance riparian woodland for CH species. • Convert unused, invasive-infested plots into oak/beech woodlands to support biodiversity. Long-term ecological monitoring is an integral part of the Habitat Management, Enhancement and Offset Plan, ensuring the success of habitat restoration efforts. Adaptive management measures will be implemented to address any unforeseen challenges, guaranteeing long-term ecological stability, ecosystem services enhancement, and alignment with sustainable land and water management practices. All potential threats from tree diseases should be taken into account when designing terrestrial habitat offsets, particularly those involving woodland restoration. Emerging diseases can compromise the success of long-term offset objectives by affecting tree survival, canopy development, and overall habitat functionality. One such concern is Beech Leaf Disease (BLD), an emerging threat to beech-dominated forests. Caused by the foliar nematode *Litylenchus crenatae* ssp. mccannii, Recent detections and concerns about its arrival in Europe have raised alarms over its potential impact on European beech (*Fagus sylvatica*), a common and ecologically valuable species used in woodland offsets. BLD leads to dark interveinal striping on leaves, bud damage, crown thinning, and ultimately tree decline or death within a few years, particularly in saplings. Given these risks, offset plans involving beech forests must be approached with caution. Measures should include monitoring for disease symptoms, avoiding large-scale monocultures of susceptible species, sourcing planting stock from disease-free nurseries, and integrating a mix of resilient native species to reduce vulnerability. By incorporating disease risk into offset design, restoration efforts can be made more robust and resilient under both ecological and climate-related pressures.			
	Lake forming / Habitat loss	The aquatic environment will be subject to careful management during both the construction and operational phases of the project, with a focus on minimizing water quality degradation and habitat loss to the greatest extent possible. The No Net Loss/Net Gain Strategy will be adapted to the aquatic environment, ensuring that any impact on critical aquatic habitats is minimized, with measures in place to replace and restore these habitats, enhancing biodiversity and ecosystem services. The Net Gain Strategy (refer to Chapter 8.8) will address the unavoidable loss of aquatic habitats, with a commitment to creating and enhancing equivalent aquatic habitats in suitable locations. The aim is to preserve ecological integrity and ensure that biodiversity values in aquatic ecosystems are maintained.	Pre-construction (Months 1–6): Design integration and planning Construction Phase (Years 1–2): Culvert and habitat works implementation	Reservoir site, watercourse crossings along access roads, offset habitat creation zones within the catchment	Lead: Aquatic Ecologist / Biodiversity Specialist Support: Design Engineers, EPC Contractor, Hydrological Consultant, Local Water Management Authority, Independent Environmental Auditor

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		Restoration efforts will focus on stabilizing riverbanks, improving water quality, and enhancing aquatic biodiversity: Reintroducing native fish species and aquatic invertebrates that are important for ecosystem balance. As with terrestrial habitats, long-term ecological monitoring will be central to ensuring the success of the aquatic restoration and offset efforts. **Watercourse crossing design** - poorly designed watercourse crossings have the potential to restrict the movement fish (PBF) and riparian species. The ecological design of all watercourse crossing (bridges and culverts) will need to consider the needs of aquatic and riparian species (amphibians, bats, mammals) and facilitate free movement through infrastructure under various flow conditions. This will be achieved through embedded design that meets good international practice and consultation with the design/engineering team (s). such as: Bottomless (or sunk/inverted 30cm below natural bed level to allow natural substrate to be deposited) and aim to maintain natural bank features. A natural bed (substrate) and riparian zone (as opposed to concrete banks) is considered key to facilitating/encouraging. Natural flow depths, widths and velocities (including natural variance and diversity) should be maintained at the culvert inlet and outlet and through the culvert, in order to provide habitat diversity and resting areas for migrating species. The culvert should be designed such that channel form and flow characteristics are consistent with that upstream and downstream. Altered channel forms and severe shading can prohibit the migration of fish and other species, so culvert beds could be designed such that the bed substrate and hydraulics serve to guide fish through the movement of aquatic species and fish. Designs must maintain free movement of riparian mammals, in particular otters and reptiles, between available areas of habitat. Where bridges and culverts are constructed where the road dissects watercourses, these must allow the safe passage of otters during spate conditions. Culverts must be as wide as possible and large enough to allow installation of a dry ledge that is accessible during high water levels. Mammal ledges can be made of solid concrete integral with the culvert or steel that is bolted onto the culvert using metal brackets. Ledges must be at least 500mm wide and be accessible both from the bank and the water by the provision of ramps or groups of large boulders. Ledges must be sited at least 150mm above the appropriate high flood level, allowing 600mm	Operation Phase: Long-term monitoring and adaptive management		

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		headroom. These can be installed on both sides of the This may involve ledges to be design into the structure.			
Action 2 Develop and implement an Ecological Monitoring Plan (terrestrial)	Bats - Disturbance and displacement; roost loss; increased mortality	Conduct pre-construction roost surveys to identify maternity, hibernation, and transient roosts. Install bat boxes and veteranisation features in adjacent habitats prior to clearance. Restrict tree and building removal to periods outside maternity (May–Aug) and hibernation (Nov–Mar). Monitor box occupancy, species activity, and flight routes during construction and operation. Adapt lighting and construction schedules where necessary.	Pre-construction (Months 1–6): Plan development and baseline surveys Construction Phase (Years 1–2): Monthly monitoring April–October Operation Phase: Biannual monitoring and adaptive management	Full project footprint including buffer zones, adjacent woodlands, River Ub corridor, and habitat offset locations	Lead: Project Biodiversity Specialist / Ecological Consultant Support: EPC Contractor's Environmental Team, Project Developer, Local Academic Institution (partnered for fauna surveys)
	Birds - Nest disturbance, habitat loss, displacement	Carry out nesting surveys prior to vegetation clearance. If active nests are found (Mar–Aug), delay works until fledging. Install nest boxes and platforms before clearance to provide alternative breeding sites. Monitor nesting success, species diversity, and activity levels.			
	Amphibians - Habitat loss and disturbance in wet habitats	Survey temporary and permanent wetland features during peak activity periods. Use drift fences and pitfall traps to prevent movement into active construction zones. Where found, relocate individuals to safe habitats. Enhance amphibian refuges (e.g., shaded moist zones) near created wetland edges.			
	Reptiles - Loss of basking/foraging sites; disturbance	Identify key basking and breeding areas. Clearly demarcate and avoid these zones where possible. Carry out hand searches and move reptiles to suitable habitats prior to vegetation removal. Restore open sunlit areas with dry vegetation piles post-construction.			
	Mammals - Habitat fragmentation, disturbance, vehicle collisions	Record mammal signs (tracks, burrows, scat) to identify high-use areas. Install wildlife crossing signage and speed bumps. Enforce vehicle speed limits. Restrict night driving in sensitive zones. Monitor mammal movement across the landscape and adapt mitigation accordingly.			
	Insects - Habitat degradation, displacement	Monitor pollinator and indicator taxa (e.g., butterflies, dragonflies) across baseline and offset areas. Enhance floral diversity in restored grasslands and riparian buffers. Adjust mowing regimes to favor insect activity periods. Track diversity and abundance trends to assess habitat quality.			
	Plants / Habitats - Vegetation loss,	Survey plant communities pre-construction. Post-clearance, monitor species richness and cover in offset areas. Track and map any INNS outbreaks, applying early-stage			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
	INNS spread, habitat change	manual or chemical control. Assess habitat quality against baseline targets using condition scoring. Replant or reseed areas not meeting benchmarks.			
Action 3 Develop and implement Freshwater Ecology Monitoring and Plan	Introduction / spread of INNS	Rivers and streams are of high conservation value and are classified as CH according to EBRD criteria, due to the presence of TSM. **PBF fish species**: • Balkan Loach (*Cobitis elongata*) • Spined Loach (*Cobitis taenia*) • Balkan Barbel (*Barbus balcanicus*) **TSM fish hosts likely include:** Common Bleak, Minnow, Roach and Chub. • Common Bleak • European Stone Loach • Minnow • Roach • Chub The **Freshwater Ecology Monitoring Plan** will cover monitoring of aquatic species and habitats, included retained riverine habitats upstream and downstream of the dam, and created open water habitats resulting from the impoundment. This monitoring **plan will be delivered in conjunction with the WEMMP** (particularly Actions 3) will involve pre-construction, construction and operations phase monitoring. The monitoring will enable **the potential construction and operations phase impacts** to be assessed against the baseline for aquatic receptors (fish, invertebrates and TSM). Monitoring during Phase 1 operation (flood reduction) will also be used to define the baseline for future assessment of Phase 2 operation (flood reduction and irrigation). There will be a focus on notable/sensitive species including PBF fish, TSM and TSM hosts Methods will follow that described in Section 5. The monitoring programme will include existing sites (to continue the baseline) and the addition of new sites as required, informed by the final project design and construction methodology, including construction zones, river diversion methods, and permanent and temporary roads / watercourse crossings. Monitoring sites will be selected strategically such that monitoring is capable of identifying adverse impacts. The plan will set out survey locations, monitoring periods	Pre-construction (Months 1–6): Baseline continuation and planning Construction Phase (Years 1–2): Routine and event-based monitoring Operation Phase: Annual monitoring and adaptive response	Ub River – upstream and downstream of dam, impounded lake area, temporary and permanent watercourse crossings	Lead: Aquatic Ecologist / Fisheries Biologist Support: EPC Environmental Team, WEMMP Coordinator, Local Water Authority, Academic Partne

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		and monitoring duration, as well as trigger values for adaptive management in response to unexpected adverse impacts. In line with the WEMMP, aquatic monitoring will follow a routine annual programme, with additional event-based monitoring as required (e.g. associated with sediment flushing). Where monitoring indicates a decline is species abundance / diversity adaptive management would be employed. This may include stocking of fish and/or artificial stocking of mussels on the gills of host fish.			
Action 4 Develop and implement an Introduction / Spread of Invasive and Non-Native Species (INNS) Management Plan	Introduction / spread of invasive / non-native species (INNS)	For the **Introduction / Spread of Invasive and Non-Native Species (INNS)**, an **Invasive Species Management Plan (ISMP)** will be developed, addressing both aquatic and terrestrial invasive species throughout construction and operation phases of the project. The ISMP will be an integral part of the broader Habitat Management Plan and will focus on the identification, monitoring, and control of invasive species to prevent their spread and mitigate potential ecological impacts. Key invasive species identified in the project area include: **Aquatic species:** • Chinese Pond Mussel (*Sinanodonta woodiana*), • Topmouth Gudgeon (*Pseudorasbora parva*), • Prussian Carp (*Carassius gibelio*). **Terrestrial species:** • Bastard Indigo (*Amorpha fruticosa*), • Common Ragweed (*Ambrosia artemisiifolia*), • Black Locust (*Robinia pseudoacacia*), which dominates specific habitat areas classified as *Robinia pseudoacacia* woodland. **Construction Phase:** Implement stringent biosecurity measures, including mandatory cleaning and inspection of equipment and materials before entering the site. Regular monitoring of aquatic and terrestrial habitats to detect new occurrences of invasive species and apply rapid response measures where needed. Mechanical and chemical control methods for terrestrial invasive plants, with preference for manual removal in sensitive habitats. Ensure construction workers are trained on invasive species identification and reporting procedures. **Operation Phase:**	Pre-construction (Months 1–6): Plan development and baseline INNS surveys Construction Phase (Years 1–2): Implementation of biosecurity and control measures Operation Phase: Monitoring, control, and habitat restoration	Entire project area: terrestrial and aquatic habitats, construction zones, roads, reservoir	Lead: Biodiversity Specialist / INNS Control Expert Support: EPC Contractor's Environmental Manager, Local Environmental Inspectorate, Construction Supervisors, Trained Field Staff

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		Long-term monitoring programs to track changes in invasive species populations and effectiveness of control measures. Adaptive management strategies based on monitoring results, including the introduction of biological control agents where feasible. Restoration of degraded areas with native vegetation to enhance habitat resilience and reduce the likelihood of re-invasion. The implementation of these measures aims to minimize the ecological impacts of invasive species, ensuring habitat quality is maintained and biodiversity is safeguarded in the long term. The success of the ISMP will be evaluated through regular ecological assessments and adaptive management approaches.			
Action 5 Develop and implement a Sensitive Site Clearance Strategy	Direct habitat loss/change (adverse, local) Degradation of Terrestrial Habitat Habitat degradation Disturbance and displacement of Fauna Species (terrestrial mammals, bats, birds, reptiles, amphibians, insects etc.) Introduction / spread of invasive / non-native species (INNS) Accidental killings and injury as a direct impact of vegetation clearance Loss (Increased mortality) and	Develop and implement this Sensitive Site Clearance Strategy covering the pre-construction, construction, and operation phases of the dam project. The preparation and implementation of the Sensitive Site Clearance Strategy will be undertaken by a suitably qualified ecologist. Site clearance methodology will be species dependant, seasonal and informed by local biodiversity specialists. The Sensitive Site Clearance Strategy will include mitigation measures aimed at minimizing land take within the construction boundary: **Pre-construction Phase:** Prior to any vegetation clearance pre-construction checks and translocation of individuals (all species) are to be carried out by an ecologist during initial vegetation removal / ground clearance. Additionally, compensation measures for nesting birds and roosting bats will be implemented prior to vegetation clearance. • For birds nesting compensation will be implemented prior to any felling activities commencing through the provision of a suitable quantity of nest boxes / platforms to be placed on suitable habitat, e.g., pylons, trees, structures. The nest boxes and platforms should be sited in the direction of adjacent habitats and be targeted to the species preferences onsite. • Similarly for bats a series of Roost compensation measures will be implemented as part of the ecological mitigation strategy for the dam project. Roost compensation will be targeted to the roosting preference of bat species present onsite. For both crevice and cavity dwelling species bat boxes will be installed within adjacent retained habitats prior to any vegetation clearance commencing. Additionally, where feasible confirmed bat roosts located during the pre-felling inspections will be translocated to within adjacent retained woodland habitat. For woodland specialists veteranisation will also be prescribed to compensate for the loss of potential roost features within trees, to address the successional growth delay in the mitigation woodland	Pre-construction (Months 1–6): Plan preparation, baseline surveys, and early compensation works Construction Phase (Years 1–2): Phased clearance, timing restrictions, and mitigation implementation Operation Phase: Monitoring, adaptive measures, and progressive habitat restoration	Full project footprint including forested areas, aquatic zones, riparian corridors, temporary workspaces, and access routes	Lead: Project Biodiversity Specialist Support: Bat Specialist, Freshwater Ecologist, EPC Environmental Manager, Fish/Mussel Translocation Team

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
	disturbance/displacement of Bat species	planting. Veteranisation will be implemented within targeted areas of adjacent retained woodland to the proposed reservoir, as advised by a bat ecologist prior to implementation Additionally, before undertaking any vegetation clearance construction areas and tree protection zones should be demarcated prior to the start of the construction activities in order to reduce the area of vegetation to be cleared and protect retained habitats from incursions. Temporary demarcation could be provided by highly visible wooden sticks (50 cm high) planted into the ground and /or flagging tape, while a more permanent fencing solution can be sought for areas of sensitivity. **Construction Phase:** Timing of construction activities should avoid critical life stages for species, such as breeding, migration and hibernation periods. It is recommended from a precautionary and best-practice approach that any habitat, structures or buildings cleared during construction follows the following: • For birds vegetation clearance should be undertaken outside of the breeding bird season (March – August inclusive). If works do occur in the breeding season, the area should be thoroughly checked for bird nests by a competent ecologist no more than 48hrs before any clearance. If nests are found in the area to be cleared, works should be delayed until the breeding attempt has naturally concluded, i.e., fledged chicks • For bats, vegetation clearance or demolition should be undertaken while avoiding critical life stages for bats. Specifically, the maternity (between May and August) and hibernation (November to March) periods. If winter vegetation clearance / demolition cannot be avoided ,trees and buildings that are marked for felling or demolition will be inspected during the bat active season of that particular winter . Any roosts that are discovered will need to be excluded and compensated for prior to the hibernation period. Additionally, during these periods any new ground disturbance activities will also be limited. In those cases where due to technical or operational reasons the suggested construction restriction periods cannot be fulfilled, additional measures shall be applied, such as the use of additional monitoring by competent bat ecologist to ensure that there are roosts for bats in an area prior to work in these sensitive areas or sub-areas. Site clearance will be phased to target the central area of vegetation clearance, extending to the site peripheries to displace species evenly and effectively into			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		neighbouring habitats. Throughout every phase of the project the ECoW will be consulted to ensure that every effort is sought to minimise disturbance and impacts to adjacent retained habitat. Furthermore, any new areas of construction to be assessed through conducting baseline surveys before any commencement of construction activities (e.g. disused quarries or new/proposed infrastructure not currently part of the design). In addition to the above the following will also be actioned as part of the Sensitive Site Clearance Strategy: • If spreading of invasive / non-native species is observed, an appropriate eradication program will be developed and implemented. an appropriate eradication program will be developed and implemented. • Conduct awareness among employees and contractor working on site about the protected species/habitats. Awareness and on-site training will be provided to employees and contractors about the protected species/habitats potentially present in the area, as well as avoidance and mitigation measures. Specific protocols or procedures will be developed and constantly monitored in the event any wildlife is encountered. • Proposed sediment traps will be micro sited through consultation with the ECoW and biodiversity specialists. • Areas cleared during construction for temporary use will be progressively restored, in accordance with agreement with landowner. (e.g., aiming production of a stable vegetative cover to minimize erosion, dust and spreading of invasive / non-native species). • Artificial lighting, where required, will be restricted to the site compound and areas of current construction work. • Avoid the creation of barriers, such as big lights that could significantly impede bats passage to move around the project area. **Aquatic Habitats:** Timing of construction activities in river should avoid critical life stages for species, such as spawning. The fish species in the project area are typically gravel-bed summer spawners.			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		Species Translocation - where instream works or dewatering are required, they will be carried out under the supervision of a suitably qualified Ecological Clerk of Works (ECoW) with a freshwater ecology and fisheries specialism and experience of overseeing construction activities in or near water. The ECoW role will involve overseeing the dewatering process and fish translocation to move fish from impacted areas. This would involve managing the drawdown rate, based on the abundance of fish, through liaison with the fish translocation team. Fish translocation would take place prior to dewatering in order to move fish from impacted areas to suitable habitat elsewhere. Netting and/or electric fishing techniques would be used, under the appropriate Serbian licenced and consent. Impoundment – prior to reservoir impoundment, TSM will be translocated to suitable sites upstream or downstream of the reservoir. This will be done under the appropriate Serbian licence, by a suitable qualified mussel specialist.			
Action 6 Develop and implement a Pollution Control Strategy	Degradation / pollution of habitats Pollution, noise, and light that cause indirect habitat degradation Disturbance and displacement of birds, bats and terrestrial fauna. Accidental killings and injury from the collision with the vehicles Introduction / spread of invasive / non-native species (INNS)	Implement a **Water Quality Management Plan** to prevent pollution from construction runoff, accidental spills, and operational discharges. Measures will include sediment traps, silt fences, and regular water quality monitoring for parameters such as temperature, dissolved oxygen, and turbidity. During operation, special attention will be given to managing water releases to prevent thermal pollution from dam discharge, ensuring temperature regulation to match natural river conditions and protect aquatic life. Develop and enforce best practices for **handling hazardous materials**, including proper storage, transportation, and disposal to minimize the risk of accidental spills. Training programs will be conducted for construction and operational staff to ensure compliance with environmental standards and emergency response procedures. Implement **erosion and sediment control measures**, such as vegetative buffers and soil stabilization techniques, to prevent sedimentation that can degrade water quality and aquatic habitats. Establish a **continuous monitoring** and reporting system to track potential sources of pollution and habitat degradation, allowing for timely intervention and adaptive management strategies. Habitat degradation, including the infestation of invasive species, is a significant concern and is addressed under **Action 1** of this Biodiversity Action Plan. **Noise generated by heavy machinery and transport, air pollution from dust and emissions** will be mitigated by measures such as noise barriers and dust suppression techniques.	Pre-construction (Months 1–6): Planning, baseline water quality testing Construction Phase (Years 1–2): Implementation of control measures and ongoing monitoring Operation Phase: Discharge management, noise/dust control, routine checks	Entire project footprint, including reservoir zone, access roads, watercourses, and construction areas	Lead: Environmental Manager (EPC Contractor) Support: Pollution Control Officer, Biodiversity Specialist, Health & Safety Officer, Independent Environmental Auditor

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		Avoid storage of large quantities/volume of waste by removing frequently/regularly any food waste or similar attractants for animals, especially carnivores. **Significant noise and human activity should be limited** as much as possible to reduce potential disruption of terrestrial and riparian fauna. Employees must be **restricted from engaging in hunting** while on duty. **Vehicle movement will be restricted to the existing roads (including haul roads)** that connect the Project site with the surrounding areas. Off-road driving will be prohibited to avoid any unnecessary disturbance of natural vegetation. Keep vehicles clean. This includes **not leaving food, lubricants, antifreeze, oils, or hydrocarbons in vehicles**. Some animals are attracted by them. Restriction in the form of **speed limits and animal crossing signs** on the access road and enforce speed limit along the site access road; if necessary, install speed bumps and noise stripes on straight sections of the access road. Prior to construction operatives will be trained on the code of conduct and care for wildlife through a series of routine **toolbox talks** that will be delivered to all operatives working in proximity to sensitive habitats. As part of these toolbox talks specific protocols or procedures will be developed and constantly monitored in the event any wildlife is encountered.			

Action 7
 	
Develop and implement an Aquatic Enhancement Plan
	Habitat fragmentation and species displacement	Approximately 5.3km of lotic riverine aquatic habitats upstream of the proposed dam (Zone 1) will be replaced by stillwater (lentic) habitats. Aquatic habitats within the proposed reservoir inundation area (based on 145m water level) are:
		
		• Littoral zone of inland surface waterbodies (EUNIS code C3) – 1.3 ha
		  • Surface running water (EUNIS code C2) – 5.3km, comprising
		  • Epipotamal streams (EUNIS code C2.31)
		  • Sparsely vegetated river gravel banks (EUNIS code C3.55)
		
		Loss-gain analysis (**Error! Reference source not found.**) has calculated the river loss (~5.3km) to equate to 3.18 Quality Hectare Units.
		
		The loss of these riverine habitat will be offset, according to Quality Hectares approaches, through delivery of the actions set out in the Aquatic Enhancement Plan. Actions will be delivered upstream and downstream of the proposed dam. Opportunities in the vicinity of the dam (i.e. within the expropriation area and upstream catchment) will be prioritised, however Srbijavode has identified significant areas of ecologically-connected (via river/riparian corridor) land adjacent to River Tamnava (immediately downstream of the Ub-Tamnava confluence to upstream of the Kolubara River) to
			Pre-construction (Months 1–6): Connectivity assessments and design of fish pass/e-flow regime
			
			Construction Phase (Years 1–2): Installation of enhancement measures
			
			Operation Phase: Monitoring and adaptive management of
				Ub River corridor downstream of the dam, including redundant weirs, and within the influence zone of the new reservoir
				
				Off-site, where appropriate in the Sava catchment
					Lead: Aquatic Ecologist / River Restoration Expert
					
					Support: EPC Design Engineers, Hydrologist, Local Fisheries Agency, Biodiversity Monitoring Team

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		deliver offsite aquatic enhancement downstream of the dam (Appendix **Error! R eference source not found.**). It should be noted PWMC Srbijavode manages water and water land in the Republic of Serbia, in accordance with the Law on Waters. Water land includes riverbeds, riverbanks, embankments, access roads, and other elements necessary for the use, protection, and maintenance of water facilities. This land is classified as public water property and cannot be privately owned. The law clearly stipulates that "Srbijavode" has the right to carry out works related to the construction, maintenance, and use of water infrastructure, as well as the implementation of flood protection measures. If these activities require the temporary use of private land, this is permitted (even without the owner's consent), provided that appropriate compensation is given and a decision is issued by the competent authority. This legal framework ensures that PWMC Srbijavode can feasibly implement activities related to the improvement of erosion control, sediment management and aquatic habitats without procedural obstacles. It should be noted that despite this legal framework in Serbia that permits Srbijavode to undertake riparian works, any proposals and subsequent works will need to be screened against the requirements of PR5 (Land Acquisition, Involuntary Resettlement and Economic Displacement) and any social mitigation required, associated to change of use in the riparian zone and social impacts implemented. Appendix **Error! Reference source not found.** shows the river lengths available u pstream and downstream of the proposed dam where riparian improvements could be made under Srbijavode's aforementioned riparian rights. The extent of the land available to Srbijavode for offsite habitat offset is provided in Appendix **Error! R eference source not found.**; this includes a total of approximately 32.4 hectares (10.30 ha, 18.29 ha, and 3.85 ha in the Brović, Piroman and Veliko Polje sub-municipalities respectively) of land located immediately adjacent to the Tamnava River; the total length of river channel within this zone is approximately 10km. To inform the Loss-Gain analysis for riverine habitats and inform the draft Aquatic Enhancement Plan, the following Tasks have been proposed, or are completed: 1. PWMC Srbijavode to map areas within 10, 20, 30km from the project area and areas within the Ub to Sava watershed closest to the project (within their ownership and jurisdiction). **Timescale:** Pre-disclosure **Status:** Completed - The extent of the riparian land and river channel available to Srbijavode for offsite enhancement is provided in Appendix A.9. This land/river	connectivity and flow		

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		channel is additional to available land with the expropriation area and in the vicinity of the proposed dam, which will be investigated further as part of detailed design and in advance of construction. 2. Undertake a review of mapped areas, confirmation of availability and desktop based, high-level, suitability assessment. Defining prioritisation for future on-site survey to determine suitability. **Timescale:** Pre-disclosure **Status:** Completed – a desk-top review of the river habitat within the offsite land parcels (Appendix A.9) has been undertaken. The land is located adjacent to River Tamnava between the river channel (~10km in total) and the flood embankment. This land is predominant a mix of meadows, grassland and shrubs, with patches of broadleaved woodland. Some of this area was visited as part of the aquatic biodiversity / otter surveys; they are subject to anthropogenic impacts such as mowing, fly-tipping of house-hold and agricultural litter, and proliferation of invasive species (e.g. black locust *Robinia pseudoacacia* and tree of heaven *Ailanthus altissima*). Based on current information (note follow up site visits are planned – see below), areas of the river channel are considered suitable to deliver the proposals in the Aquatic Enhancement Plan, specifically riparian improvements and litter removal. Riverine / riparian habitat enhancement / creation in these areas will be designed and implemented in conjunction with the terrestrial/riparian habitat enhancement and creation (see BMP Action 1). River / riparian habitat types will confirmed, and enhancement opportunities mapped, along with the current condition of the habitats during the proposed site visits and ground-truthing (see below). 3. Undertake walkover surveys of riverine / riparian habitats within the offset areas. Opportunity mapping and suitability assessment of the land within the offset areas to deliver the measures in the Aquatic Enhancement Plan will be undertaken. **Timescale:** During-disclosure period **Status:** To be completed. This task will involve walk over surveys to a) characterise the riverine EUNIS categories present, to align with the baseline studies and b) assess the condition of the riverine/riparian habitats, which will feed into the site selection process (i.e. identification of the most suitability areas to deliver aquatic enhancements). This opportunity mapping will inform the draft Aquatic Enhancement Plan. Data collected will feed into an update of the riverine Loss-Gain analysis (see Task 4 below).			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		4. Develop draft methodology for riverine offset based on the selected areas and requirements set out in the ESIA (mitigation needed in each of the selected areas) with timeline for offset implementation and cost estimate. **Timescale:** During-disclosure period **Status:** To be completed. Based on the findings of Task 3. The Loss-Gain analysis for riverine habitats will be updated using the Quality Hectare approach. 5. Finalisation of the draft Aquatic Enhancement Plan, including riverine offset calculation using Quality Hectares approaches. The draft Aquatic Enhancement Plan (inc. offset) will be submitted to Lenders for approval. Note that whilst the draft of the Aquatic Enhancement Plan (inc. offset) will demonstrate that PR6 compliance can be achieved, this iteration of the document will focus on the offsite areas. Opportunities in the expropriation zone and upstream of the proposed dam will be completed post-financing as part of the detailed design; this will be implemented in a coordinated way with the of sediment control measures proposed for upstream rivers. **Timescale:** During-disclosure period **Status:** To be completed, based on Tasks 1-4 set out above. 6. Finalisation of the Aquatic Enhancement Plan, including riverine offset calculation using Quality Hectares approaches. This final draft of the Aquatic Enhancement Plan (inc. offset) will include all agreed commitments and be submitted to Lenders for approval. This will include elements located in the vicinity of the dam, expropriation area and upstream, as well of offsite measures on the Tamnava River. **Timescale:** Pre-construction **Status:** To be completed, based on Tasks 1-5 set out above Construction activities will be phased to minimize disruption, and temporary habitat refuges will be provided. The construction of the dam will result in the physical separation of the river, leading to population fragmentation of aquatic species. Similarly, the formation of a larger water body will alter habitats for terrestrial species, potentially causing displacement and fragmentation of their populations. One of the proposed management measures to mitigate these impacts includes the **mitigation of downstream barriers to migration** to enhance connectivity along the remaining river length. Improving fish passage and this increasing connectivity for fish in the lower River Ub. This could be achieved by fish passage improvements / creation of a fish pass at redundant weir (formerly for the			

Action / receptor	Identified Impacts	Mitigation, Management or Monitoring Measure	Timeframe	Locations	Responsible party
		purpose of a fishery) that is acting as a barrier to all fish species (see Figure 13 Section 5.1.2). **Riparian enhancement and buffer strips** - to help offset the described losses in river habitat, degraded sections of river habitat will be identified and improved. These measures can be implemented through Srbijavode's aforementioned riparian rights, both upstream and downstream of the proposed dam. This may be achieved by restricting cutting/mowing with a defined buffer of the river to enable natural re-vegetation of the riparian zone and through the use of fencing to restrict access for grazing up to the water's edge. Access to water for grazing would be via designated fenced locations. Upstream enhancement will be implemented in a coordinated way with the of sediment control measures proposed for upstream rivers. These include: Double living wicker – Five braids at a distance of 5-10m. Up to 90 braids to be planted. Success will be assessed through monitor braid and bank stability. Afforestation in/or adjacent to the river. Ilofilters (forest grass belts) and improved agricultural practices and prohibition on poor agricultural practices (including buffer strips) to reduce bank erosion and sediment ingress. The **removal of solid waste (including plastics and fly-tipped material)** will be removed at key locations where it forms around logjams. The benefit of removing natural material (logjams) will be assessed by a suitable qualified freshwater ecology. The reservoir itself will also likely collect solid water that will be removed and disposed of cleansing downstream section of the River Ub. Aquatic enhancement will also be delivered through improved hydrological conditions during drought, that offer more resilient for aquatic habitats. This will be achieved by delivery of a sustainable E Flow, included the Serbian minimum flow in summer which will be higher than baseline in dry years. Drought is something that has been previously hindered the River Ub, suffering extreme droughts— the E Flow will help maintain continuous flow and favourable conditions over a longer stretch downstream of the dam. Given the significant rise in pollution levels downstream, especially beyond the city of Ub, maintaining the e-flow will also contribute to improving the water quality / chemical status of the River Ub downstream through increase dilution, compared to baseline. **Species Monitoring** programs (BMP Action 2) will assess species movement and habitat use, adjusting mitigation measures as needed to optimize connectivity and minimize displacement effects.			

8.8 Net Gain Strategy

The Pambukovica Dam project aims to align with international biodiversity conservation standards, including the principles of No Net Loss (NNL) and Net Gain (NG). These principles emphasize avoiding and minimizing impacts on biodiversity during project planning and implementation, restoring degraded ecosystems, and offsetting residual impacts to achieve a net positive outcome for biodiversity. Such variations in water levels necessitate an adaptive management plan, outlining key strategies for mitigating ecological impacts.

The strategy for achieving NG for this project is built on four key pillars:

- Avoidance of critical biodiversity features (Figure 26) during planning and design.
- Implementation of effective mitigation measures (see chapter 8.3) to minimize biodiversity impacts.
- Restoration and enhancement of impacted ecosystems.
- Biodiversity offsets, where necessary, to address residual impacts.

8.8.1 Avoidance and Minimization Measures:

- The project design has been adjusted to avoid areas with high ecological sensitivity, particularly woodlands.
- Construction activities will be restricted to defined zones to minimize habitat disturbance and fragmentation.
- Equipment and material storage areas will be located away from sensitive habitats.

8.8.2 Restoration and Enhancement Measures:

- A Habitat Management, Enhancement and Offset Plan will be implemented, focusing on restoring degraded terrestrial habitats impacted during construction.
- Native species planting will be prioritized in restoration efforts to enhance habitat quality and connectivity.
- Replanting and the formation of new habitats, in line with the offset strategy, will commence before vegetation removal to ensure that the newly established habitats have time to develop and effectively replace the lost ones.
- Long-term monitoring programs will assess the success of restoration and inform adaptive management.

8.8.3 Offset Strategy

- Residual impacts on high-value habitats will be offset through the creation or enhancement of equivalent habitats in nearby locations where possible and offsite as required (see Appendix **Error! Reference s ource not found.**).
- A Biodiversity Net Gain (BNG) metric has been applied to quantify habitat losses and ensure a net positive outcome. This uses Quality Hectares approaches. The offset will be delivered through the Habitat Management, Enhancement and Offset Plan (BMP Action1) which will be an iterative document that will evolve throughout the Project life-cycle under the oversight of a suitable qualified biodiversity specialist. This includes aquatic habitats. Figure 37 show some potential location where habitat enhancement could create richer, more connected woodland habitats adjacent to river, within the offsite areas adjacent to the Tamnava River. Further downstream locations suitable for offset are presented in Figure 35, Figure 36, Figure 37 and Appendix 9.

8.8.4 Monitoring and Reporting:

Regular monitoring of terrestrial habitats will track the effectiveness of avoidance, restoration, and offset measures. Results will be shared with stakeholders to maintain transparency and accountability.

8.8.5 Freshwater Habitats

The freshwater habitats impacted by the project, including the littoral zones and running water ecosystems, support a diverse range of aquatic species and provide essential ecological functions.

8.8.5.1 Avoidance and Minimization Measures:

- Construction activities near watercourses will be minimized, with strict buffer zones established to protect riparian and aquatic habitats.
- Erosion and sediment control measures, such as sediment traps and silt fences, will be installed to prevent sedimentation in water bodies.
- Residual impacts on aquatic habitats will be offset through the enhancement of riverine habitats upstream and downstream of the proposed dam. This will be focussed in nearby locations where possible and offsite as required (see Appendix A.9). Figure 37 show some potential locations where habitat enhancement could create richer, more connected riparian habitats.
- Maintain sustainable E Flows, including the delivery of the Serbian minimum flow during periods of drought to preserve and increase the ecological resilience of downstream ecosystems.

8.8.5.2 Restoration and Enhancement Measures:

Degraded riparian zones will be restored by planting native vegetation to stabilize riverbanks and improve water quality.

8.8.5.3 Monitoring and Reporting:

Continuous monitoring of water quality, aquatic biodiversity, and habitat conditions will be conducted to evaluate the success of the NNL/NG strategy for freshwater habitats. Adaptive management will address any emerging issues or gaps.

8.8.6 Biodiversity Net Gain Calculation

The required habitat creation is calculated using Quality Hectares approaches in **Error! Reference source n ot found.**. Post development habitat areas are shown in Figure 35 (expropriation area) , Figure 36 and Figure 37 and Appendix 9 (offsite areas).

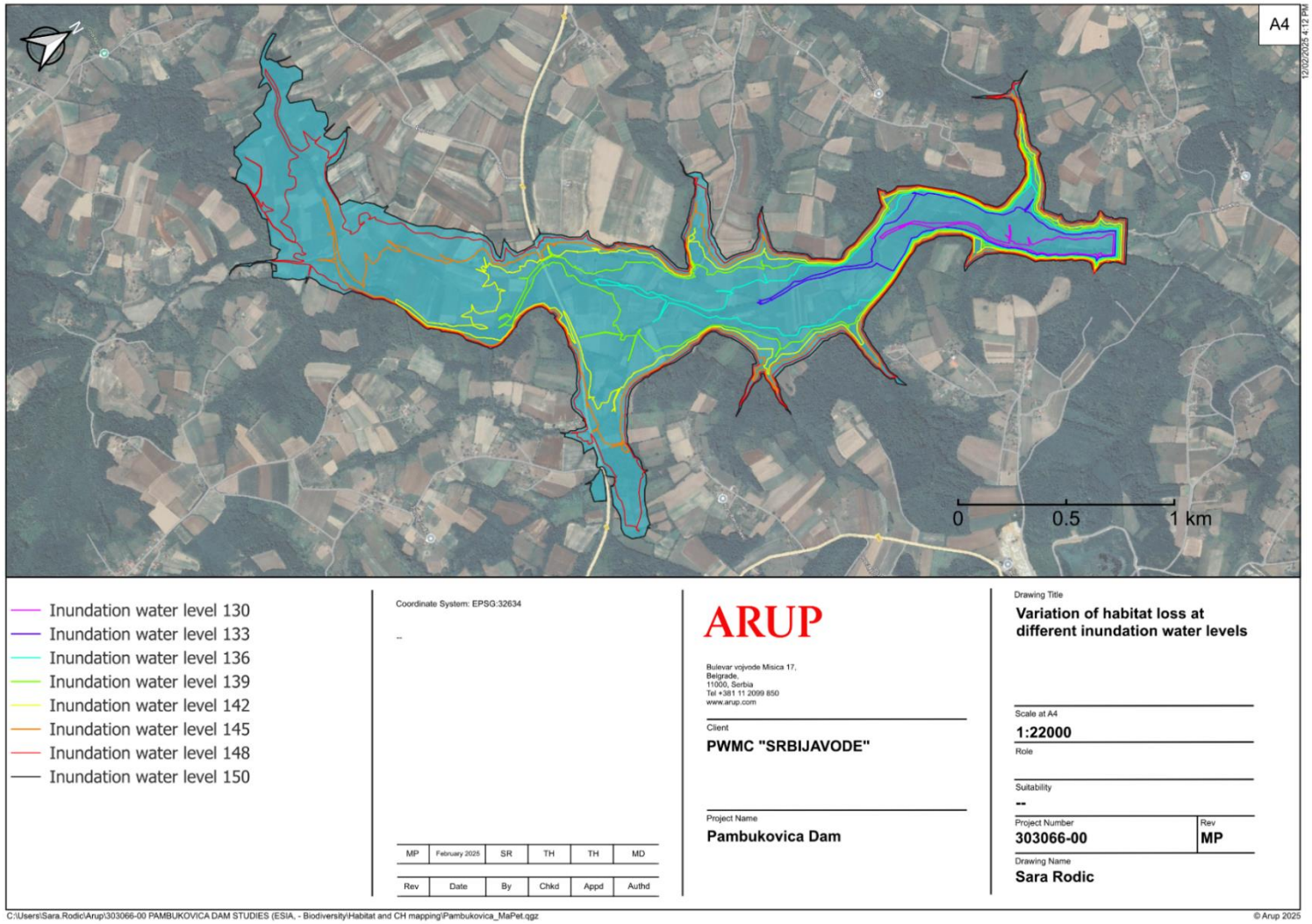


Figure 34 - Variation of habitat loss at different inundation water levels

Table 67 - Variation of habitat loss at different inundation water levels

Code	EUNIS Habitat	With Bufer Zone (ha)	130 m	133 m	136 m	139 m	142 m	145 m	148 Q1000	150 Dam Crest
J4	Transport networks and other constructed hard-surfaced areas	2.94	0	0	0.01	0.21	0.67	1.07	1.59	1.93
J2	Low density buildings	1.82	0	0	0	0	0	0.07	0.44	0.63
I1	Arable land and market gardens	187.143	1.43	8.95	23.3	40.95	61.09	79.79	102.99	125.83
E2	Mesic grasslands	17.578	0.12	0.69	0.71	0.81	2.46	5.08	6.38	8.28
E7	Sparsely wooded grasslands	21.91	0.08	1.11	1.81	2.76	3.95	4.93	7.3	9.19
F9.123	Balkan riverine willow scrub	1.86	0	0	0	0	0	0	0.01	0.07
G1.69	*Fagetum moesiace submontanum typicum* woodland	29.16	0.03	0.17	0.37	0.62	1.05	1.82	2.99	4.14
G1.76811	*Quercetum frainetto-cerris* woodland	67.14	0	0.39	1.86	3.57	6.07	9.47	13.29	17.18
G1.C3	*Robinia pseudoacacia* woodland	23.99	0.06	1.33	2.12	4.27	8.65	10.81	14.4	15.93
G1.1	Riparian and gallery woodland, with dominant *Alnus glutinosa/Populus nigra/Salix alba*	22.68	1.21	2.54	3.9	4.71	6.87	8.55	10.47	12.33
G5	Lines of trees, small anthropogenic woodlands, with dominant Populus nigra cv. italica.	9.55	0.02	0.34	1.14	2.28	2.71	3.11	3.62	4.54
C3	Littoral zone of inland surface waterbodies	1.8	0.21	0.44	0.73	0.95	1.12	1.3	1.55	1.71
C2: C2.31 C3.55	Surface running water,comprising Epipotamal streams Sparsely vegetated river gravel banks	5.07	0.59	1.4	2.14	2.7	3.09	3.68	4.45	4.87
Sum all		392.641	3.75	17.36	38.09	63.83	97.73	129.68	169.48	206.63
Sum CH		176.748	2.26	7.08	12.66	18.4	27.32	37.94	50.06	62.31
Habitat maps according to water level in **Error! Reference source not found.**			**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**	**Error! Reference source not found.**

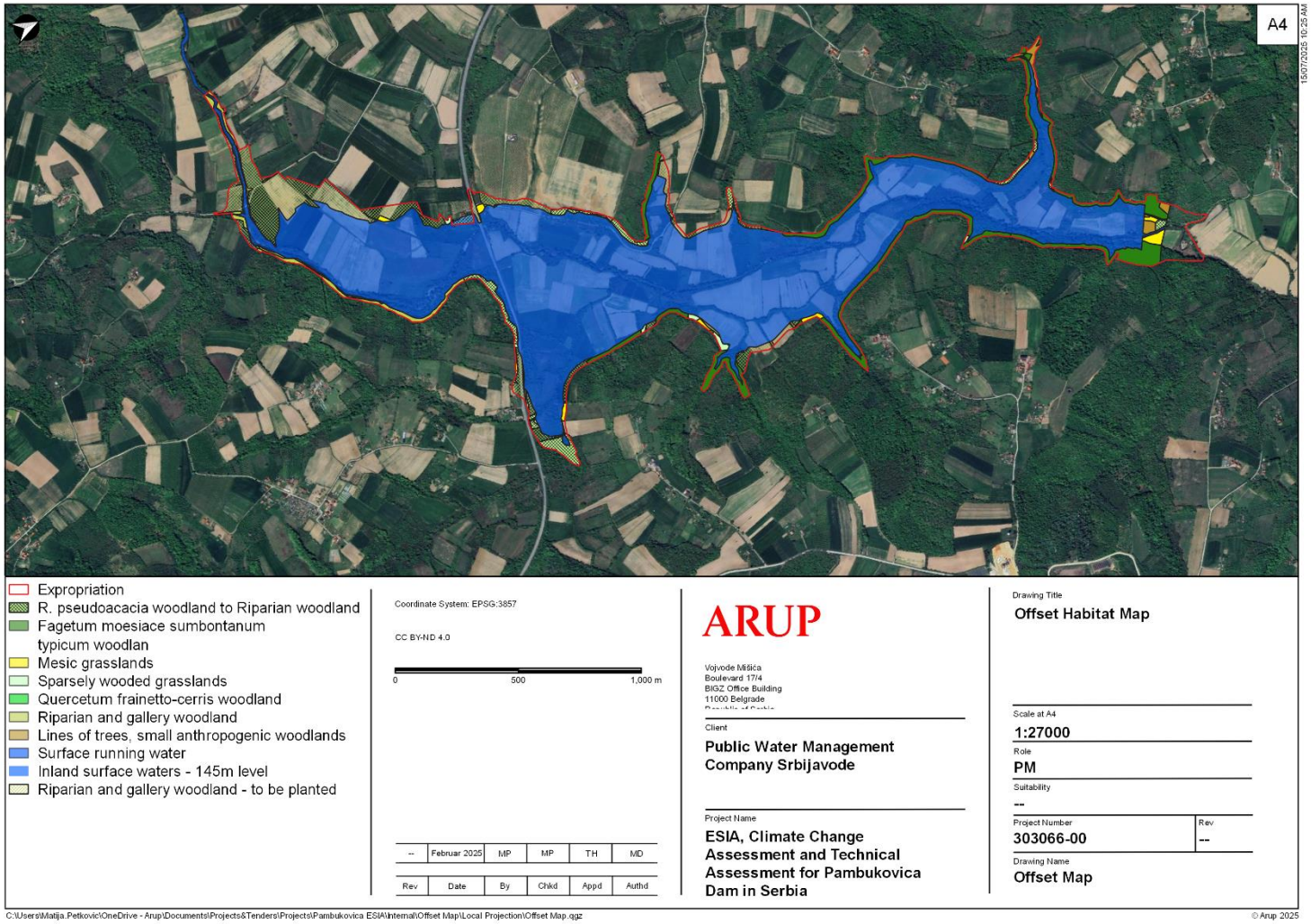


Figure 35 -Offset Habitat Map – inside expropriation zone

Table 68 - Habitat net-gain calculation for 145 m

EUNIS code	EUNIS habitat name	Baseline			Offset			Analysis		
		Area (ha)	Condition	QH Unit Baseline	Area (ha)	Condition	QH Post-Dev (ha)	% Net Gain QH	Net Gain (ha)	Targeted % Net Gain*
E2	Mesic grasslands	c	0.8 - Fairly High	4.06	5.59	0.8 - Fairly High	4.47	10.04	0.51	10
E7	Sparsely wooded grasslands	4.93	0.6 - Moderate	2.96	5.92	0.8 - Fairly High	4.74	60.11	0.99	20
G1.69	Fagetum moesiace submontanum typicum woodland	1.82	0.8 - Fairly High	1.46	2.46	0.6 - Moderate	1.48	1.37	0.64	35
G1.76811	Quercetum frainetto-cerris woodland	9.47	0.8 - Fairly High	7.58	12.75	0.6 - Moderate	7.65	0.98	3.28	35
G1.1	Riparian and gallery woodland, with dominant Alnus glutinosa/Populus nigra/Salix alba	8.55	0.6 - Moderate	5.13	10.26	0.6 - Moderate	6.16	20.00	1.71	20
G5	Lines of trees, small anthropogenic woodlands, recently felled woodland, early-stage woodland and coppice	3.11	0.4 - Poor	1.24	3.73	0.6 - Moderate	2.24	79.00	0.62	20
C3	Littoral zone of inland surface waterbodies	1.3	0.6 - Moderate	0.78	1.56	0.6 - Moderate	0.94	20.00	0.26	20
C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	5.30**	0.6 - Moderate	3.18**	See **Error! Reference source not found.** and explanation below					20
C1	Surface standing waters	0	See chapter on freshwater habitats		128.79	0.6 - Moderate	77.27		128.79	

The total amount of critical **habitats lost** due to the flooding is **34.26 ha and 5.3 km river** .

The total amount of critical **habitats gained**, excluding areas with standing water, is **42.27 ha**, while the standing water gain is 128.79 ha.

* 10% ‘area’ net gain has been applied for habitats with a short time to target condition period, while a 20% gain has been applied to habitats with a longer time to condition period. 35% ‘area’ net gain has been applied to G1.69 *Fagetum moesiace submontanum typicum* woodland and G1.76811*Quercetum frainetto-cerris* woodland habitats; this is to account for the precautionary post-development ‘moderate’ condition for this habitat type and provide a ‘Quality Hectares’ net gain. Quality Hectares net gain may be greater should these woodland habitats achieve a higher condition than ‘moderate’

** Only the surface running water habitat is measured in kilometres, not hectares.

Error! Reference source not found. presents a habitat net-gain calculation, comparing baseline (pre-development) habitat conditions with post-development conditions to evaluate changes in habitat area, quality, and net ecological value. It categorizes habitats by EUNIS codes and names, providing initial area, condition, and Quality-Weighted Habitat (QH) units before development. The post-development scenario updates these values to reflect changes in habitat conditions.

The decrease in post-development habitat quality in certain areas is primarily due to the slow growth and formation of natural habitats, particularly woodlands, which take time to reach their full ecological potential. As a result, these habitats have been assigned a lower quality status than recorded at baseline.

Overall, the total critical habitat loss due to flooding is 34.26 ha, while the total critical habitat gains, excluding standing water, is 42.27 ha. The standing water habitat increases by 128.79 ha, which, with proper management, has the potential to be categorized as critical in the future. The net changes indicate a shift in habitat composition, with certain ecosystems expanding at the cost of others. This analysis helps assess the ecological impact of development, ensuring that biodiversity considerations are factored into project planning and mitigation strategies.

Error! Reference source not found. outlines the baseline river habitat units lost a result of the Project, along with some hypothetical offset scenarios (to be finalised as the Aquatic Enhancement Plan develops) using the Quality Hectares (QH) approach. Given that it is not technical feasible to create entirely new river systems, the focus of the offset is on enhancing the ecological quality of existing surface running water habitats, rather than expanding their spatial extent. This will be achieved through BMP Action 7 Aquatic Enhancement Plan. The objective is to achieve a net gain of 20% in overall habitat value, which can be realized by upgrading habitat condition in areas of existing habitat (e.g. through an increase in habitat condition from poor to moderate to fairly high ecological status).

This approach acknowledges the longer time required for some elements of the riparian improvements, such as riparian trees in aquatic systems to stabilise and function ecologically. Therefore, a 20% gain factor is applied to offset areas to account for the time to target condition. Improvements include transitioning habitats from poor (0.2) to fairly poor (0.4) to moderate (0.6) to fairly good (0.8) or poor (1) condition, based on factors such as substrate quality, water flow, riparian vegetation structure, and biological community health. Pristine habitat conditions were not recorded during the baseline surveys and are not expected to be present in downstream areas either. Similarly, it is not anticipated that habitats of pristine quality will develop within the foreseeable timeframe. This assumption has been applied as a precautionary approach in the offset planning, ensuring that expectations remain realistic and mitigation measures are based on achievable ecological outcomes. The strategy ensures functional gains in biodiversity value and long-term resilience of the river corridor, even without full structural reconstruction of the riverbed.

Table 69 - Potential River habitat net-gain calculation

EUNIS code	EUNIS habitat name	Baseline				Potential Offset		
		River Length (km)	Condition	Q River Lenghtht Unit Baseline	Q River Lenghtht Unit Offset	From Condition	QRiver Lenght Post-Dev (km)	Targeted % Net Gain
C2: C2.31 C3.55	Surface running waters: Epipotamal streams Sparsely vegetated river gravel banks	5.30	0.6 - Moderate	3.18	3.81	0.2 - Poor ↓ 0.4 – Fairly Poor	19.08 km at 0.2 Up 1 condition classes	20
						0.6 – Moderate ↓	9.54 km at 0.4 Up 2 condition classes	
						0.8 - Fairly Good ↓ 1 - Good	3.31 km at 0.6 Up 3 condition classes	

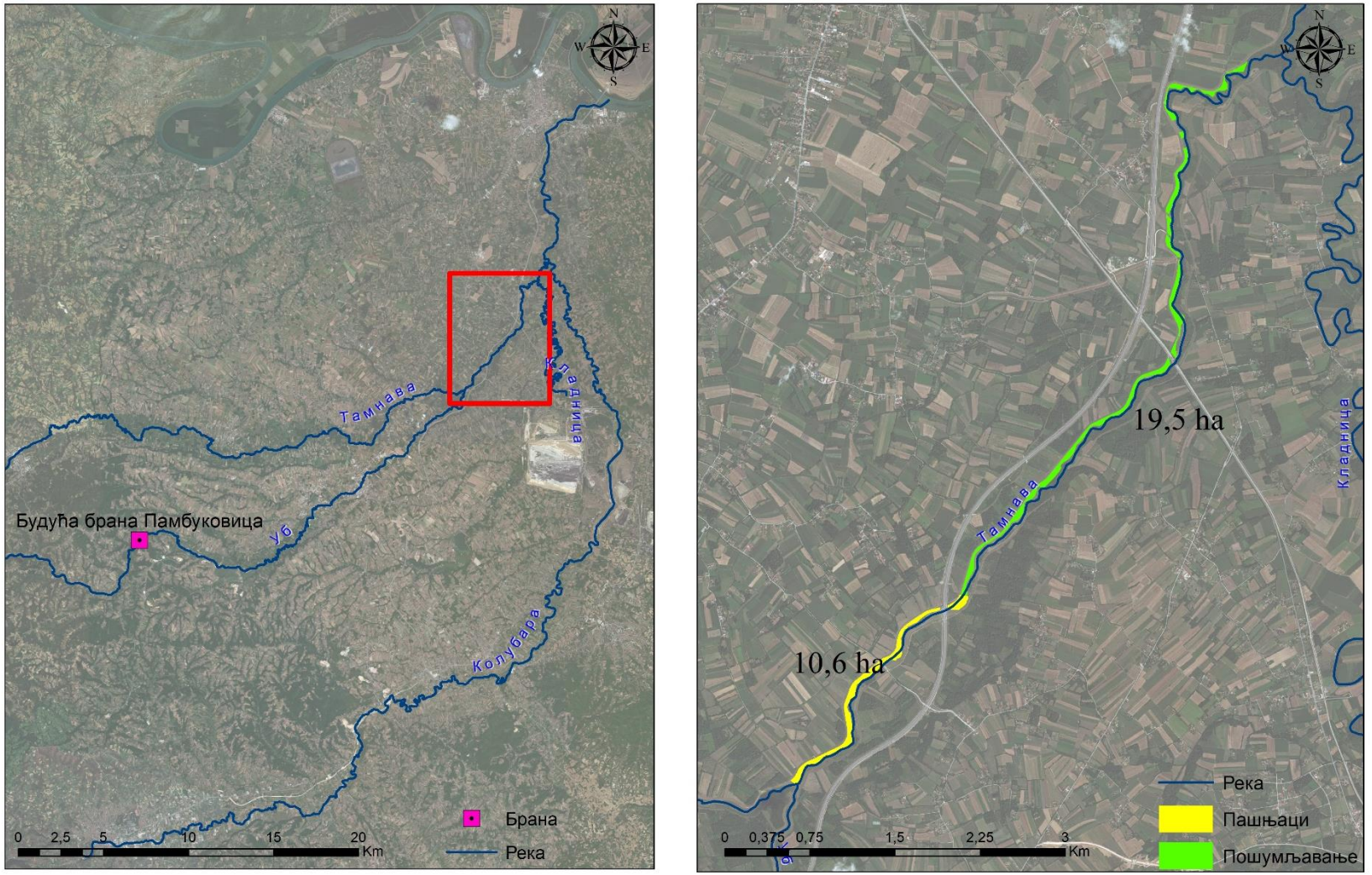


Figure 36 - Offset Habitat Map – Offsite Opportunity Area

Figure 37 - Offset Habitat Map – Example Offsite Opportunity Sites

8.8.7 Terrestrial Habitats

Rather than being permanently lost or fragmented, many terrestrial and riparian habitats will transition into wetland or aquatic ecosystems, forming new ecological niches that support biodiversity. This natural succession process will result in the gradual establishment of riparian and wetland habitats along the new shoreline, maintaining ecological connectivity and providing critical habitats for aquatic and semi-aquatic species.

The offset strategy will account for these dynamic habitat shifts by ensuring that biodiversity conservation measures are adaptive and responsive to long-term hydrological changes. Gradual habitat transition will allow former terrestrial and riparian zones to evolve into wetland ecosystems rather than being entirely lost, supporting species adapted to fluctuating water levels. Natural regeneration and targeted restoration efforts will promote the establishment of stable riparian vegetation, enhancing ecosystem resilience. Monitoring programs will track changes in species composition and habitat structure, informing further adaptive management strategies to mitigate biodiversity impacts. Maintaining linkages between terrestrial, riparian, and aquatic habitats will ensure that species can migrate and adapt to new environmental conditions.

The estimated area of future habitat zones connected to inland surface waterbodies for the upcoming lake at various water levels was calculated using the following equation:

$$\text{Habitat type} = \text{Shoreline Length} * \text{Average Habitat Zone Width}$$

For the littoral zone, an average width of 3 meters was assumed, based on a moderate slope model for the lake's shoreline and the existing littoral zone of the river.

As the lake forms as part of the dam project, these habitats will be created by the rising water levels, and their area will increase accordingly. By multiplying the shoreline length at each water level by the assumed average width, the total area of each habitat type at different water levels was determined. These estimations are critical for assessing the development of new habitats and will inform offset strategies aimed at mitigating potential ecological impacts.

Table 70 - Habitat gain according to water level and their width

EUNIS Code	EUNIS Habitat	130 m	133 m	136 m	139 m	142 m	145 m	148 m Q1000	150 Dam Crest
	Lake border length (m)	2772.2	4185.5	6636.9	9354.1	12127.6	14052.0	19348.8	20219.9
C3 Estimation	Littoral zone of inland surface waterbodies	0.83	1.26	1.99	2.81	3.64	4.22	5.80	6.07
C1	Surface standing waters	3.74	17.29	37.99	63.62	97.18	128.79	168.14	204.26

Robinia pseudoacacia woodland, dominated by the invasive species black locust, is mostly found bordering riparian and gallery woodlands. Without the presence of black locust, these habitats would resemble those found in more natural environments. This species should be eradicated as per the future Invasive Species Management Plan, with native plants such as *Alnus glutinosa, Populus nigra*, and *Salix alba* being planted to help transform the habitat into a natural one. This will make the area suitable for species classified as CH (critical habitats) in this study. The area of *Robinia pseudoacacia* woodland, located between the future water line of 145m and the expropriated land, spans 2.99 hectares. Being in close proximity to water supports the transformation of this habitat into a riparian one.

The arable land occupying the area between the future water line of 145m and the expropriated land zone presents an opportunity to modify and transform the habitat into a natural one, covering an area of 14.03 hectares. Since this area will be in contact with the future water line, riparian and gallery woodland should be chosen as the habitat type. This type of habitat will be lost in an area of 8.55 hectares due to flooding.

The remaining habitats that need to be offset due to the flooding, totalling 26.08 hectares, include:

- Mesic grasslands: 5.59 ha
- Sparsely wooded grasslands: 5.92 ha
- *Fagetum moesiace submontanum typicum* woodland: 2.46ha
- *Quercetum frainetto-cerris* woodland: 12.75ha

To enhance the ecological integrity of the area, these habitats should be incorporated into the expansion of the lake's border zone. Establishing riparian and gallery woodland at the water line offers multiple benefits as a Nature-based Solution (NbS). These habitats play a crucial role in stabilizing the soil, preventing erosion and landslides, and enhancing bank resilience against flooding events. Additionally, they contribute to water quality improvement by filtering pollutants, reducing nutrient runoff, and enhancing sediment retention. Riparian woodlands also support local biodiversity by providing habitat for key species, including those classified as Critical Habitat (CH) in this study. Furthermore, they act as natural carbon sinks, contributing to climate change mitigation by sequestering carbon dioxide. Their presence also improves microclimatic conditions, reducing extreme temperature fluctuations and enhancing overall ecosystem resilience. Due to the stable water levels expected during the first phase of operation, as defined by usage and operational rules, the development of shoreline riparian habitats is anticipated. These habitats are likely to fully establish and extend to the shoreline, particularly along the gentle slopes that will make up the majority of the future lake perimeter. Once the irrigation phase begins, slight water level fluctuations may occur; however, by that time, the riparian zone is expected to be fully developed and resilient to such changes.

Arable land surrounding the project site could be purchased and, depending on its location, transformed into the necessary habitat for offset. Steeper plots, primarily those near the dam, should be converted into *Fagetum moesiace submontanum typicum* woodland or *Quercetum frainetto-cerris* woodland to enhance soil stability, preventing erosion and landslides. Meanwhile, arable land on flatter terrain can be selected based on the required habitat types, ensuring connectivity with the future lake's green belt.

It is also possible to convert *Robinia pseudoacacia* woodland by removing invasive black locust and planting oaks or beech trees (*Fagus* sp.), transforming it into one of the required habitats for offset. The plots with this habitat border the future lake and are mostly unused by their owners, which has led to infestation with invasive species.

All potential threats from tree diseases should be taken into account when designing terrestrial habitat offsets, particularly those involving woodland restoration. Emerging diseases can compromise the success of long-term offset objectives by affecting tree survival, canopy development, and overall habitat functionality. One such concern is Beech Leaf Disease (BLD), an emerging threat to beech-dominated forests[78]. Caused by the foliar nematode *Litylenchus crenatae* ssp. *mccannii*, Recent detections and concerns about its arrival in Europe have raised alarms over its potential impact on European beech (*Fagus sylvatica*), a common and ecologically valuable species used in woodland offsets.

BLD leads to dark interveinal striping on leaves, bud damage, crown thinning, and ultimately tree decline or death within a few years, particularly in saplings. Given these risks, offset plans involving beech forests must be approached with caution. Measures should include monitoring for disease symptoms, avoiding large-scale monocultures of susceptible species, sourcing planting stock from disease-free nurseries, and integrating a mix of resilient native species to reduce vulnerability. By incorporating disease risk into offset design, restoration efforts can be made more robust and resilient under both ecological and climate-related pressures.

By implementing this habitat transformation, the project will not only offset habitat loss but also contribute to long-term ecological stability, improve ecosystem services, and align with sustainable land and water management practices.

8.8.8 Aquatic Habitats

Loss of surface running water habitat is almost impossible to offset with a like-to-like habitat, according to EBRD guidelines. However, considering that due to climate change, the Ub River is experiencing prolonged

[78] https://holdenfg.org/blog/new-study-confirms-beech-leaf-disease-threatens-european-beech-trees-too/?utm_source=chatgpt.com

stagnation during summer, the transformation into a surface standing water habitat may be less problematic for aquatic organisms detected in the baseline study.

The formed lake could serve as a future refugium for several detected aquatic endangered species, offering suitable habitat conditions for their survival. Based on ecological requirements, the following assessments can be made:

Species likely to thrive in the lake ecosystem:

- Balkan loach (*Cobitis ohridana* or related species) – Can adapt to still or slow-moving waters.
- Spined loach (*Cobitis taenia*) – Tolerant of lake environments with suitable sediment.
- Green hawker (*Aeshna viridis*) – Dependent on aquatic vegetation, which can be established in the lake.
- River clubtail (*Gomphus flavipes*) – Suitable habitat conditions can be provided if the lake bottom consists of sandy or silty sediments, which are essential for larval development.
- Thick-shelled river mussel (*Unio crassus*) – Can inhabit the lake if appropriate fish hosts are present to support its larval (glochidia) development. To enhance the survival of this species, an experimental fishpond could be established to propagate and breed only suitable host fish species. These fish could then be periodically released into the lake to sustain *Unio crassus* populations.

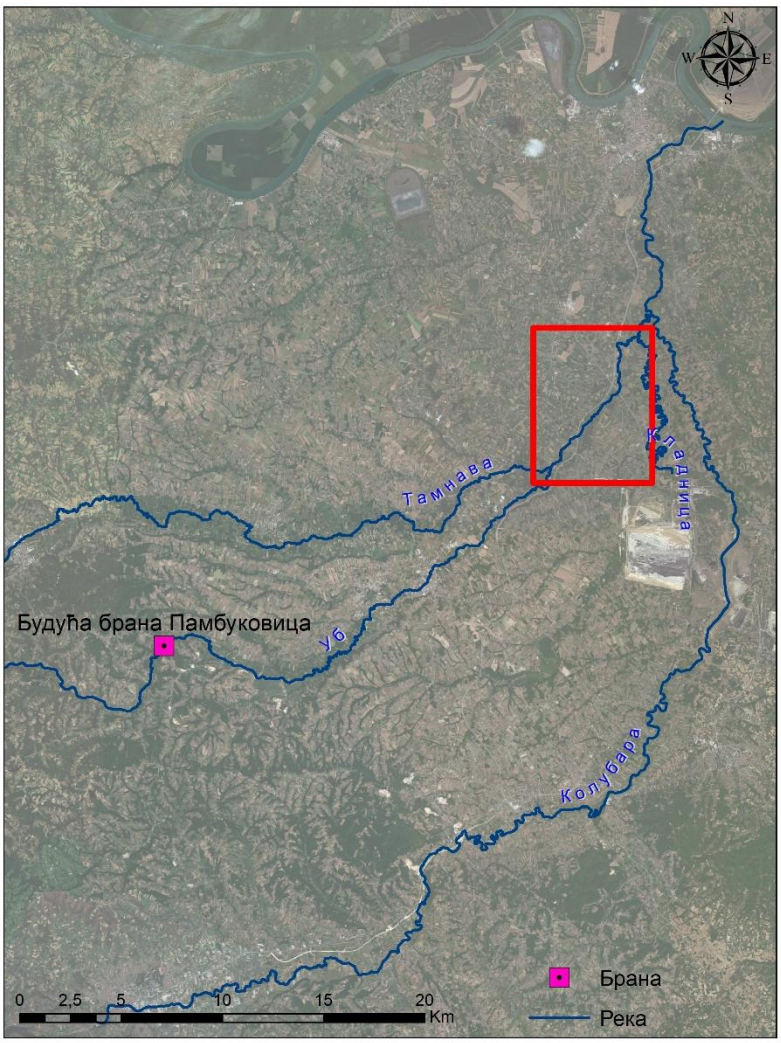
Species unlikely to thrive in the lake ecosystem:

- Green snaketail (*Ophiogomphus cecilia*) – Requires clean, fast-flowing water, making a lake environment unsuitable. However, gravel-bed riverine habitats suitable for this species are widespread upstream and downstream of the proposed dam. Downstream habitat will become more resilient to drought as a result of the Serbian minimum flow to be releases in summer; in drier periods/years this minimum flow will be greater than the baseline scenario.

With appropriate habitat design, including the presence of host fish species for *Unio crassus* (potentially supported by an experimental fish breeding program) and ensuring sediment composition suitable for *Gomphus flavipes*, the lake could function as a valuable refugium for five out of the six listed species, enhancing local biodiversity and conservation efforts.

Figure 35 -Offset Habitat Map – inside expropriation zone

and



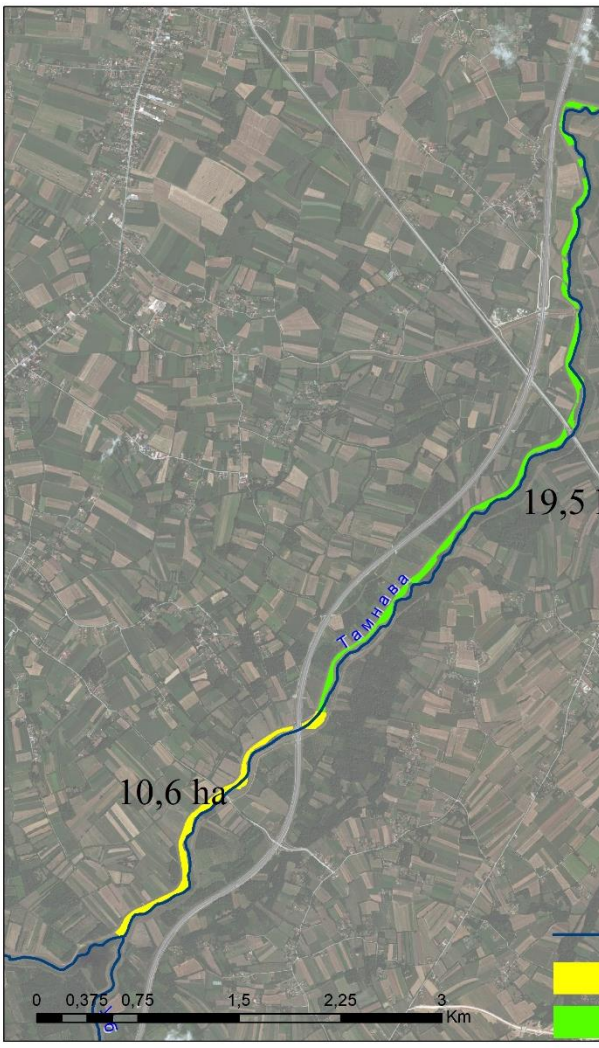


Figure 36 are illustrating the potential habitat map and habitat areas of the proposed lake and its surrounding area, as informed by the offset strategy.

To achieve the targeted 20% net gain in river habitat value, the offset strategy focuses on improving the ecological condition of existing river segments rather than expanding habitat area. This will be accomplished through a series of practical enhancement measures. Riverbed and bank clean-up operations will be conducted to remove accumulated waste, debris, and unnatural obstructions, which currently degrade habitat quality and limit the movement and reproduction of aquatic species. In parallel, riparian zone restoration will play a key role—by planting native vegetation along riverbanks, erosion will be reduced, shading improved, and nutrient input regulated, all of which contribute to better water quality and microhabitat diversity. These restored buffer zones will also support biocleaning functions, filtering runoff and stabilizing sediments, which in turn benefit aquatic invertebrates and fish. By systematically improving physical structure, water quality, and riparian complexity, the overall ecological status of the habitat can be raised from poor or moderate to fairly high condition over time—meeting the requirements for net gain under the Quality Hectares framework.

8.8.9 Summary

To compensate for the residual impacts on critical habitats due to flooding and associated infrastructure, the Pambukovica project applies a biodiversity offset strategy guided by the Biodiversity Net Gain (BNG) principle and quantified using the Quality Hectares (QH) approach.

A portion of this offset will be implemented within the expropriation zone, specifically in the transitional strip between the future reservoir shoreline (defined by the 145 m contour) and the boundary of the

expropriated land. This area offers an immediate opportunity for habitat restoration and transformation, particularly the conversion of *Robinia pseudoacacia* woodland and arable land into riparian and gallery woodlands. These efforts will both compensate for the loss of similar habitats due to inundation and enhance the ecological function of the lake's perimeter by stabilizing soils, improving water quality, and supporting species of conservation concern.

In addition to these areas, stands of *Fagetum moesiace submontanum typicum* and *Quercetum frainetto-cerris* woodland located within the expropriated zone and outside of the future flood area offer further potential for ecological enhancement. These woodlands, which will be preserved, can be improved through targeted management actions aimed at increasing their structural complexity and suitability for bats and birds, including the installation of artificial roosting and nesting structures, selective thinning, and veteranisation techniques

However, the offset potential within the expropriated area is not sufficient to fully address the scale of habitat loss. Therefore, additional land will need to be secured outside the expropriation zone to complete the offset requirements. This external land will be selected based on its suitability for the restoration of habitats that were lost, including mesic grasslands, sparsely wooded grasslands, and native woodlands. In total, the offset measures are expected to deliver a net gain of critical terrestrial habitats, exceeding the amount lost and contributing to long-term landscape resilience. These gains, while initially established at moderate quality, are expected to improve over time through natural succession and targeted management interventions.

Offsetting the loss of surface running water habitat is challenging, as true like-for-like replacement is not feasible within the reservoir footprint. However, due to existing stagnation in the Ub River during summer months, the transition to standing water may not significantly worsen conditions for several aquatic species recorded during baseline surveys.

While the reservoir will provide new aquatic habitat, these combined measures aim to retain and enhance remaining flowing water ecosystems, achieving the closest possible approximation to like-for-like compensation within the Ub River catchment.

A.1 Bat Activity Survey Technical Reports

(See separate file)

A.2 River Ub Habitat Map

(See separate file)

A.3 Fish Biomass Calculations 2023

(See separate file)

A.4 Fish Biomass Calculations 2024

(See separate file)

A.5 Conservation-important / “Priority” Species Map

(See separate file)

A.6 Inundation Area Maps

(See separate file)

A.7 Bird Species Observed at Dokmir Fishpond (Based on 2003 Study)

(See separate file)

A.8 Potential Habitat Offset Areas (Offsite)

(See separate file)

A.9 River Catchment Upstream and Downstream of the Proposed Dam

(See separate file)

A.10 Potential Habitat Offset Areas

(see separate file)