

# PROJECT SUMMARY FOR KOVILJ- PETROVARADIN MARSH, SERBIA

**EU 4 Green: Support the implementation of the Green Agenda for the Western Balkans**

WP1-16: Biodiversity: Integrated Management of Floodplains in Protected Areas

Deliverable WP1-16\_Del-1 Project summary for each study area of the 6 economies

**February 2026**

## Project Summary for Kovilj-Petrovaradin marsh, Serbia

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**Responsible EU Member State project lead:**

Laura Hohoff

**Authors:**

Katharina Huchler

Stefan Fuchs

Martin Suanjak

**With contributions from:**

Mirjana Ćuk, Dimitrije Radišić, Thomas Ellmauer, Philipp Semenchuk, Peter Tramberend

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## ABBREVIATIONS

<b>EC</b>	European Commission
<b>CLC</b>	CORINE Land Cover
<b>CLC+B</b>	CLCplus Backbone
<b>EU</b>	European Union
<b>GIS</b>	Geographic Information System
<b>IUCN</b>	International Union for Conservation of Nature
<b>NbS</b>	Nature-based Solutions
<b>NGO</b>	Non-Governmental Organisation
<b>SDF</b>	Standard Data Form for Natura 2000 sites
<b>SRB</b>	Serbia
<b>WB6</b>	Western Balkans (Albania, Bosnia and Herzegovina, Kosovo <sup>1</sup> , Montenegro, North Macedonia and Serbia)

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<sup>1</sup> This designation is without prejudice to positions on status, and it is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo\* declaration of independence.

# PREFACE

The world of nature largely depends on the human factor, especially regarding the conservation of biodiversity. At the same time, human well-being depends on biodiversity. The Western Balkans (WB6) are engaged in efforts to safeguard biodiversity, striving to balance the demand for development with the necessity for environmental conservation.

The project EU4Green: Support the implementation of the Green Agenda for the Western Balkans (short: EU4Green) assists the WB6 – Albania, Bosnia and Herzegovina, Kosovo<sup>1</sup>, Montenegro, North Macedonia, and Serbia – in greening their economies and in enhancing monitoring and reporting as well as aligning with the EU standards. It is also tightly linked to the Green Agenda for the Western Balkans (GAWB)<sup>2</sup>. The project includes different pillars, with one of them being biodiversity. Financed by the European Union (EUR 10 million) and the Austrian Development Agency (EUR 1 million), the project was implemented by the Environment Agency Austria in cooperation with public authorities and institutions of the WB6. The project was implemented from 2022 to 2025.

EU4Green Biodiversity activities placed their focus on floodplain ecosystems as they encompass a naturally high but threatened biodiversity and unique spatial and temporal variability, while providing important functions and services to landscapes and humans. Shaped by the rivers and the adjacent wetlands and floodplain forests, they are an important and characteristic natural feature of the WB6, in terms of nature conservation but also for recreation and (eco-)tourism. They are increasingly recognized as key assets for the Green Agenda for the Western Balkans. Providing biodiversity conservation, carbon storage, and climate resilience, they are the backbone of a sustainable landscape and its biological heritage. Their protection and restoration align with EU Directives and strategies, underscoring their role in regional ecological and rural development<sup>3,4</sup>. Yet, they are threatened by river regulation, land-use changes and pollution. Due to their many-faceted character, floodplain ecosystems need conservation measures that maintain their various functions in an integrative way, considering a wide range of different natural assets and their threats. Thus, they act as suitable case studies for training and applying methodologies related to nature conservation.

EU4Green Biodiversity activities provided such trainings and materials to support the WB6 in three thematic fields – species and habitats of Natura 2000 network, Nature-based Solutions, and connectivity. This report outlines the most important background information, used methodologies and achieved results and outputs of the covered topics for the case study of Serbia (SRB). Furthermore, the methods used for gathering all knowledge presented in this report can be transposed to other ecosystems, habitats and species.

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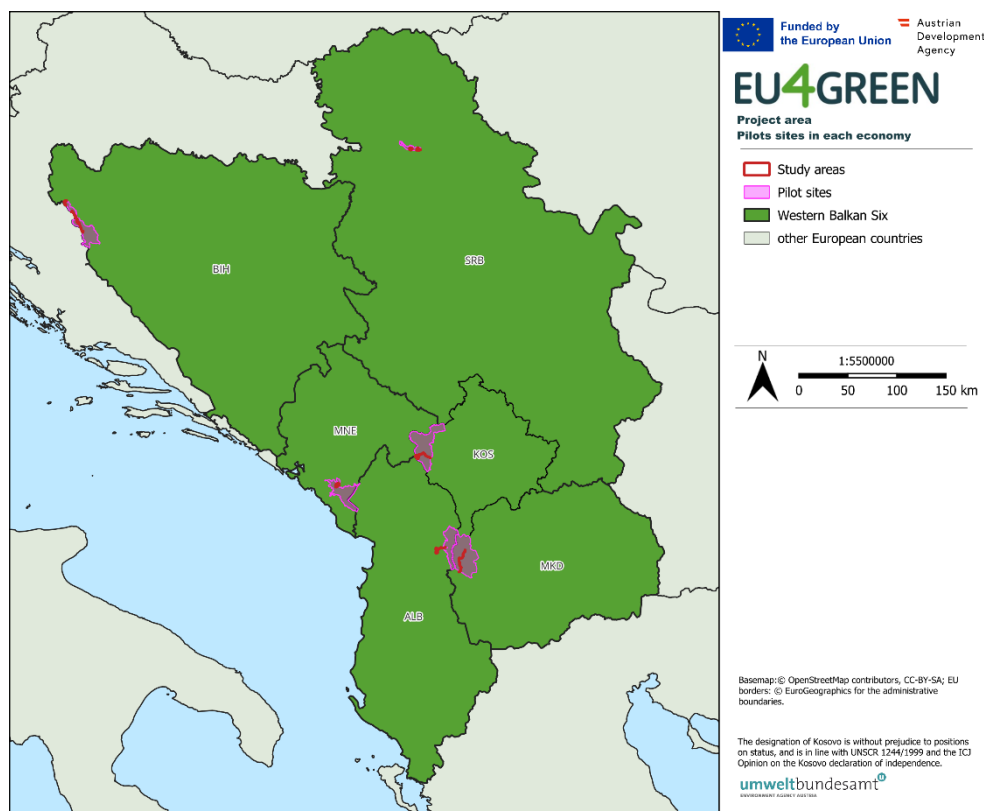
<sup>2</sup> EUROPEAN COMMISSION, 2020. Green Agenda for the Western Balkans. Brussels: European Commission. Available at: [https://neighbourhood-enlargement.ec.europa.eu/system/files/2020-10/green\\_agenda\\_for\\_the\\_western\\_balkans\\_en.pdf](https://neighbourhood-enlargement.ec.europa.eu/system/files/2020-10/green_agenda_for_the_western_balkans_en.pdf)

<sup>3</sup> EUROPEAN ENVIRONMENT AGENCY, 2019. Floodplains: a natural system to preserve and restore. EEA Report No 24/2019. Publications Office of the European Union, Luxembourg.

<sup>4</sup> EUROPEAN COMMISSION, 2020. An Economic and Investment Plan for the Western Balkans: Green Agenda for the Western Balkans. COM(2020) 641 final. Brussels: European Commission.

# 1. EU4GREEN'S PILOT SITE IN SERBIA

The activities of the EU4Green project were conducted within six pilot sites – one in each economy (Figure 1), selected by the National Focal Points at the beginning of the project.



**Figure 1: The six pilot sites in the economies of the Western Balkans.**

In Serbia, the Kovilj-Petrovaradin marsh was chosen. Established as a Special Nature Reserve (SNR) in 2011 by decree and protected by Article 29 of the Law on Nature Protection, it is one of more than 130 SNRs in the Autonomous Province of Vojvodina<sup>5</sup>. It covers almost 4,840 hectares and is located in the alluvial plain of the Danube, about 20 kilometres downstream of Novi Sad. The SNR is primarily located on the northern (left) bank of the Danube, where the Kovilj marsh is located. But also, on the other side of the Danube, the Petrovaradin marsh belongs to the SNR. The third spatial unit is the island of Krčedin and the marsh area of Gardinovci village.

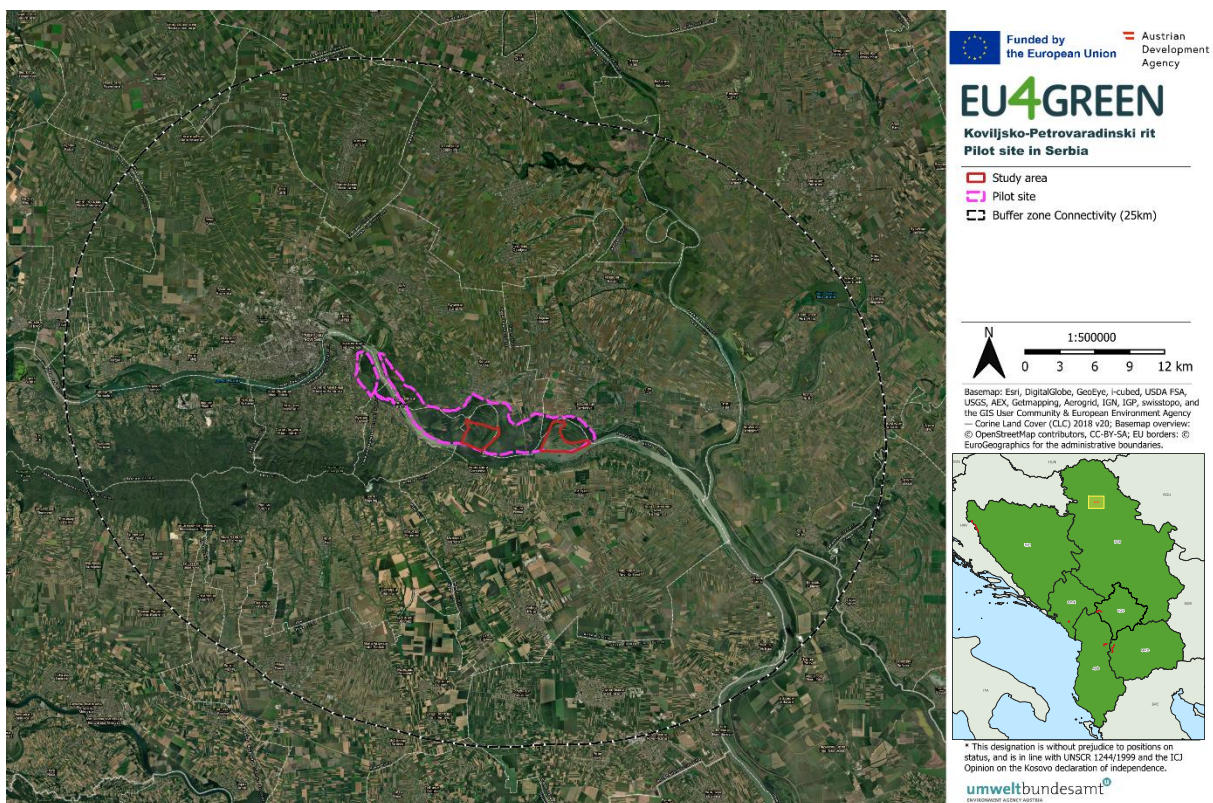
The Kovilj-Petrovaradin marsh represents the biggest preserved marsh complex along the Danube in Serbia. It features a high diversity of marshes (holms, backwaters, swamps and ponds), with forests and pastures in between. The complex of habitats is highly important

<sup>5</sup> Štetić, S. and I. Trišić, 2019. Use of Natural Tourism Potentials for Sustainable Development in the Special Nature Reserve "Koviljkopetrovaradinski rit" Vojvodina (Northern Serbia). Central European Journal of Geography and Sustainable Development, 1(1), p. 3-12.

for their native species communities, among them also for bird, fish and habitat diversity. First spatial protection efforts date back to 1970, and the SNR also is recognized as Important Bird Area by BirdLife International, as Important Plant Area and as Ramsar site. It is considered as a potential future Natura 2000 site.

As a complex of habitats surrounded by agricultural land and in close proximity to human settlements, the SNR Kovilj-Petrovaradin marsh faces threats and pressures. Known challenges are habitat loss, fragmentation (also due to urbanization and infrastructure development), the spread of invasive alien species, anthropogenic fires, uncontrolled fishing and poaching, overgrazing and eutrophication due to entry of fertilizers from adjacent agricultural land. The SNR is actively managed by the Public Enterprise Vojvodinašume, with a management plan in place and active monitoring activities, for example for White-tailed eagles.

Because each thematic field in EU4Green Biodiversity requires its own appropriate spatial scale, the analyses are conducted at different extents around the core study area or pilot site in Serbia. This ensures that the applied methods remain feasible and that the conclusions drawn from the elaborated outcomes are meaningful. As a result, each topic refers to a specific spatial extent and corresponding buffer zone (**Fehler! Verweisquelle konnte nicht gefunden werden.Fehler! Verweisquelle konnte nicht gefunden werden.**).



**Figure 2: The different spatial extents of the local activities carried out in and around SNR Kovilj-Petrovaradin marsh (depicted in pink). The core study area for mapping species and habitats of Natura 2000 sites (chapter Fehler! Verweisquelle konnte nicht gefunden werden., depicted in red) stretches along the river floodplain. The area assessed for connectivity (chapter Fehler! Verweisquelle konnte nicht gefunden werden., depicted in black) was derived by adding a buffer around the nature reserve’s borders.**



## 2. CONNECTIVITY

Authors: Martin Suanjak and Katharina Huchler, EAA

With contributions from: Philipp Semenchuk, EAA

### 2.1. Summary

The ecological connectivity of landscapes shapes species distributions, enables genetic exchange, and ensures long-term biodiversity conservation. In human-modified environments, habitat fragmentation threatens these processes, making the identification and preservation of ecological corridors essential. Protected areas risk isolation without connectivity to other relevant populations, ultimately reducing their effectiveness over time.

To address these challenges, a least-cost path analysis was performed to identify the “cheapest” corridors based on resistance maps. Using CORINE Land Cover data, resistance values were assigned to land cover classes for two target land cover classes: Broad-leaved forest and Natural grasslands. The Kovilj-Petrovaradin marsh in Serbia served as the study site, with a 25 km buffer zone analysed for ecological connectivity of the two target land cover classes. **Results** show that Broad-leaved forests are well connected through forests along the rivers, while Natural grasslands are less common and threatened with isolation. Conservation priorities include maintaining existing forest corridors and promoting land-use practices that sustain connectivity in designated corridors for Natural grasslands. The study acknowledges limitations such as reliance on expert judgment, data resolution, and temporal validity of the land cover dataset, but highlights the method’s simplicity as a practical tool for conservation planning. Ultimately, it underscores the need for strategic spatial conservation planning to secure ecological corridors and enhance biodiversity resilience within and between protected areas.

## 2.2. Introduction

The movement of organisms is a fundamental ecological process that influences species distribution, population dynamics, and evolutionary trajectories. This movement is shaped by a range of intrinsic and extrinsic factors, including life-history traits, landscape structure and environmental variability<sup>6</sup>. In an increasingly human-modified world, where habitat fragmentation and changes in climate disrupt natural landscapes, understanding and maintaining the functional connectivity of ecosystems is vital for biodiversity conservation.

Landscape connectivity refers to the degree to which the landscape facilitates or impedes movement of organisms among habitat patches<sup>7</sup>. It plays a central role in enabling gene flow across populations, enhancing species' persistence in fragmented habitats, and supporting ecological resilience under changing environmental conditions. Understanding these processes is of particular importance in the light of protected areas, which act as harbours for biodiversity in a more modified landscape. With increased development in the surroundings of protected areas, this effect gets more pronounced over time. For example, without appropriate buffer zones, landscape diversity shows greater decreases closer to national park borders<sup>8</sup>. The resulting isolation of protected areas undermines the effectiveness of long-term conservation of the local populations. However, quantifying connectivity across heterogeneous landscapes is complex and demands robust analytical approaches<sup>9</sup>.

To address this challenge, a variety of modelling tools and algorithms have been developed to simulate and map potential movement pathways. Among these, the least-cost path analysis has emerged as a widely applied method in connectivity modelling. This analysis identifies the 'cheapest' and most efficient route between two areas based on a resistance surface, which acts as a connectivity indicator mapping the 'cost', permeability or relative difficulty for an organism to traverse different habitats<sup>8,10,11</sup>. Although conceptually simple, this method provides valuable insights into likely movement patterns by highlighting important corridors and potential barriers and therefore supports the design of effective conservation measures along critical pathways facilitating the gene flow between populations.

The aim of this study is (a) to provide a simple method for the planning of corridors to enhance connectivity between populations which can be easily adapted to other areas or

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<sup>6</sup> NATHAN, R., W. M. GETZ, E. REVILLA, M. HOLYOAK, R. KADMON, D. SALTZ & P.E. SMOUSE, 2008. A movement ecology paradigm for unifying organismal movement research. In: *Proceedings of the National Academy of Sciences*, 105(49), 19052–19059. <https://doi.org/10.1073/pnas.0800375105>

<sup>7</sup> RUDNICK, D.A., S.J. RYAN, P. BEIER, S.A. CUSHMAN, F. DIEFFENBACH, C.W. EPPS, L.R. GERBER, J. HARTTER, J.S. JENNESS, J. KINTSCH, A.M. MERENLENDER, R.M. PERKL, D.V. PREZIOSI & S.C. TROMBULAK, 2012. The role of landscape connectivity in planning and implementing conservation and restoration priorities. In: *US Forest Service Research and Development*. <https://research.fs.usda.gov/treesearch/42229>

<sup>8</sup> KUBACKA, M., P. ŻYWICA, J.V. SUBIRÓS, S. BRÓDKA & A. MACIAS, 2022. How do the surrounding areas of national parks work in the context of landscape fragmentation? A case study of 159 protected areas selected in 11 EU countries. In: *Land Use Policy*, 113, 105910. <https://doi.org/10.1016/j.landusepol.2021.105910>

<sup>9</sup> ZELLER K.A., K. MCGARIGAL, A.R. WHITELEY, 2012. Estimating landscape resistance to movement: A review. In: *Landscape Ecology*, 27(6), 777–797. <https://doi.org/10.1007/s10980-012-9737-0>

<sup>10</sup> ADRIAENSEN F., J. CHARDON, G. DE BLUST, E. SWINNEN, S. VILLALBA, H. GULINCK & E. MATTHYSEN, 2003. The application of 'least-cost' modelling as a functional landscape model. In: *Landscape and Urban Planning*, 64(4), 233–247. [https://doi.org/10.1016/s0169-2046\(02\)00242-6](https://doi.org/10.1016/s0169-2046(02)00242-6)

<sup>11</sup> KUMAR S.U., S.A. CUSHMAN, 2022. Connectivity modelling in conservation science: a comparative evaluation. In: *Scientific Reports*, 12(1). <https://doi.org/10.1038/s41598-022-20370-w>

updated data sources and (b) to show outputs of this method to provide a first draft of potential corridors for efficient and effective nature conservation actions at the pilot sites.

## 2.3. Material and methods

### 2.3.1. Resistance map

The CORINE Land Cover 2018 dataset with a pixel size (resolution) of 100 m x 100 m was chosen as source for the resistance map. CORINE Land Cover (CLC) is a European-wide open-source land cover dataset developed under the Copernicus Programme, managed by the European Environment Agency<sup>12</sup>. Each CORINE land cover class<sup>13</sup> was assigned a resistance value based on expert judgment, reflecting its relative permeability with respect to the target ecological feature and using a discrete exponential scale (values 1, 2, 4, 8; see Table 1 Fehler! Verweisquelle konnte nicht gefunden werden.).

**Table 1: Resistance values of different CORINE land cover classes in relation to Natural grasslands and Broad-leaved forest, respectively. Resistance values are based on expert opinion and form the basis of the resistance maps.**

Level 3 Code	CORINE land cover class	Resistance value of	
		Natural grasslands	Broad-leaved forest
1.1.1	Continuous urban fabric	8	8
1.1.2	Discontinuous urban fabric	8	8
1.2.1	Industrial or commercial units	8	8
1.2.2	Road and rail networks and associated land	4	8
1.2.3	Port areas	8	8
1.2.4	Airports	4	8
1.3.1	Mineral extraction sites	8	8
1.3.2	Dump sites	8	8
1.3.3	Construction sites	8	8
1.4.1	Green urban areas	4	4
1.4.2	Sport and leisure facilities	8	8
2.1.1	Non-irrigated arable land	4	8
2.1.2	Permanently irrigated land	4	8
2.1.3	Rice fields	4	8
2.2.1	Vineyards	4	8
2.2.2	Fruit trees and berry plantations	8	4
2.2.3	Olive groves	4	4
2.3.1	Pastures	2	4
2.4.1	Annual crops associated with permanent crops	8	4

<sup>12</sup> CORINE Land Cover. [Retrieved November 12, 2025] <https://land.copernicus.eu/en/products/corine-land-cover>

<sup>13</sup> CLC Nomenclature EN. [Retrieved November 12, 2025] [https://clc.gios.gov.pl/doc/clc/CLC\\_Nomenclature\\_EN.pdf](https://clc.gios.gov.pl/doc/clc/CLC_Nomenclature_EN.pdf)

Level 3 Code	CORINE land cover class	Resistance value of	
		Natural grasslands	Broad-leaved forest
2.4.2	Complex cultivation patterns	4	4
2.4.3	Land principally occupied by agriculture, with significant areas of natural vegetation	2	2
2.4.4	Agro-forestry areas	4	2
3.1.1	Broad-leaved forest	8	1
3.1.2	Coniferous forest	8	2
3.1.3	Mixed forest	8	1
3.2.1	Natural grasslands	1	8
3.2.2	Moors and heathland	1	4
3.2.3	Sclerophyllous vegetation	4	2
3.2.4	Transitional woodland-shrub	4	4
3.3.1	Beaches, dunes, sands	4	8
3.3.2	Bare rocks	4	8
3.3.3	Sparsely vegetated areas	2	8
3.3.4	Burnt areas	4	4
3.3.5	Glaciers and perpetual snow	8	8
4.1.1	Inland marshes	4	8
4.1.2	Peat bogs	2	4
4.2.1	Salt marshes	4	8
4.2.2	Salines	8	8
4.2.3	Intertidal flats	8	8
5.1.1	Water courses	8	8
5.1.2	Water bodies	8	8
5.2.1	Coastal lagoons	8	8
5.2.2	Estuaries	8	8
5.2.3	Sea and ocean	8	8

### 2.3.2. Pilot site, buffer and target land cover classes

The Kovilj-Petrovaradin marsh was chosen as the pilot site to test the connectivity model in Serbia (see also chapter 1EU4Green's pilot site in Serbia). To assess the ecological connectivity of the pilot site with the surrounding area, a 25 km buffer was applied around the pilot site's boundary to form the buffer zone.

We analysed the same two CORINE land cover classes in all six study areas: Broad-leaved forest and Natural grasslands. Broad-leaved forest is the most common land cover type in all assessed sites, covering on average 37 % of the sites' area. They provide crucial ecosystem services such as clean drinking water and timber. Natural grasslands in Europe are biodiversity hotspots, often even at a small scale, but are threatened by land-use change<sup>14</sup>. They are a less common land cover class in the assessed sites, covering only 18 % on average. However, they provide vital ecosystem services such as areas for extensive grazing and play an important role in providing habitat for a wide range of (critically) endangered species (further information on ecosystem services in chapter 4.2.2).

### 2.3.3. Connectivity analysis

To test the connectivity of the largest patches of the target land cover, all directly connected pixels of the target land cover were classified as one patch. Subsequently, the connectivity was tested for the ten largest patches through a least-cost path analysis. The least-cost-path analysis was performed in R with the package *grainscape* (the annotated R code can be found in Annex I). The connectivity of each target land cover class was analysed separately.

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<sup>14</sup> HABEL, J.C., J. DENGLER, M. JANIŠOVÁ et al. 2013. European grassland ecosystems: threatened hotspots of biodiversity. In: *Biodivers Conserv* 22, 2131–2138 (2013). <https://doi.org/10.1007/s10531-013-0537-x>

## 2.4. Results and discussion

The study area around Kovilj-Petrovaradin marsh is a relatively densely populated area encompassing Novi Sad, a city of over 300,000 inhabitants. Most natural areas are found along the river Danube and its tributaries Tisa and Tamiš. Our target land cover classes of Broad-leaved forest and Natural grasslands cover 66 % and 1 % of the pilot site respectively.

### 2.4.1. Natural grasslands

Only one small patch of Natural grassland lies within the boundaries of the pilot site (Figure 3). This patch is poorly connected to larger expanses of Natural grassland near Zrenjanin and Farkaždin respectively (Figure 3, A & B). To improve the poor connectivity of Natural grasslands in the study area, establishing grassland corridors along the floodplain forest edge could help link fragmented habitats and provide a buffer against intensive agricultural land.

### 2.4.2. Broad-leaved forest

There are well connected Broad-leaved forests along the Danube and its tributaries (Tisa and Tamiš) and towards Fruška Gora National Park (Figure 4). Key ecological corridors are located near Sremski Karlovci (Figure 4, A) which facilitate the connectivity between the pilot site and Fruška Gora National Park. Due to the proximity of the city of Novi Sad, it will be important to protect corridors in this area from housing and industrial development. Larger woodland corridors are lacking across the high-intensity agricultural landscape.

### 2.4.3. Limits of the study

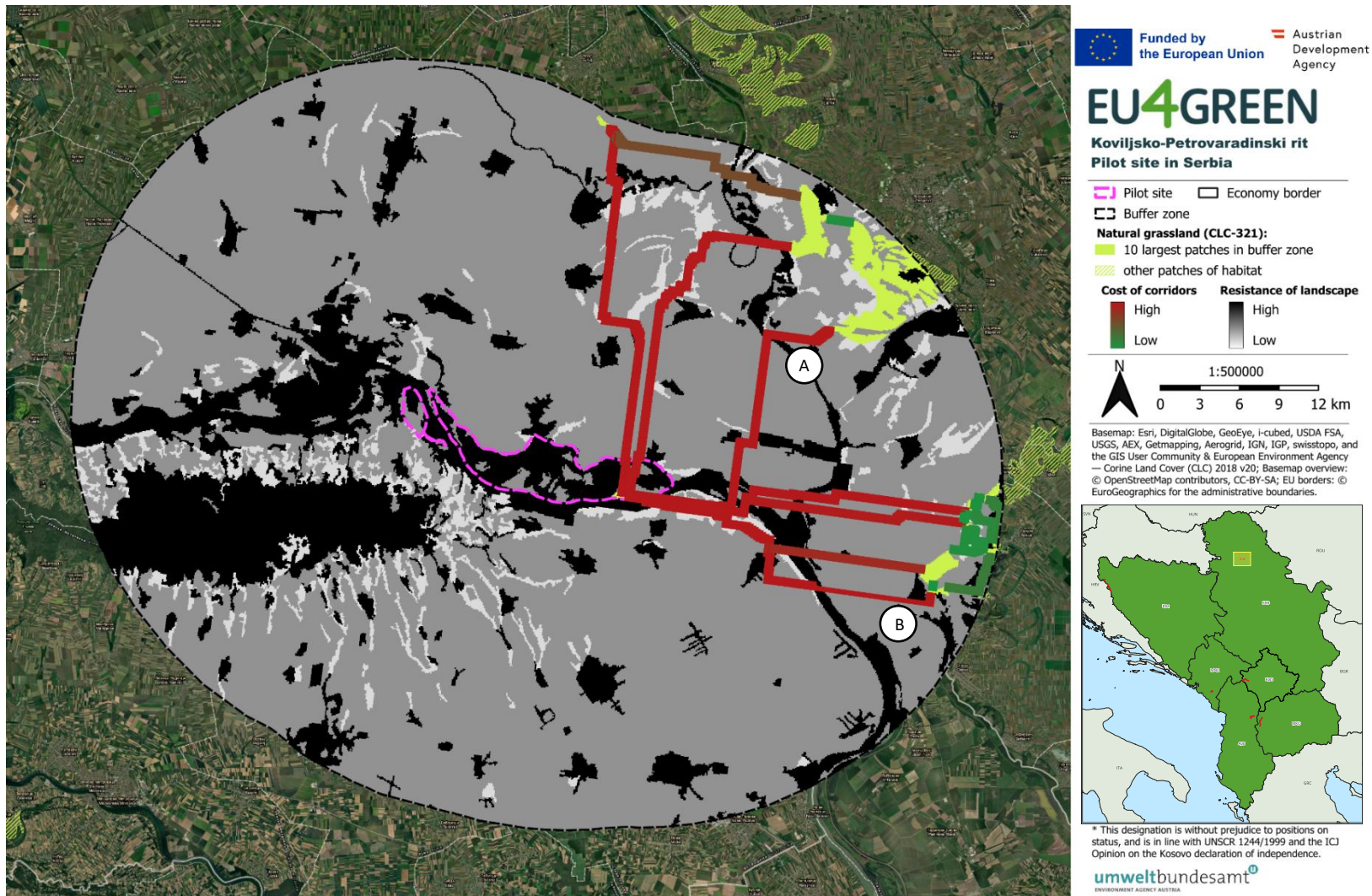
The least-cost path analysis offers a simple and recommendable scoping tool for gaining insights into connectivity at the local level. Clear advantages of the approach are its modest data requirements and simple application. However, the approach relies on several assumptions. The underlying cost landscape depends on expert judgement which is rarely tested with empirical data<sup>15</sup>. The spatial extent of the study area and resolution (pixel size) highly influences the output of the algorithm<sup>16</sup>. The used CORINE land cover data set is from 2018. Land use changes since 2018 have therefore not been accounted for. The next CORINE land cover data set is being released in 2026, and stakeholders are being advised to run the model with the provided code (Annex I) again to receive updated results. Another assumption is that organisms find and use these corridors, although individual preference and variability are not accounted for. The concept of least-cost path informed corridors is rarely tested with in-situ movement data<sup>17</sup>. The analysis could be taken further by verification of results through movement data, in-situ studies or expert knowledge.

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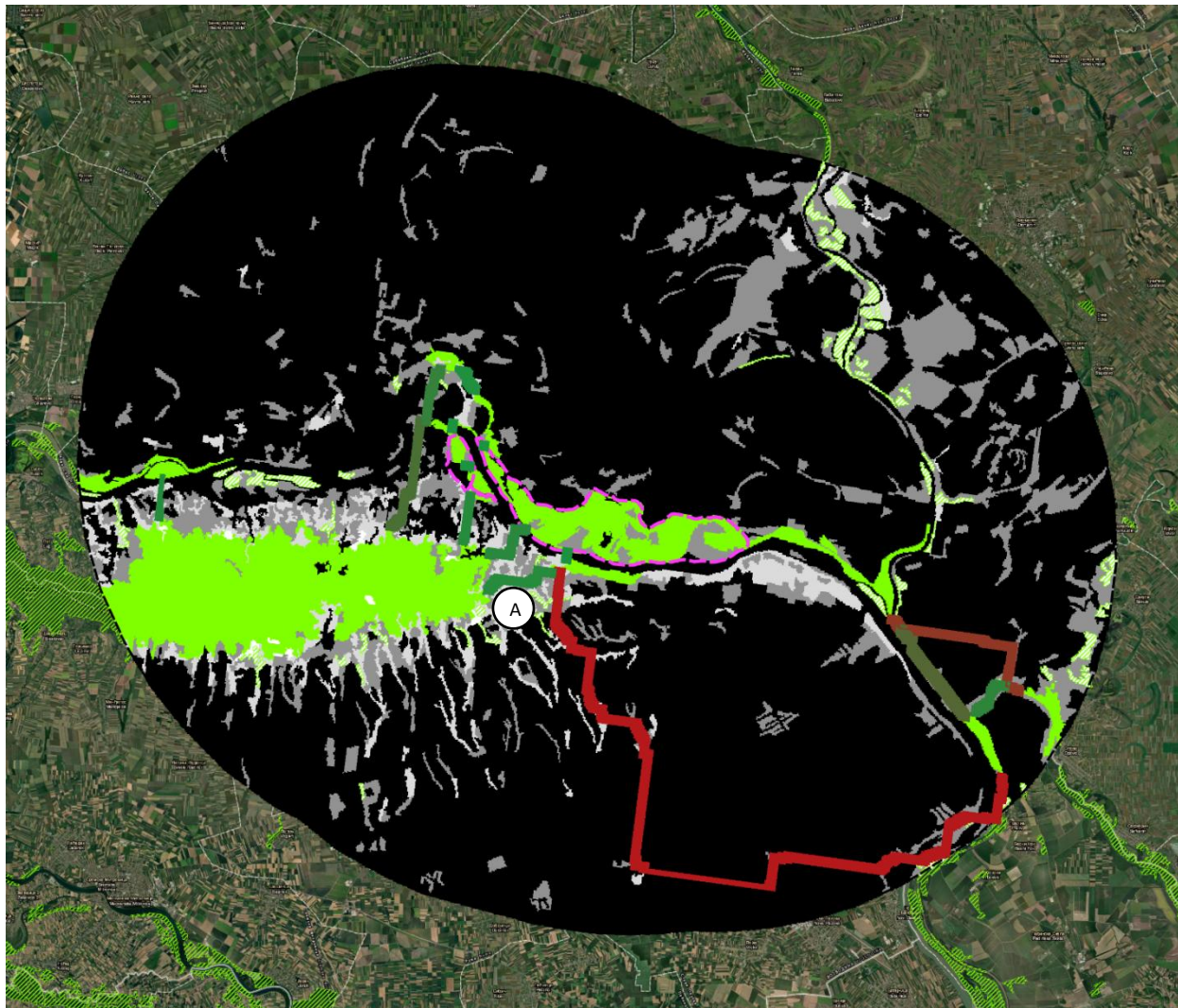
<sup>15</sup> STEVENSON-HOLT, C.D., K. WATTS, C.C. BELLAMY, O.T. NEVIN, A.D. Ramsey, 2014. Defining landscape resistance values in least-cost connectivity models for the invasive grey squirrel: a comparison of approaches using expert-opinion and habitat suitability modelling. In: *PLoS One*. 2014 Nov 7;9(11):e112119. doi: 10.1371/journal.pone.0112119. PMID: 25380289; PMCID: PMC4224439.

<sup>16</sup> MUREKATETE, R.M. & T. SHIRABE, 2021. On the effects of spatial resolution on effective distance measurement in digital landscapes. In: *Ecol Process* 10, 50. <https://doi.org/10.1186/s13717-021-00296-3>

<sup>17</sup> LALIBERTÉ J., M.-H. ST-LAURENT, 2020: Validation of functional connectivity modeling: The Achilles' heel of landscape connectivity mapping. In: *Landscape and Urban Planning*, Volume 202, <https://doi.org/10.1016/j.landurbplan.2020.103878>.



**Figure 3: Connectivity of Natural grasslands in the buffer zone around Kovilj-Petrovaradin marsh, Serbia.** The grayscale background map shows landscape resistance values (from 1= white = low resistance to 8 = black = high resistance), green areas the Natural grasslands. The corridors between the ten largest patches of Natural grasslands show the results of the least-cost path analysis. The colours of the corridors correspond to the cost in relation to the permeability of the landscape (from green = 8 to red = 1218). The thickness of the corridors has been enhanced for better visibility. The letters highlight corridors or large patches mentioned in the text.



Funded by the European Union Austrian Development Agency

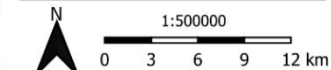
## EU4GREEN

Koviljsko-Petrovaradinski rit  
Pilot site in Serbia

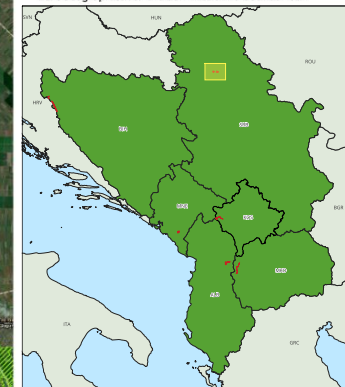
Pilot site Economy border  
Buffer zone

**Broad-leaved forest (CLC-311):**  
10 largest patches in buffer zone  
other patches of habitat

**Cost of corridors**      **Resistance of landscape**  
High Low                  High Low



Basemap: Esri, DigitalGlobe, GeoEye, i-cubed, USDA FSA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community & European Environment Agency — Corine Land Cover (CLC) 2018 v20; Basemap overview: © OpenStreetMap contributors, CC-BY-SA; EU borders: © EuroGeographics for the administrative boundaries.



\* This designation is without prejudice to positions on status, and is in line with UNSCR 1244/1999 and the ICJ Opinion on the Kosovo declaration of independence.

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**Figure 4: Connectivity of Broad-leaved forests in the buffer zone around Kovilj-Petrovaradin marsh, Serbia. The grayscale background map shows landscape resistance values (from 1 = white = low resistance to 8 = black = high resistance), green areas show the Broad-leaved forests. The corridors between the ten largest patches of Broad-leaved forests show the results of the least-cost path analysis. The colors of the corridors correspond to the cost in relation to the permeability of the landscape (from green = 8 to red = 1218). The thickness of the corridors has been enhanced for better visibility. The letter highlights corridors or large patches mentioned in the text.**

## 2.5. Conclusion

This study shows potential corridors which facilitate the movement of organisms between large patches of the target land cover classes of Natural grasslands and Broad-leaved forests. The objectives the study area of Kovilj-Petrovaradin marsh are to enhance the connectivity of natural grasslands patches with designated corridors and to protect floodplain forest corridors along the rivers.

The results highlight the need for well-informed and anticipatory spatial planning in the surroundings of the Kovilj-Petrovaradin marsh, securing the long-term persistence of corridors. Well-functioning corridors avoid genetic impoverishment of the national park itself but also amplify the positive effects of the national park on its surroundings, e.g. by allowing individuals to disperse into adequate habitat patches within the surrounding landscape. To secure these processes and support sustainable development in the surroundings, the designation of less strict spatial protection schemes as buffer zones is a popular tool.

# 3. SPECIES AND HABITAT TYPES OF NATURA 2000 SITES: REQUIREMENTS AND METHODS FOR REPORTING ON THEIR ECOLOGICAL INFORMATION

Authors: Katharina Huchler and Stefan Fuchs, EAA

With contributions from: EU4Green contracted biodiversity experts (Mirjana Ćuk, Dimitrije Radišić), Thomas Ellmauer, EAA

## 3.1. Summary

Identification of suitable sites and preparation of all relevant materials are major milestones required for proposing the future Natura 2000 network to the European Commission and therefore are an important endeavour for Accession Candidates. For each potential Natura 2000 site, a wide range of evidence-based and scientific information is required. Accession Candidates are required to set up systematic approaches to gather this information, but there are pitfalls which should be avoided to gather the required data efficiently. The activities summarised in this chapter are based on the approach developed in Austria. EU4Green offered a training for local biodiversity experts from the WB6, who learned and applied – in an exemplary manner – all subsequent steps of mapping and assessing species and habitat types in potential Natura 2000 sites. They were familiarised with the Standard Data Forms (more particularly, the ecological information), which is the format required for providing the information to the European Commission. Furthermore, the biodiversity experts were trained in developing Site-specific Conservation Objective and conservation measures, which are a prerequisite for all Natura 2000 sites confirmed by the European Commission, also following a standardised approach. All methodologies are described in detail. The fieldwork results of the biodiversity experts are presented and discussed. The chapter illustrates how a synergistic and efficient system for fulfilling the provisions of the Nature Directives towards Natura 2000 sites could look like on the local level.

## 3.2. Introduction

### 3.2.1. The Natura 2000 network of protected areas

The designation of protected areas is one of the prime tools in biodiversity protection. The Kunming-Montreal Global Biodiversity Framework, signed by 196 countries, foresees the halt and reverse of biodiversity loss. One of its key global targets for 2030 is effectively conserving and managing 30 % of all land, waters and seas<sup>18</sup>. The EU Biodiversity Strategy for 2030 sets out the goal to not only protect at least 30 % of all land and sea, but also bring 10 % of all EU land and sea under strict protection<sup>19</sup>. In this context, the GAWB calls upon the WB6 to align their policies to the EU Biodiversity Strategy for 2030<sup>20</sup>.

EU4Green placed a strong focus to support the WB6 with alignment to the EU legislation for nature protection, more precisely on the Birds Directive (2009/147/EC \_ ex 79/409) and the Habitats Directive (92/43/EEC). They define species and habitats of Community interest, and measures for species and site protection. The EU Member States are to implement it through interdependent steps, hence for accession candidates, a similar approach was considered.

The primary objective of the EU Nature Directives is achieving and maintaining a Favourable Conservation Status for all species and habitats of Community interest. An important part is the designation and good management of Natura 2000 sites that form an EU-wide coordinated network of protected areas. The aim of each site is to ensure the long-term conservation of the habitats and species of Community interest that occur within them. Additionally, the Natura 2000 sites simultaneously act as contribution to the Pan-European Emerald Network of the Bern Convention<sup>21</sup>. Accession candidates are required to prepare their future Natura 2000 sites, using the framework of the Emerald Network<sup>22</sup>.

### 3.2.2. Standard Data Forms

For each Natura 2000 site, Member States fill a Standard Data Form (SDF)<sup>23</sup>, thereby providing information on area, location, characteristics and management, as well as ecological information on its habitat types and species<sup>24</sup>. As the EC uses the SDFs to review

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<sup>18</sup> CONVENTION ON BIOLOGICAL DIVERSITY, 2022. Decision adopted by the Conference of the Parties to the Convention on Biological Diversity. 15/4. Kunming-Montreal Global Biodiversity Framework. [Last access: 9 December 2024]. Available at: <https://www.cbd.int/doc/decisions/cop-15/cop-15-dec-04-en.pdf>

<sup>19</sup> EUROPEAN COMMISSION, 2020. EU Biodiversity Strategy for 2030. Bringing nature back into our lives. Brussels: European Union. [Last access: 9 December 2024]. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52020DC0380>

<sup>20</sup> EUROPEAN COMMISSION, 2020. Guidelines to the Implementation of the Green Agenda for the Western Balkans. Brussels: European Union. [Last access: 9 December 2024]. Available at: [https://neighbourhood-enlargement.ec.europa.eu/system/files/2020-10/green\\_agenda\\_for\\_the\\_western\\_balkans\\_en.pdf](https://neighbourhood-enlargement.ec.europa.eu/system/files/2020-10/green_agenda_for_the_western_balkans_en.pdf), p. 1 – 22.

<sup>21</sup> European Environment Agency, 2023. The Natura 2000 protected areas network. [Last access: 23 September 2025] Available at: <https://www.eea.europa.eu/themes/biodiversity/natura-2000/the-natura-2000-protected-areas-network>

<sup>22</sup> Secretariat of the Bern Convention, 2017. The Emerald Network. A tool for the protection of European natural habitats. [Last access: 23 September 2025]. Available at: <https://rm.coe.int/the-emerald-network-a-tool-for-the-protection-of-european-natural-habi/1680728438#:~:text=EUROPEAN%20STATES%20NOT%20MEMBERS%20OF%20THE%20EUROPEAN%20UNION&text=observer%20states%20in%20the%20neighbouring%20areas%20of%20the%20EU.&text=accession%20to%20the%20EU%20in,therefore%20for%20joining%20the%20EU.&text=actively%20working%20on%20the%20Emerald,the%20Russian%20Federation%20and%20Ukraine>

<sup>23</sup> The European Commission updated the format of the Standard Data Form in 2023; its use is required from February 2025 onwards.

<sup>24</sup> C/2023/8623. ABI L, 2023/8623. Available at: [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L\\_202302806](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L_202302806)

the contribution of Natura 2000 towards the achievement of the Nature Directive’s objectives, the EC recommends an update to the SDFs at least every six years.

Filling SDFs requires evidence-based information, with several provisions specified in the explanatory notes of the SDFs<sup>24</sup>. To guarantee transparent and reproducible results, particularly regarding the ecological information on habitat types and species, a standardized methodology is required. Nevertheless, the EC does not provide a methodological standard for the required fieldwork and methodology to produce the results for the SDFs. In the light of EU accession, accession candidates are required to develop and apply a methodology that fits the provisions.

EU4Green offered a training for local experts in the Austrian methodology. Throughout the training, the experts learned all subsequent steps of mapping and assessing species and habitats in an exemplary manner. They first learned about the official requirements and the Austrian methodology. One of the most important tasks was adapting the methodology to the local circumstances and the present species and habitats. Then, the experts applied and tested the developed methodology through fieldwork. Ultimately, the results were summarized, following the standards laid out by the SDFs.

**3.2.3. Structure and parameters of the SDFs**

The SDF contains six main sections with fields to fill (Table 2). Most sections are filled once for the entire Natura 2000 site, like the site location, description and management. However, the ecological information needs to be filled for every habitat type and species, respectively, occurring in the Natura 2000 site. The SDFs are then delivered to the EC through the Reportnet 3.0 of the EU.

**Table 2: Sections of the Standard Data Form for species and habitats.** Source: European Commission<sup>24</sup>.

Section	Requirement
1. Site identification	Required for each Natura 2000 site
2. Site area and location	
3. Ecological information	
3.1 Habitat types	Required for each Annex I habitat type present within the Natura 2000 site
3.1.a Essential information	
3.1.b Site assessment & Degree of Conservation	
3.2 Species	Required for each bird species relevant for Article 4(1) and 4(2) of the Birds Directive and each Annex II species of the Habitats Directive present within the Natura 2000 site
3.2.a Essential information	
3.2.b Site assessment & Degree of Conservation	
3.3 Other species	Optional
Site description	
Site management	Required for each Natura 2000 site
Geospatial representation	

The trainings focused on how to gather the data required for the ecological information. The ecological information includes two sub-sections for both habitat types and species: the essential information (Infobox 1) and the site assessment (Infobox 2).

### Infobox 1 – SDF’s Essential information

For habitat types, this section includes covers basic information like the **habitat type code**, information on the **period of data collection**, and the **cover** of the habitat type in hectares. The cover can be gathered by either complete mapping, statistical estimation, extrapolation of a limited amount of data, or, with very limited data, by expert opinion.

For species, this section includes **species group, code and name, population type** (e.g. permanent, reproducing) and **size** (min. and max.), and **species abundance** (e.g. common, rare). Population data can come from complete mapping, statistical estimation, extrapolation, or, with very limited data, by expert opinion. It is possible to indicate that species data is sensitive, thereby avoiding disclosure to the public by the EC.

Under certain circumstances, species and habitats can be categorized as non-present or non-significant, so that only selected fields need filling<sup>25</sup>. Apart from that, the more elaborate site assessment is required.

### Infobox 2 – SDF’s Site assessment

For habitat types, this section includes the **representativity** (e.g. excellent, significant) in comparison to the interpretation manual of Annex I habitat types. This parameter equals one of the criteria of Annex III of the Habitats Directive for Natura 2000 site selection and states how typical a habitat type is. Secondly, the **relative surface**, i.e. the share of the habitat types cover *within the Natura 2000 site* in the *total habitat area of the economy*, is classified in one of six pre-defined range categories, from 0 – 2 % up to 75 – 100 %.

For species, this section includes the share of the site’s **population** in the population in the entire economy. There are six pre-defined range categories. Explanatory text may be provided.

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<sup>25</sup> Non-presence means that either the habitat or species was present at the time of site designation but is no longer present, or was not present at the site of site designation but is intended to be re-established. Non-significance for habitat types means little conservation value (very small, degraded, fragmented, limited fulfilment of ecological functions, structural components, and characteristic species) that does not offer relevant restoration possibilities (already previous to site designation). Non-significant species are very rarely observed on site.

Ultimately, the key parameter of the SDF for both species and habitat types is the Degree of Conservation (Infobox 3).

### Infobox 3 – Degree of Conservation

The Degree of Conservation equals the Annex III criteria for Natura 2000 site selection and is also referred to as the **local condition of a habitat type or species**. It addresses the **quality of the habitat type or the habitat of the species** and requires information on the **spatial extent in good or not good / sufficient or non-sufficient quality**.

Depending on the methodology used, the Degree of Conservation offers high potential for synergies with the assessments on biogeographical level, thus providing an efficient and holistic system for mapping and monitoring the species and habitats of Community interest. While the information gathered on site level can be incorporated into Article 17 reporting, the information on biogeographical level provides important input when defining conservation objectives on site level.

### 3.2.4. Condition indicators and threshold values

When mapping specific species and habitat types in Natura 2000 sites, condition indicators define how to measure and grade the circumstances that affect their local preservation. The application of condition indicators in itself is not a requirement for fulfilling the EU Nature Directives; however, it is an exceptional opportunity for using synergies between the obligations on local (Natura 2000 sites) and biogeographical level<sup>26</sup>. Therefore, it is applied by several EU member states (e.g. Austria, Germany). Furthermore, it provides a comparable, repeatable and reliable framework for assessing the Degree of Conservation of a species or habitat within a given area.

Condition indicators root in the ecological requirements of species and habitat types and are tightly linked to parameters that are required for Article 17 reporting (Infobox 4).

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<sup>26</sup> Evans & Arvela (2011): Assessment and reporting under Article 17 of the Habitats Directive. Explanatory Notes & Guidelines for the period 2007-2012, p. 9.

#### Infobox 4: Condition indicators

For a **habitat type**, condition indicators allow to measure the conservation of its structure and function. To reflect on ecological integrity, condition indicators relate to three assets:

- **Species composition:** presence/absence, number or abundance of indicative species,
- **Structure and functions:** determinative structural, dynamic or ecological factors, and
- **Impacts:** most important driving factors (natural or anthropogenic)

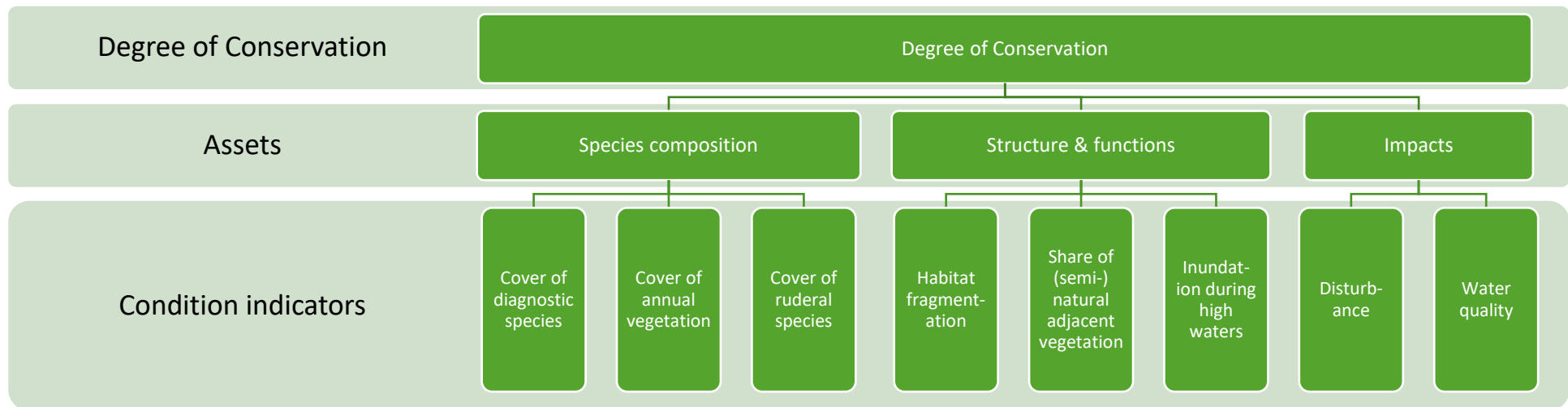
The condition indicators for a **species** relate to three assets:

- **Population:** reproduction or mortality rates, population density
- **Habitat:** necessary habitat size and habitat elements (structures and/or quality required for reproduction, resting, foraging)
- **Impacts:** most important driving factors (natural or anthropogenic)

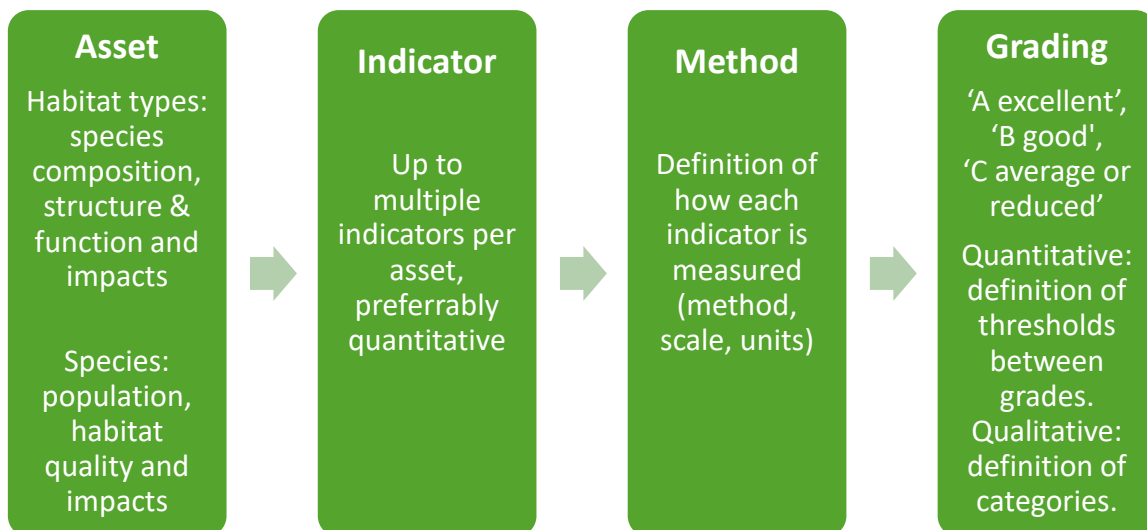
Population indicators may be difficult to assess and/or fluctuate over time. Therefore, a strong focus is given to the condition of the habitat for the species, like the Degree of conservation does.

Linking these standardized assets to the ecological requirements of the species or habitat type is the basis for formulating condition indicators (Figure 5, Figure 6). Depending upon the complexity of the ecological requirements, up to several indicators per asset can be necessary.

To ensure comparability between different sites, years (repeated monitoring) and experts carrying out fieldwork, condition indicators ought to be measurable. Therefore, for each condition indicator the method of measurement requires definition, specifying how to assess the indicator during fieldwork. In general, quantitative indicators are easier to standardize than qualitative indicators.



**Figure 5: Exemplary illustration of the Degree of Conservation for habitat type ‘3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoeto-Nanojuncetea*’** (wording of indicators was simplified for understandability). The Degree of Conservation is composed of three different assets (species composition, structure and functions, and impacts), each of them with condition indicators. For each condition indicator, a method for measurement and a grading system with threshold values is needed.



**Figure 6: Procedure for defining condition indicators.**

Ultimately, a grading system is used to specify if measurements correspond with a good or not-good Degree of Conservation. Based on the provisions for the SDFs, the grading system has three grades: ‘A excellent’, ‘B good’ and ‘C average or reduced’. For quantitative indicators, thresholds are required to differentiate between excellent, good and average/degraded. For qualitative indicators, the three categories need detailed qualitative description to allow for clear differentiations.

### 3.2.5. Site-Specific Conservation Objectives based on condition indicators

Condition indicators support the concise development of Site-Specific Conservation Objectives (SSCOs). SSCOs set out the conservation priorities for Natura 2000 sites and make sure that they contribute to achieving a Favourable Conservation Status on biogeographical level. The Habitats Directive foresees that SSCOs are required for each target feature and Natura 2000 site. They must be specific to the target feature and formulated precisely, quantitatively and in a measurable manner to allow for monitoring and reporting. SSCOs should follow a consistent approach and comprehensively define the desired condition of the target feature, including its ecological characteristics<sup>27</sup>.

The methods presented in this report aim at establishing a synergistic and efficient system, fulfilling the provisions of the Nature Directives. Through well-defined indicators, the acquired ecological data is comparable, repeatable and reliable, and can be used for other mandatory activities like development of SSCOs and Art. 17 monitoring. During the trainings of EU4Green, 14 biodiversity experts – between one and three per economy – learned how to develop such indicators, define meaningful thresholds, and will be able to share their knowledge in related future projects.

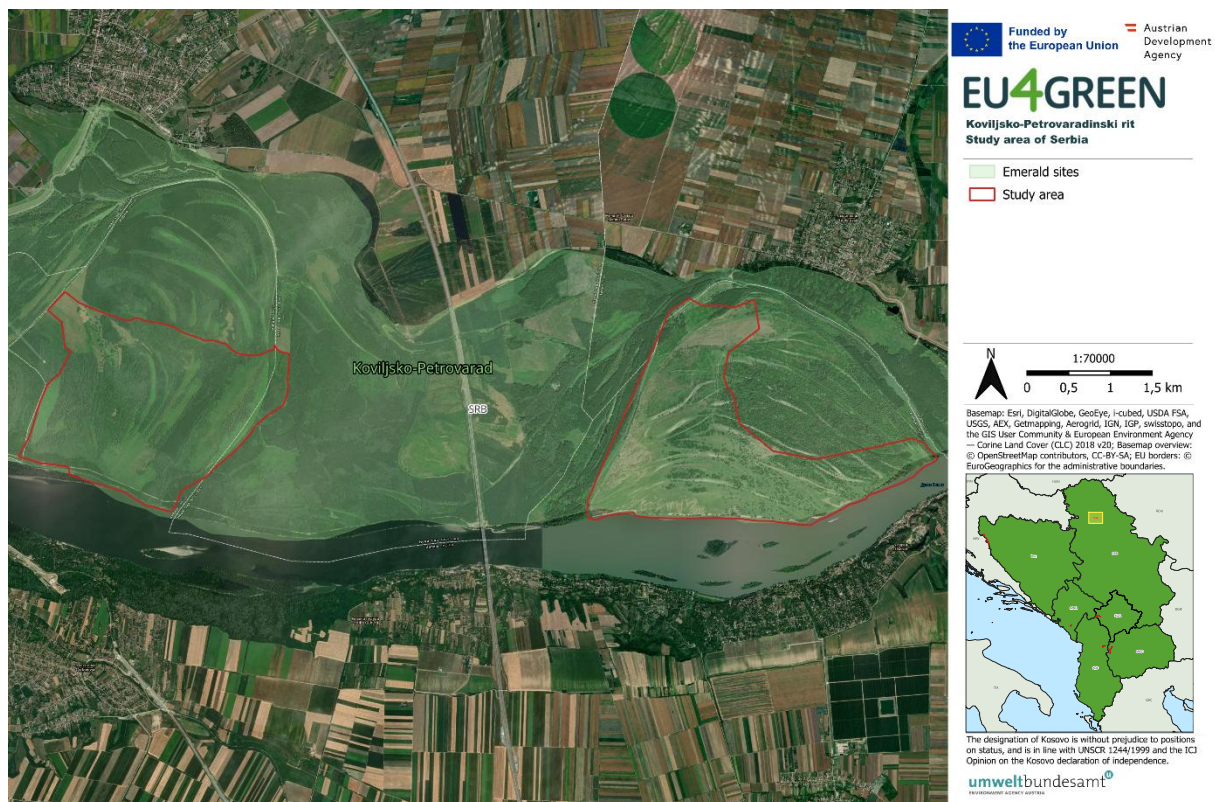
<sup>27</sup> European Commission, 2024. Commission Note on Setting Conservation Objectives for Natura 2000 Sites. [Last access: 15/10/2025] Available at: <https://circabc.europa.eu/ui/group/3f466d71-92a7-49eb-9c63-6cb0fadf29dc/library/4f06f774-df20-4269-9e49-1a79a95fa040/details>

### 3.3. Material and methods: the case study

#### 3.3.1. Study area

For training the methods, a case study was established (Figure 7). The study area was delineated by the biodiversity experts and measures approx. 10 km<sup>2</sup> in size. The study area is located in northern Serbia within the alluvial plain of the Danube, approximately 20 kilometres downstream of Novi Sad. It encompasses the Special Nature Reserve Kovilj–Petrovaradin Marsh, established in 2011 and covering nearly 4.840 ha. It is characterised by a mosaic of floodplain habitats, including backwaters, oxbows, swamps, ponds, riparian forests and wet meadows. This habitat diversity supports rich plant, fish and bird communities and underpins its designation as a Ramsar site, Important Bird Area, and Important Plant Area, with potential future inclusion in the Natura 2000 network. Situated within an intensively cultivated agricultural landscape and near human settlements, the reserve faces pressures such as habitat fragmentation, invasive species, eutrophication and hydrological alterations, requiring continuous management and monitoring.

By splitting the study into subareas (approx. 1 km<sup>2</sup> each), the assessment of the target features (habitats, birds) in corresponding areas was facilitated.



**Figure 7: Study area at the SNR Kovilj–Petrovaradin Marsh, Serbia.**

The study area was placed based on the subsequent criteria:

- Located within or surrounding the pilot site
- Borders corresponding with natural water dynamics and other already occurring features (roads, dams, trees, etc.)

- Covering the locally typical zonation of the vegetation on one or both sides of the river
- Access possible (almost) entirely (regarding permits, barriers, etc.)
- Appropriate for sampling the selected habitats and species (see 3.3.2 Features of the Birds and Habitats Directive)

The study area was not required to be identical with borders of existing protected areas.

For practical reasons and a more detailed mapping during the fieldwork, the mapping scale was standardized to 1:5.000 and a grid with the cell size of ca. 62.5 ha was created. A subsequent division into four sub-cells ensured a more precise estimation of coverages and thresholds, especially for the indicators of the bird species assessments.

### 3.3.2. Features of the Birds and Habitats Directive

The activities of EU4Green focused on birds (especially grassland and forest birds) and habitats as groups of target features that acted as examples, outlining the process behind the conservation assessments. The features sampled within the study area of Serbia can be found in Table 3.

**Table 3: Assessed species and habitats for the study area of Serbia.**

Group	Code	Feature
Birds	A030	<i>Ciconia nigra</i>
Birds	A307	<i>Curruca (Sylvia) nisoria</i>
Birds	A238	<i>Dendrocopos (Leicopicus) medius</i>
Birds	A236	<i>Dryocopos martius</i>
Birds	A321	<i>Ficedula albicollis</i>
Birds	A075	<i>Haliaeetus albicilla</i>
Birds	A338	<i>Lanius collurio</i>
Birds	A246	<i>Lullula arborea</i>
Habitat types	3130	Oligotrophic to mesotrophic standing waters with vegetation of the <i>Littorelletea uniflorae</i> and/or of the <i>Isoeto-Nanojuncetea</i>
Habitat types	3150	Natural eutrophic lakes with <i>Magnopotamion</i> and <i>Hydrocharition</i> type vegetation
Habitat types	3270	Rivers with muddy banks with <i>Chenopodion rubri</i> pp and <i>Bidention</i> pp vegetation
Habitat types	91E0	Alluvial forests with <i>Alnus glutinosa</i> and <i>Fraxinus excelsior</i> (Alno-Padion, Alnion incanae, Salicion albae)
Habitat types	92A0	<i>Salix alba</i> and <i>Populus alba</i> galleries

### 3.3.3. Fact files and condition indicators

The experts developed fact files for the species and habitat types that were assessed in the pilot sites. These fact files summarize the knowledge available for each species and habitat, giving a well-structured overview of the identification and ecological requirements (Table 4, Table 5). During development, the trained experts collaborated and brought together their knowledge to produce harmonized fact files with condition indicators and thresholds that can potentially be applied across the WB6. All fact files are found in Annex II.

Fact files act both as a guidance for field mapping identification (interpretation) and as basis for the assessment of condition indicators. The condition indicators were defined based on the theory specified in chapter 3.2.4 Condition indicators and threshold values. For birds, priority was given to the habitat indicators, as reliable population assessments were not feasible under the time frame of the training activities.

**Table 4: Fact file structure for a habitat type.**

Section	Content
<b>Fact File</b>	
<b>Code and name</b>	In accordance with Annex I of the Habitats Directive; names in English and in local languages.
<b>Short profile</b>	Summary of most significant features of the habitat type.
<b>Cross-references to classification systems</b>	Cross-references between the interpretation manual of Annex I habitat types and relevant international, national and/or local classification systems (e.g. phytosociology, biotopes). The classification could be identical (=), broader and therefore encompassing the Annex I habitat type (>), narrower than the Annex I habitat type (<), or partly overlapping (#).
<b>Coenosis</b>	Typical plant species (characteristic, dominant, indicative species), typical other species.
<b>Ecology</b>	Ecological requirements regarding soil (soil type, acidity, nutrients), water regime, climatic condition, elevation.
<b>Structure</b>	Horizontal and vertical structure (e.g. zonation, patchiness, life forms, vegetation layers), structural components (e.g. dead wood).
<b>Dynamics</b>	Vegetation phases, ecological cycles.
<b>Dependency on maintenance</b>	If human maintenance is required, specification of required type of utilization, intensity of use, etc.
<b>Threats and pressures</b>	Future threats and present pressures, Red List status, typical impacts.
<b>Typical conservation measures</b>	Regularly applied conservation measures.
<b>Distribution</b>	Description and/or distribution maps.
<b>Assessment of Degree of Conservation</b>	
<b>Species composition indicators</b>	Indicators for assessing species composition by presence or absence, number or abundance of indicative species. Assigned with thresholds for excellent, good or average/reduced condition.
<b>Structure and functions indicators</b>	Indicators for assessing the determinative structural, dynamic or ecological factors. Assigned with thresholds for excellent, good or average/reduced condition.
<b>Impact indicators</b>	Indicators for assessing the most important pressures and impacts (natural and anthropogenic). Assigned with thresholds for excellent, good or average/reduced condition.
<b>Species observations during fieldwork</b>	Overview of observations made during field work.
<b>Aggregation Scheme</b>	Scheme for aggregating population, habitat and impact indicators.

**Table 5: Fact file structure for a species.**

Section	Content
<b>Code and name</b>	In accordance with Habitats or Birds Directive; names in English and in local languages.
<b>Short profile</b>	Summary of most significant features of the species.
<b>Characteristics for species identification</b>	Characteristics in size, coloration, behaviour, etc., including sex and age differences as well as comparison to other, similar species.
<b>Biology</b>	Details on reproduction, feeding, resting.
<b>Population ecology</b>	Data regarding reproduction rate, mortality and migration, preferably numeric.
<b>Habitat for the species</b>	Description of habitat requirements and typical biomes, if necessary, differentiated into life cycle habitats (reproduction, feeding, resting) and with description of relevant habitat elements (e.g. open water, deadwood).
<b>Threats and pressures</b>	Future threats and present pressures, Red List status, typical impacts.
<b>Species protection measures</b>	Regularly applied conservation measures.
<b>Distribution</b>	Description and/or distribution maps.
<b>Assessment of Degree of Conservation</b>	
<b>Population indicators</b>	Indicators for assessing the reproduction, mortality or population density. Assigned with thresholds for excellent, good or average/reduced condition.
<b>Habitat indicators</b>	Indicators for assessing the habitat quantity and quality. Assigned with thresholds for excellent, good or average/reduced condition.
<b>Impact indicators</b>	Indicators for assessing the most important pressures and impacts (natural and anthropogenic). Assigned with thresholds for excellent, good or average/reduced condition.
<b>Species observations during fieldwork</b>	Overview of observations made during field work.
<b>Aggregation scheme</b>	Scheme for aggregating population, habitat and impact indicators.

### 3.3.4. Mapping units, field protocols and fieldwork

Mapping units specify the spatial scale on which the condition indicators are measured. During fieldwork, the habitat experts delineated every patch of homogenous habitat on a map, with the aim to cover the entire study area. After assessing the spatial extent of a homogenous patch, the habitat was classified as either a habitat type of the Habitats Directive or no (protected) habitat type. For the habitat types of Community interest, further data was assessed, including the condition indicators.

For the mapping of the bird species, a raster-based approach with pre-defined grid cells (1:5.000) was used. The bird experts subdivided the grid cells into four sub-grid cells each. Within each sub-cell, the general land cover and, particularly for forests and grasslands, several other indicators were assessed. These indicators were general indicators, not (yet) linked to the condition indicators and threshold values of specific species. This was done post hoc by data transformation and statistical analysis.

The field protocols are to be found in Annex IIIa-b. All mappings were carried out between May and September 2024 (Table 6).

**Table 6: Mapping period and fieldwork days for each study area and feature group.**

Feature group	Mapping period	Fieldwork days
<b>Birds</b>	May and August 2024	5
<b>Habitat types</b>	June, August and September 2024	12
<b>Total</b>	May – September 2024	17

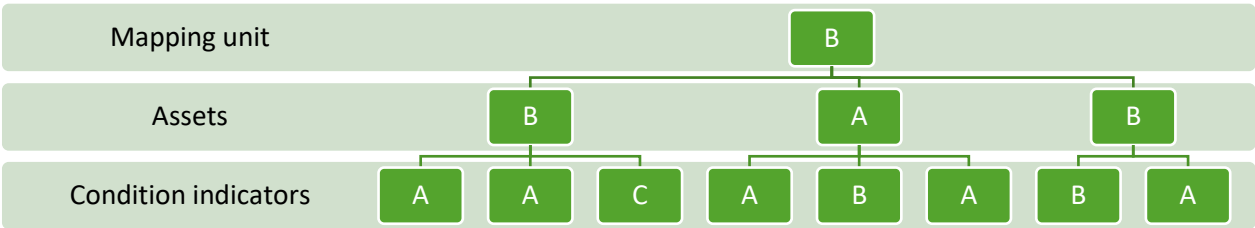
**3.3.5. Occupancy**

For bird species, priority was given to assessing habitat and impact indicators for several reasons: i) assessing habitat quality and impacts was new to most of the trained experts, while knowledge on population assessments was relatively high; ii) fieldwork protocols for mapping bird populations are available in the WB6 but less so for habitat quality and impacts; iii) possible time frames for fieldwork were better suited for habitat and impact assessment.

Therefore, population indicators were not targeted during fieldwork for birds. In consequence, occupancy of habitats was not assessed in the field. It was assumed that if a species is generally present within the 10 km<sup>2</sup> study area, all suitable habitat for the species is occupied.

**3.3.6. Aggregation within mapping units**

On completion of fieldwork, the condition indicators were aggregated, first within each asset and then for the entire mapping unit. If an asset had two or more condition indicators, logical aggregation was used (see Annex IV). In case a particular asset had only one condition indicator, the grade was used directly for the asset. The grading system is designed in a way that single condition indicators with low grading have a significant effect on the aggregated grade of the asset and the grade of the entire mapping unit (Figure 8).



**Figure 8: Exemplary illustration of the aggregation from the grades of condition indicators to the grades of the assets within each mapping unit.**

For habitats, all three assets were then aggregated to receive the aggregated grade for the entire mapping unit, i.e. the habitat polygon. For species on the other hand, only the habitat asset and impact asset were aggregated within each grid cell, while the population asset (where available) was kept separate. This is because the Degree of Conservation and the Area in Good Condition only relate to the species’ habitat, not its actual population.

### 3.3.7. Aggregation to Degree of Conservation and Area in Good Condition

The final step was aggregating the mapping units within the entire pilot site for each species and habitat. For this, the area of all relevant mapping units with identical aggregated grade (A, B or C) was summed up. For the categorized Degree of Conservation, thresholds were applied:

- If  $\geq 70\%$  of the habitat area within the pilot site is graded A, the categorized Degree of Conservation is A.
- If  $\geq 50\%$  of the habitat area within the pilot site is graded C, the categorized Degree of Conservation is C.
- For all other cases, the categorized Degree of Conservation is B.

For the Area in Good Condition, the sums of grade A and B were combined. The Area in Not Good Condition is the area of all mapping units with grade C.

### 3.3.8. Site-Specific Conservation Objectives

The Site-Specific Conservation Objectives (SSCOs) were developed by the biodiversity experts from the WB6, following methodological guidance from the EU4Green project team. For all target features, the concept of Favourable Reference Values<sup>28</sup> was used, although this is not a provision of the Birds Directive. The biodiversity experts deduced the current state in the economy or the biogeographical region, and the Favourable Reference Values for range, area, population, or amount of habitat in good condition based on literature research and GIS (Geoinformation System) analyses. This benchmark acted as first-level conservation objectives, to which the SSCOs contribute. Then, the maximum contribution of the site was identified based on the knowledge gained during fieldwork to identify the SSCOs. Ultimately, the SSCOs were concretised to identify concrete conservation measures. The best showcases are presented.

### 3.3.9. Software

Geo data compilation and spatial analysis was done in QGIS<sup>29</sup> as well as R version 4.3.1<sup>30</sup>. Statistical analysis was carried out with Microsoft<sup>®</sup> Excel<sup>®</sup> 2016 and R version 4.3.1.

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<sup>28</sup> In preparation: Environment Agency Austria. (2026). The implementation of the EU Nature Directives: a manual for the Western Balkans. (WP-16\_Del-2). Huchler, K., Samec, S., Fuchs, S. Ellmauer, T. EU4Green project, Biodiversity.

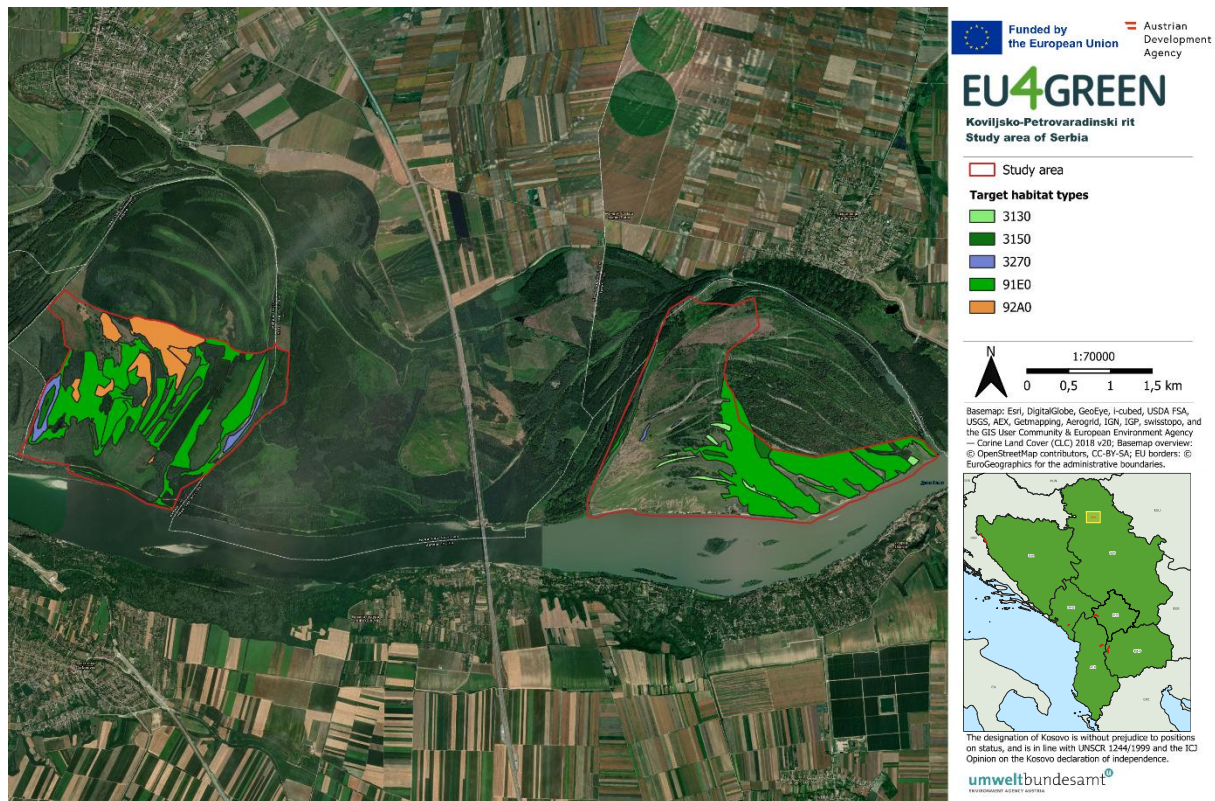
<sup>29</sup> QGIS Development Team. (2025). QGIS Geographic Information System (Version 3.40). QGIS Association. <https://www.qgis.org>

<sup>30</sup> R Core Team (2023). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>

## 3.4. Results and discussion

### 3.4.1. Habitat types

With a total of five recorded habitat types under the Habitats Directive, the study area at the SNR Kovilj-Petrovaradin marsh is hosting several habitat types protected in the EU. During fieldwork, all habitat types of the Habitats Directive were identified and spatially delineated to gather their distribution (Figure 9). The habitat patches (= occurrences) on the Danube's floodplains are quite extensive, specifically the forested habitat types.



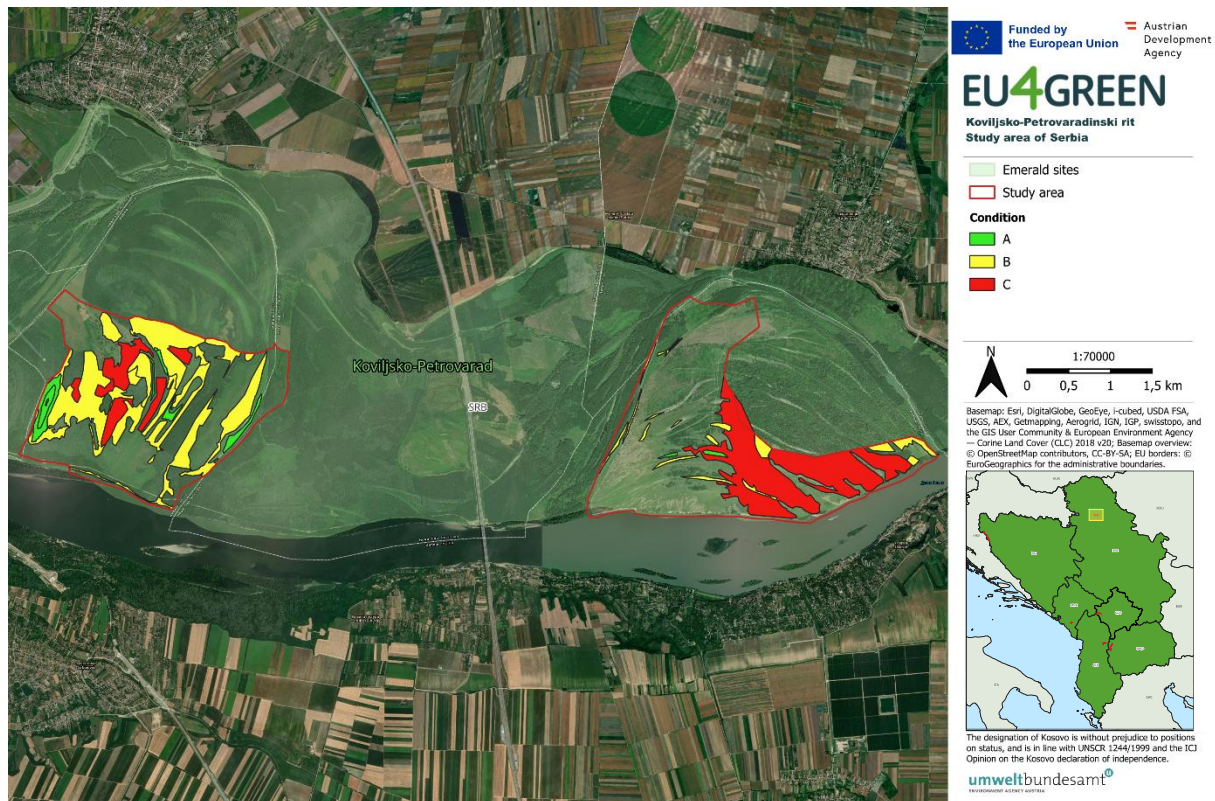
**Figure 9: Distribution of the assessed Natura 2000 habitat types in the SNR Kovilj-Petrovaradin marsh study area.**

Many of the habitat types are well-preserved, as the overall condition of most habitat types is graded as 'B good' or even 'A excellent'.

Specifically, the habitat types '3150 - Natural eutrophic lakes with Magnopotamion and Hydrocharition type vegetation' and '3270 - Rivers with muddy banks with *Chenopodium rubri* pp and *Bidention* pp vegetation' are in excellent condition, with 75% (9.9 ha) and 89% (10.5 ha) of the total assessed area in condition 'A excellent'.

Although, as the most extensive habitat type in the study area covering 292.0 ha, the habitat type '91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)' holds a lot of potential for improvement. 39% of the area of 91E0 (112.6 ha) were assessed as 'C average or degraded'. For the habitat type '92A0 - *Salix alba* and *Populus alba* galleries' 19% of the assessed area (9.4 ha) were graded as 'C average or degraded' as well and should be improved in the future (Figure 10, Figure 11). The

information gathered during fieldwork was then added to the ecological information of the Standard Data Forms (Table 7, Table 8, Table 9Table 8Table 9).

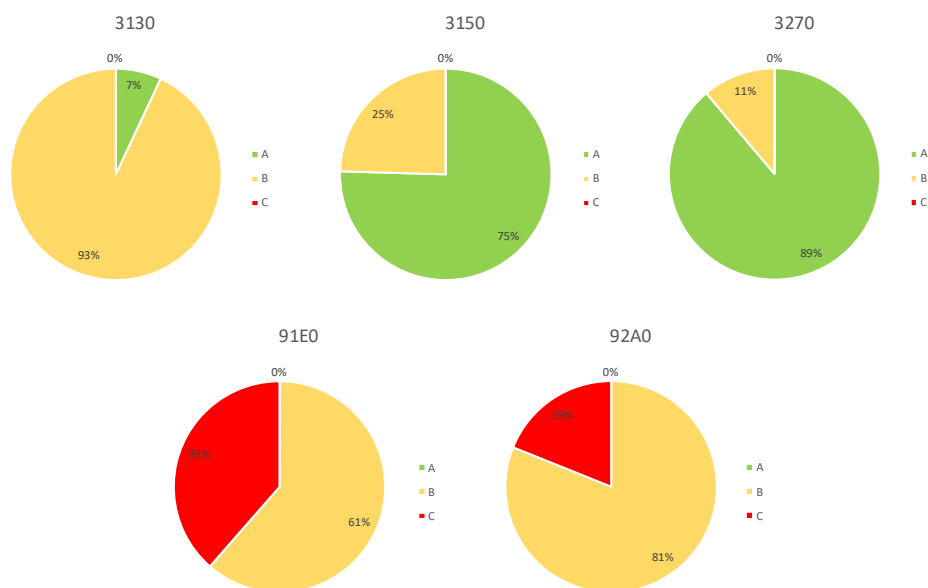


**Figure 10: Condition of the assessed Natura 2000 habitat types in the SNR Kovilj-Petrovaradin marsh study area.**

Regarding the driving factors for the average or degraded condition of habitat type 91E0, the most relevant is the impact through invasive or ruderal species and also the lack of rare characteristic species in the species composition. Structural improvement is needed for the occurrence of old tree and dead wood as well as a reduction of coppiced stems. In some of the sites, the impact through disturbance from anthropogenic origin, such as logging, grazing, flow water deviation and dams, or natural causes, such as windfalls, also contributes to the overall bad condition of some of the sites of the habitat type.

Despite the overall 'B good' condition of habitat type 92A0, invasive or ruderal species are in general an issue. For several smaller stands of the habitat type a low cover of tree a shrub species adds to their decreasing state additionally. While being undisturbed with a high degree of naturalness, they are impacted by a high degree of fragmentation, the lack of deadwood and rare species as well.

For habitat type 3130, the improvement of the condition from 'B good' to 'A excellent' can be pursued by the decreasing the disturbed areas and increasing the water quality.



**Figure 11: Condition of the assessed habitat types in the SNR Kovilj-Petrovaradin marsh study area.**

The improvements for '91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* were elaborated in greater details through SSCOs by Mirjana Ćuk. At the national level, data from the National Forest Inventory of the Republic of Serbia (2018-2023)<sup>31</sup>, EU for Serbia GIS data<sup>32</sup>, data from the studies of Tomovic et al. (2013)<sup>33</sup> and Blaženčić et al. (2005)<sup>34</sup> as well as data from JP "Vojvodinašume" (2023) was used to create a spatial overview of known occurrences, including existing habitats and destroyed stands. To complement this information, the qualitative estimation of the current habitat condition was done by using the gathered information above in combination with the experts' opinion on the development of 91E0 and floodplains in general. These destroyed sites were explicitly considered when deducing the Favourable Reference Value, in order to reflect the historical and ecological potential of the habitat rather than only its current condition. Based on the consolidation of all available sources – including existing occurrences, degraded and destroyed sites, and areas outside formal protection – the total area of habitat type 91E0 in Serbia was estimated at approximately 38,000 ha. This figure represents all known occurrences at national level, including currently unprotected sites, and serves as the basis for further conservation assessment and target setting. The national assessment is found in Table 10 and formed the basis for developing SSCOs for habitat type 91E0 for Kovilj-Petrovaradin marsh.

<sup>31</sup> National Forest Inventory of the Republic of Serbia (2018-2023), URL: <https://upravazasume.gov.rs/>

<sup>32</sup> "EU for Serbia - Continued support to implementation of Chapter 27 in the area of nature protection (NATURA 2000; 2021): SCI - GIS and DATABASES, URL: <https://daphne.sk/Natura2000Serbia/>

<sup>33</sup> Tomovic, Z (ed.) 2013. Deset godina poslovanja JP "Vojvodinasume" JP "Vojvodinasume". Petrovaradin. 152p./Tomović, Z. (ed.) 2013. Ten Years of Operations of the Public Enterprise "Vojvodinašume": Anniversary Monograph. Public Enterprise "Vojvodinašume", Petrovaradin. 152 pp.

<sup>34</sup> Blaženčić, J., Randelović, V., Butorac, B., Vukojičić, S., Zlatković, B., Žukovec, D., Čalić, I., Pavićević, D., Lakušić, D. (2005): Habitats of Serbia. Manual with descriptions and basic data. Institute of Botany and Botanical Garden "Jevremovac". Faculty of Biology, University of Belgrade. Belgrade.

Kovilj-Petrovaradin marsh offers significant restoration opportunities of destroyed areas, currently featuring 179.5 ha in good condition, with 0.3 ha in condition A and 179.2 ha in condition B. 112.6 ha of the habitat type's area was found in not good condition. Therefore, the following SSCOs are recommended:

- Maintenance of 179.5 ha of habitat type 91E0.
- Maintenance of 0.3 ha of habitat type 91E0 in condition A.
- Improvement of condition of 179.2 ha from condition B to condition A.
- Improvement of 112.6 ha in bad condition - from condition C to condition B.

The following conservation measures can be applied to reach the SSCOs:

- Strong protection regime that prohibits destroying existing occurrences, more strict protection in the field.
- The occurring plantations should at least partly be converted into natural habitats with careful selection of species and method of establishment.
- Creation of transitional (buffer) or protective zones between plantations and natural forests.
- Management of invasive species in the high-risk areas, with particular focus on woody and shrub species.

**Table 7: Ecological information for ‘3130 - Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or of the Isoeto-Nanojuncetea’ and ‘3150- Natural eutrophic lakes with Magnopotamion and Hydrocharition type vegetation’ at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Habitat 1	Habitat 2
<b>3.1a Essential information (habitat type)</b>		
<b>3.1.1 Habitat type code</b>	3130	3150
<b>3.1.2 Priority form</b>	not applicable	not applicable
<b>3.1.3 Non-presence</b>	not applicable	not applicable
<b>3.1.4 Cover</b>	8.45 ha	13.08 ha
<b>3.1.5 Caves</b>		not assessed
<b>3.1.6 Method used for cover</b>	expert opinion with very limited data	expert opinion with very limited data
<b>3.1.7 Period of last data collection</b>		not assessed
<b>3.1b Site assessment (habitat type)</b>		
<b>3.1.8 Significance</b>	significant	significant
<b>3.1.9 Representativity</b>	B: good	A: excellent
<b>3.1.10 Relative surface</b>	B: 15% ≥ p > 2%	B: 15% ≥ p > 2%
<b>3.1.11 Relative surface explanations (optional)</b>		
<b>3.1.12 Degree of conservation</b>		
<b>3.1.12.1 Degree of conservation – categorised</b>	B: good	A: excellent
<b>3.1.12.2 Degree of conservation – area</b>	Good condition: 8.45 ha Not-good condition: 0 ha	Good condition: 13.08 ha Not-good condition: 0 ha
<b>3.1.12.3 Degree of conservation – method used</b>	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
<b>3.2.19 Global</b>	B: good value	A: excellent value
<b>3.2.20 Update date</b>	January 2025	January 2025

**Table 8: Ecological information for ‘3270 - Rivers with muddy banks with *Chenopodium rubri* pp and *Bidenton* pp vegetation’ and ‘91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)’ at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Habitat 3	Habitat 4
<b>3.1a Essential information (habitat type)</b>		
<b>3.1.1 Habitat type code</b>	3270	91E0
<b>3.1.2 Priority form</b>	not applicable	not applicable
<b>3.1.3 Non-presence</b>	not applicable	not applicable
<b>3.1.4 Cover</b>	11.82 ha	292.02 ha
<b>3.1.5 Caves</b>		not assessed
<b>3.1.6 Method used for cover</b>	expert opinion with very limited data	expert opinion with very limited data
<b>3.1.7 Period of last data collection</b>		not assessed
<b>3.1b Site assessment (habitat type)</b>		
<b>3.1.8 Significance</b>	Significant	Significant
<b>3.1.9 Representativity</b>	B: good	C: significant
<b>3.1.10 Relative surface</b>	B: 15% ≥ p > 2%	B: 15% ≥ p > 2%
<b>3.1.11 Relative surface explanations (optional)</b>		
<b>3.1.12 Degree of conservation</b>		
<b>3.1.12.1 Degree of conservation – categorised</b>	A: excellent	B: good
<b>3.1.12.2 Degree of conservation – area</b>	Good condition: 11.82 ha Not-good condition: 0 ha	Good condition: 179.42 ha Not-good condition: 112.60 ha
<b>3.1.12.3 Degree of conservation – method used</b>	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
<b>3.2.19 Global</b>	B: good value	C: significant value
<b>3.2.20 Update date</b>	January 2025	January 2025

**Table 9: Ecological information for ‘92A0 Salix alba and Populus alba galleries’ at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Habitat 5
<b>3.1a Essential information (habitat type)</b>	
3.1.1 Habitat type code	92A0
3.1.2 Priority form	not applicable
3.1.3 Non-presence	not applicable
3.1.4 Cover	49.49 ha
3.1.5 Caves	not assessed
3.1.6 Method used for cover	expert opinion with very limited data
3.1.7 Period of last data collection	not assessed
<b>3.1b Site assessment (habitat type)</b>	
3.1.8 Significance	Significant
3.1.9 Representativity	C: significant
3.1.10 Relative surface	A4: 25% ≥ p >15%
<b>3.1.11 Relative surface explanations (optional)</b>	
<b>3.1.12 Degree of conservation</b>	
3.1.12.1 Degree of conservation – categorised	B: good
3.1.12.2 Degree of conservation – area	Good condition: 40.13 ha Not-good condition: 9.36 ha
3.1.12.3 Degree of conservation – method used	Based mainly on extrapolation from a limited amount of data (expert judgement)
3.2.19 Global	C: significant value
3.2.20 Update date	January 2025

**Table 10: Restoration and conservation objectives for ‘91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)’ on national level, compiled for deduction of SSCOs for SNR Kovilj-Petrovaradin marsh. For the parameter area, the target Favourable Reference Area (FRA) is derived from the National Forest Inventory of the Republic of Serbia (2018-2023)<sup>35</sup>, EU for Serbia GIS data<sup>36</sup>, data from the studies of Tomovic et al. (2013)<sup>37</sup> and Blaženčić et al. (2005)<sup>38</sup> as well as data from JP “Vojvodinašume” (2023) by Mirjana Ćuk, carried out for the EU4Green project. For the parameter Structure and functions, the target of restoring 90 % of all occurrences to a good condition is derived from the Nature Restoration Regulation.**

	Area		Area (source)	Structure and functions (absolute area)		Structure and functions (relative area)		Structure and Functions (source)
Status	380,000	ha	Survey of existing data on Alluvial forests	20,140	ha in good condition	53 %	in good condition	Survey of existing data on Alluvial forests
				17,860	ha in not-good condition	47 %	in not-good condition	
Target	430,000	ha	Total area of existing and destroyed Alluvial forests					
FRVs	11-25 % < FRA		Current value is 11.6 % under FRA	38,700	ha in good condition	90 %	in good condition	application of 90 % goal of the Nature Restoration Regulation; historical data
				4,300	ha in not-good condition	10 %	in not-good condition	
Difference to FRVs	5,000	ha	Increase of 5,000 ha in area needed	18,560	ha more in good condition	Increase towards good condition for 18,560 ha needed.		

<sup>35</sup> National Forest Inventory of the Republic of Serbia (2018-2023), URL: <https://upravazasume.gov.rs/>

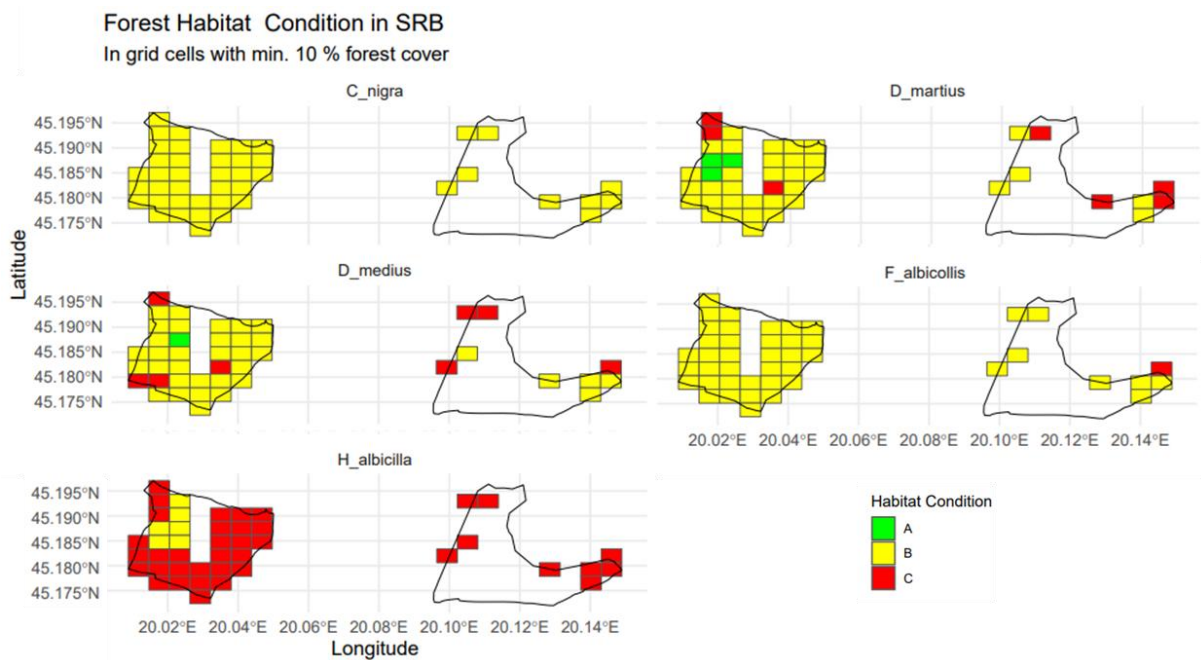
<sup>36</sup> "EU for Serbia - Continued support to implementation of Chapter 27 in the area of nature protection (NATURA 2000; 2021): SCI - GIS and DATABASES, URL: <https://daphne.sk/Natura2000Serbia/>

<sup>37</sup> Tomovic, Z (ed.) 2013. Deset godina poslovanja JP "Vojvodinasume" JP "Vojvodinasume". Petrovaradin. 152p./Tomović, Z. (ed.) 2013. Ten Years of Operations of the Public Enterprise "Vojvodinašume": Anniversary Monograph. Public Enterprise "Vojvodinašume", Petrovaradin. 152 pp.

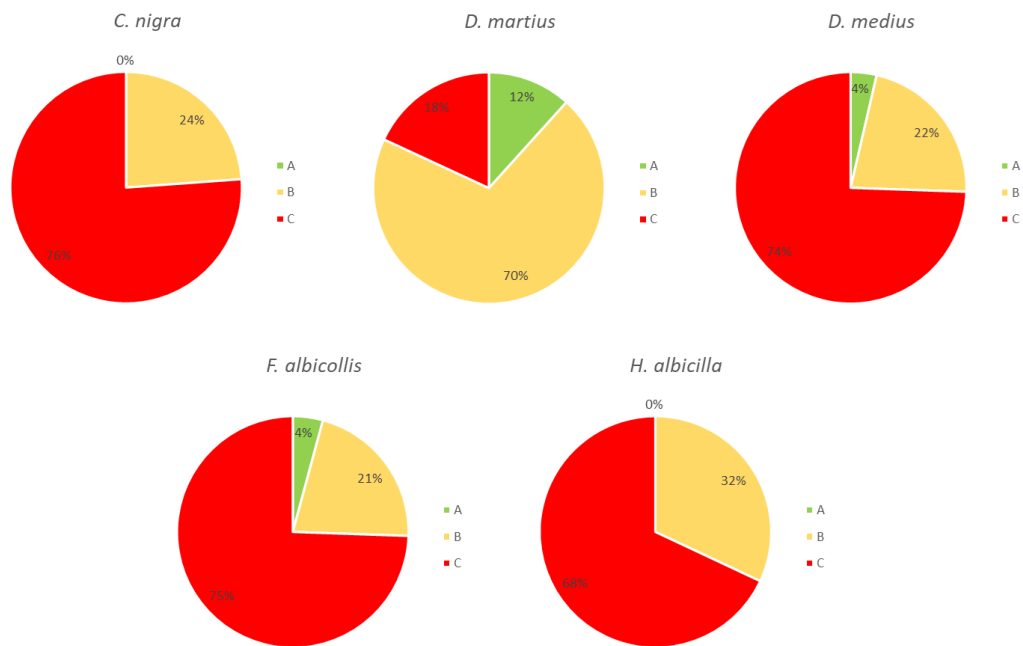
<sup>38</sup> Blaženčić, J., Ranđelović, V., Butorac, B., Vukojičić, S., Zlatković, B., Žukovec, D., Čalić, I., Pavićević, D., Lakušić, D. (2005): Habitats of Serbia. Manual with descriptions and basic data. Institute of Botany and Botanical Garden "Jevremovac". Faculty of Biology, University of Belgrade. Belgrade.

### 3.4.2. Birds

At the SNR Kovilj-Petrovaradin marsh study area, seven bird species were studied. Five of them require forested areas for reproduction (*Ciconia nigra*, *Dendrocopos medius*, *Dryocopos martius*, *Ficedula albicollis* and *Haliaeetus albicilla*) and are hereafter referred to as forest bird species. As the two grassland bird species, *Lanius collurio* and *Sylvia nisoria* were studied. In total, about 43 % of the 10 km<sup>2</sup> study area are forested, equalling a total area of forest habitats of 428.48 ha. Both habitat condition (Figure 12) and overall condition (Figure 13) of forest birds were not as good as for habitat types.



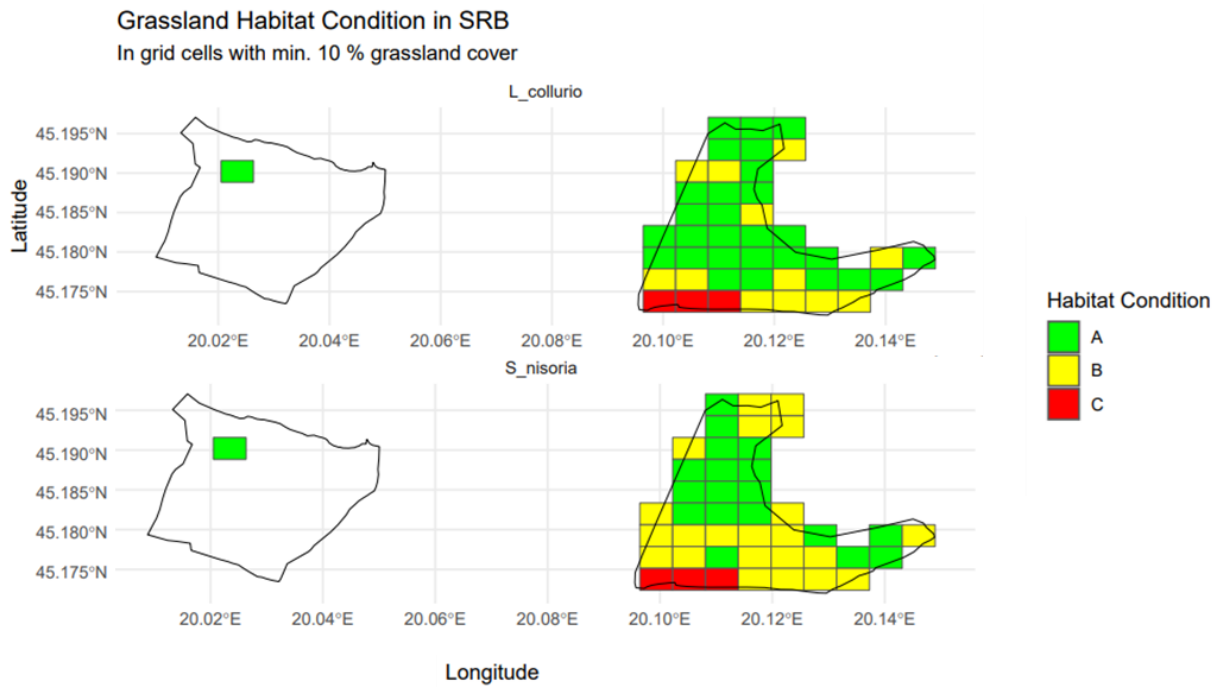
**Figure 12: Maps of the sub-grid cells with the assessed conditions in the SNR Kovilj-Petrovaradin marsh study area for the forest bird species *Ciconia nigra*, *Dendrocopos medius*, *Dryocopos martius*, *Ficedula albicollis* and *Haliaeetus albicilla*.**



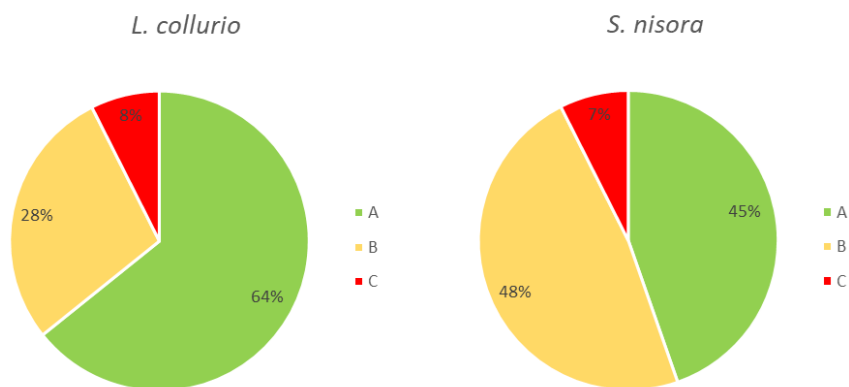
**Figure 13: Condition of the assessed forest birds in the SNR Kovilj-Petrovaradin marsh study area.**

Best results were found for the Black Woodpecker *Dryocopus martius*, with 12 % in condition 'A excellent' and only 22 % in condition 'B good'. Grid cells with a grading of 'C average or reduced' covered 74 % of the studied area. This grading was primarily received mainly because of a high level of disturbance with an additional effect through the lack of standing deadwood and low canopy density for some sites. Also, the other forest bird species are mostly affected by similar parameters, including the lack of old forest stands or large trees as well. Improving these indicators would lead to a decrease of area in condition 'C average or degraded', now ranging between 68-76 % of the total assessed area.

Regarding grassland habitats, a total of 352.6 ha (or 35.3% of the study area) are available and both the condition of the habitat and the overall condition are rather good (Figure 14, Figure 15). It appears that most open areas do meet the habitat requirements of both assessed species, which require richly structured open or partly forested landscapes with particularly thorn hedges, shrubs or forest fringes. They prefer flat or gently sloping terrain. However, they are also common in agricultural farmland or grassland. The assessments have shown that parameters like the percentage of thorny species in the bush vegetation as well as the overall coverage influence the overall condition of both grassland bird species negatively and should be improved.



**Figure 14: Maps of the sub-grid cells with grassland habitat and the assessed condition in the SNR Kovilj-Petrovaradin marsh study area for *Lanius collurio* and *Sylvia nisoria*.**



**Figure 15: Condition of the assessed grassland birds in the SNR Kovilj-Petrovaradin marsh study area.**

Based on the information gathered during fieldwork, the ecological information for the SDF's were compiled (Table 11, Table 12, Table 13).

The improvements for *Haliaeetus albicilla* were elaborated in greater detail through SSCOs by Dimitrije Radišić. At the national level, the study by Puzović et al. (2015)<sup>39</sup> and the European Red List of Birds 2021<sup>40</sup> were used for the estimation of the Population parameter. For the Habitat of the species on the national level, the estimation was mainly based on expert's knowledge. Based on the consolidation of all available sources the population size and area of the habitat for the species *Haliaeetus albicilla* in Serbia was estimated at approximately 314-364 individuals and 70,000-80,000 ha, respectively. This represents all known occurrences at national level, including currently unprotected sites, and serves as the basis for further conservation assessment and target setting. The national assessment is found in Table 14 and formed the basis for developing SSCOs for *Haliaeetus albicilla* for SNR Kovilj-Petrovaradin marsh.

SNR Kovilj-Petrovaradin marsh offers significant opportunities for restoration of destroyed areas, currently featuring a total of 428.4 ha of habitat for the species, with 137.0 ha in good condition (A+B) and 291.4 ha in not-good condition. Therefore, the following SSCOs are recommended:

- Increase total area of habitat (forests) from 428 ha to 500 ha (17% increase)
- Improvement of 291.4 ha of habitat from condition C to condition A or B.
- Maintenance of the current 137.0 ha of habitat for the species in good condition (categories A+B).
- Increase population number from 1-2 breeding pairs to 2-5 breeding pairs.

The following conservation measures can be applied to reach the SSCOs:

- Increase the number of large trees (oak, white or black poplar) in forest stands—trees that are approximately 25 meters in height, around 120 years old, and roughly 60 cm in diameter at breast height—to more than 5 per hectare across at least 300 ha of surveyed area
- Expand the area covered by old, undisturbed forests (A) to at least 200 ha
- Prevent all activities within a 100-meter radius around nests throughout the year and within a 300-meter radius during the period from December 15 to June 15.

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<sup>39</sup> Puzović, S., Radišić, D., Ružić, M., Rajković, D., Radaković, M., Pantović, U., ... & Raković, M. (2015). Birds of Serbia: Breeding population estimates and trends for the period 2008-2013. Novi Sad: Društvo za zaštitu i proučavanje ptica Srbije i Prirodno-matematički fakultet, Univerzitet u Novom Sadu

<sup>40</sup> BirdLife International (2021) European Red List of Birds. Luxembourg: Publications Office of the European Union

**Table 11: Ecological information for *Ciconia nigra*, *Haliaeetus albicilla* and *Dryocopus martius* at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Species 1	Species 2	Species 3
<b>3.2a Essential information (species)</b>			
3.2.1 Species group	B = Birds	B = Birds	B = Birds
3.2.1 Species code	A030	A075	A236
3.2.3 Scientific name	<i>Ciconia nigra</i>	<i>Haliaeetus albicilla</i>	<i>Dryocopus martius</i>
3.2.4 Sensitivity of species data		not assessed	
3.2.5 Non-presence	not applicable	not applicable	not applicable
3.2.6 Population type	Reproducing	Permanent	Permanent
<b>3.2.7 Population size and unit</b>			
3.2.7.1 Population size	1-2	1-2	5-7
3.2.7.2 Population unit	p = pairs	p = pairs	p = pairs
3.2.8 Abundance category	Rare	Rare	Rare
3.2.9 Method used for population size	Based mainly on expert opinion with very limited data	Based mainly on expert opinion with very limited data	Based mainly on expert opinion with very limited data
3.2.10 Period of last data collection		not assessed	
<b>3.2b Site assessment (species)</b>			
3.2.11 Significance		Significant	
3.2.12 Species meeting ornithological criteria for SPA classification		not assessed	
3.2.13 Population	C: 2% ≥ p > 0%	C: 2% ≥ p > 0%	C: 2% ≥ p > 0%
<b>3.2.13 Population – explanations (optional)</b>			
<b>3.2.15 Degree of conservation</b>			
3.2.15.1 Degree of conservation – categorised	C: reduced	C: reduced	B: good
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 102.2 ha (23.9 %) Non-sufficient quality: 326.3 ha (76.1 %)	Sufficient quality: 137.0 ha (32 %) Non-sufficient quality: 291.4 ha (68 %)	Sufficient quality: 350.9 ha (81.9 %) Non-sufficient quality: 77.5 ha (18.2 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 0-25 % Non-sufficient quality: 76-100 %	Sufficient quality: 26-50 % Non-sufficient quality: 51-75 %	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %
3.2.18 Isolation	C: population within distribution range	C: population within distribution range	C: population within distribution range
3.2.19 Global	B: good value	B: good value	C: significant value
3.2.20 Update date	December 2024	December 2024	December 2024

**Table 12: Ecological information for *Dendrocopos medius*, *Ficedula albicollis* and *Lanius collurio* at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Species 4	Species 5	Species 6
<b>3.2a Essential information (species)</b>			
3.2.1 Species group	B = Birds	B = Birds	B = Birds
3.2.1 Species code	A238	A321	A338
3.2.3 Scientific name	<i>Dendrocopos medius</i>	<i>Ficedula albicollis</i>	<i>Lanius collurio</i>
3.2.4 Sensitivity of species data		not assessed	
3.2.5 Non-presence	not applicable	not applicable	not applicable
3.2.6 Population type	Permanent	Reproducing	Reproducing
<b>3.2.7 Population size and unit</b>			
3.2.7.1 Population size	10-15	15-25	30-60
3.2.7.2 Population unit	p = pairs	p = pairs	p = pairs
3.2.8 Abundance category	Rare	Rare	Common
3.2.9 Method used for population size	Based mainly on expert opinion with very limited data	Based mainly on expert opinion with very limited data	Based mainly on expert opinion with very limited data
3.2.10 Period of last data collection		not assessed	
<b>3.2b Site assessment (species)</b>			
3.2.11 Significance		Significant	
3.2.12 Species meeting ornithological criteria for SPA classification		not assessed	
3.2.13 Population	C: 2% ≥ p > 0%	C: 2% ≥ p > 0%	C: 2% ≥ p > 0%
<b>3.2.13 Population – explanations (optional)</b>			
<b>3.2.15 Degree of conservation</b>			
3.2.15.1 Degree of conservation – categorised	C: reduced	C: reduced	B: good
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 109.4 ha (25.5 %) Non-sufficient quality: 319.0 ha (74.5 %)	Sufficient quality: 109.4 ha (25.5 %) Non-sufficient quality: 319.0 ha (74.5 %)	Sufficient quality: 445.3 ha (92.6 %) Non-sufficient quality: 35.8 ha (7.4 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 26-50 % Non-sufficient quality: 51-75 %	Sufficient quality: 26-50 % Non-sufficient quality: 51-75 %	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %
3.2.18 Isolation	C: population within distribution range	C: population within distribution range	C: population within distribution range
3.2.19 Global	C: significant value	C: significant value	C: significant value
3.2.20 Update date	December 2024	December 2024	December 2024

**Table 13: Ecological information for *Ficedula albicollis* at the SNR Kovilj-Petrovaradin marsh study area (10 km<sup>2</sup>).**

Information	Species 7
<b>3.2a Essential information (species)</b>	
3.2.1 Species group	B = Birds
3.2.1 Species code	A307
3.2.3 Scientific name	<i>Curruca (Sylvia) nisoria</i>
3.2.4 Sensitivity of species data	not assessed
3.2.5 Non-presence	not applicable
3.2.6 Population type	Reproducing
<b>3.2.7 Population size and unit</b>	
3.2.7.1 Population size	10-20
3.2.7.2 Population unit	p = pairs
3.2.8 Abundance category	Rare
3.2.9 Method used for population size	Based mainly on expert opinion with very limited data
3.2.10 Period of last data collection	not assessed
<b>3.2b Site assessment (species)</b>	
3.2.11 Significance	not assessed
3.2.12 Species meeting ornithological criteria for SPA classification	not assessed
3.2.13 Population	C: 2% ≥ p > 0%
<b>3.2.13 Population – explanations (optional)</b>	
<b>3.2.15 Degree of conservation</b>	
3.2.15.1 Degree of conservation – categorised	C: degraded
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 445.3 ha (92.6 %) Non-sufficient quality: 35.8 ha (7.4 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %
3.2.18 Isolation	C: population within distribution range
3.2.19 Global	C: significant value
3.2.20 Update date	December 2024

**Table 14: Restoration and conservation objectives for *Haliaeetus albicilla* on national level, compiled for deduction of SSCOs for SNR Kovilj-Petrovaradin marsh. For the parameter population, the target Favourable Reference Population (FRP) is derived from the study by Puzović et al. (2015)<sup>41</sup> and the European Red List of Birds 2021<sup>42</sup> for Serbia by Dimitrije Radišić, carried out for the EU4Green project. For the parameter Habitat for the species, the target of restoring 90 % of all occurrences to a good condition is derived from the Nature Restoration Regulation and based on expert's opinion.**

	Population		Population (source)	Habitat for the species (absolute area)		Habitat for the species (relative area)		Habitat for the species (source)
Status	314-364	individuals	Puzović et al. (2015); European Red List of Birds 2021	70,000	ha in good condition	56 % or 43 %	in good condition	estimate based on expert's opinion
				54,444-98,889	ha in not-good condition	44 % or 57 %	in not-good condition	
Target	500	individuals						
FRVs	27-37 % < FRA		Current value is 27- 37 % below the FRP	112,000- 152,000	ha in good condition	90 %	in good condition	application of 90 % goal of the Nature Restoration Regulation
				12,444-16,889	ha in not-good condition	10 %	in not-good condition	
Difference to FRVs	<b>136-186</b>	<b>individuals</b>	Increase of 136-186 individuals needed	<b>42,000-72,000</b>	<b>ha more in good condition</b>	Increase towards good condition for 42,000- 72,000 km <sup>2</sup> needed.		

<sup>41</sup> Puzović, S., Radišić, D., Ružić, M., Rajković, D., Radaković, M., Pantović, U., ... & Raković, M. (2015). Birds of Serbia: Breeding population estimates and trends for the period 2008-2013. *Novi Sad: Društvo za zaštitu i proučavanje ptica Srbije i Prirodno-matematički fakultet, Univerzitet u Novom Sadu*

<sup>42</sup> BirdLife International (2021) European Red List of Birds. Luxembourg: Publications Office of the European Union

### 3.5. Conclusions

The fieldwork conducted within SNR Kovilj-Petrovaradin marsh confirmed its exceptionally high natural value, yielding particularly strong results for the studied habitat types as well as for key species such as the Black Woodpecker (*Dryocopus martius*) in forests and the Barred Warbler (*Sylvia nisoria*) and Red-backed Shrike (*Lanius collurio*) in the open landscapes. At the same time, the investigations brought to light several challenges, both in terms of methodology and conservation practice, which should be addressed in future work.

The exemplary Site-specific conservation objectives and conservation measures developed during the study not only illustrate the applied approach but also provide a foundation for proposing new objectives to guide the management of the Special Nature Reserve. These findings highlight how the local circumstances, both natural and human-influenced, can be brought together with the overall conservation status through a structured approach, ensuring that each site contributes as much as possible to the conservation of the species or habitat type.

In the eyes of EAA experts on biodiversity, the expert team responsible for the fieldwork demonstrated a high level of professionalism and motivation, successfully tailoring the methodological framework to local circumstances. In doing so, they gained valuable new insights that will prove highly useful for extending and refining mapping activities in the future, thereby strengthening the long-term conservation efforts in SNR Kovilj-Petrovaradin marsh. They also gathered important knowledge to support the development of a general methodology to map potential future Natura 2000 sites in Serbia.

## 4. NATURE-BASED SOLUTIONS IN FLOODPLAINS: METHODS FOR ASSESSING IMPLEMENTATION POSSIBILITIES ON A REGIONAL LEVEL

Authors: Stefan Fuchs, EAA

with contributions from: Peter Tramberend, Katharina Huchler, EAA

### 4.1. Summary

EU4Green aimed to highlight the potential of innovative Nature-based Solutions (NbS) at the Kovilj-Petrovaradin marsh in Serbia. River regulation, intensification of land use and habitat fragmentation threaten biodiversity, ecosystem services and human well-being. NbS are increasingly recognised in policy frameworks such as the Green Agenda for the Western Balkans, the EU Biodiversity Strategy 2030 and the EU Nature Restoration Regulation as effective, multifunctional responses to these challenges. To define realistic objectives for the development of NbS, the methodology combined literature review, expert questionnaires and participatory workshops with an analysis of geospatial data to identify and localise priority areas. The results were developed in close consultation with local experts.

Major societal challenges – such as flood risk, water pollution, soil erosion and habitat degradation – were linked to appropriate NbS, associated ecosystem services, indicators and data sources, joint in a NbS matrix, structuring the relationship between challenges, ecosystem functions, expected benefits and monitoring parameters. In addition, a dedicated NbS guidance document on riparian buffer zones was elaborated as a key thematic output. The guidance provides practical recommendations for the design, implementation and monitoring of buffer strips rivers and floodplains, emphasising their multifunctional role and important steps and issues during the planning and implementation process.

Overall, the EU4Green NbS outputs provide a robust and practical basis for advancing restoration, biodiversity conservation and climate resilience on the local level, in line with EU and global objectives.

## 4.2. Introduction

### 4.2.1. EU4Green's activities on NbS

EU4Green assessed and highlighted the potential of Nature-based Solutions (NbS) on pilot site level. Because of anthropogenic activities, such as river regulations, intensification of land use and habitat fragmentation, the pressure on riparian ecosystems like floodplains is increasing. Over time, these pressures threaten the rich nature of those ecosystems and affect human well-being. The disturbed natural systems contribute to a range of societal challenges, e.g. water pollution, flood risk or soil erosion. NbS can serve as a valuable tool that help to tackle those challenges, reducing the exposure of negative effects.<sup>43, 44</sup>

Furthermore, NbS are promoted as valuable tool by the GAWB<sup>2</sup> and explicitly mentioned in many other major EU frameworks and strategies, such as the EU Biodiversity Strategy 2030<sup>19</sup>, the EU Nature Restoration Regulation<sup>45</sup>, the Common Agricultural Policy<sup>46</sup> and the Water Framework Directive<sup>47</sup>. These alignments emphasise the importance and necessity of the NbS concept.

Within EU4Green, the promotion of the NbS concept was supported through capacity building, such as expert workshops and webinars and establishment of a Community of Practice together with IUCN. Furthermore, EU4Green developed a comprehensive guidance document on riparian buffer zones, a NbS that provides multiple benefits when implemented along rivers. The guidance document highlights how to plan, finance, implement and evaluate such NbS.

### 4.2.2. NbS as sustainable tool

#### Definition of societal challenges, NbS and ecosystem services

Before diving into the topic of NbS, a few definitions are required for a common understanding of terms and, furthermore, intention and aim of the activities.

The term *societal challenges (SC)* refers to complex issues and problems that affect communities, societies, or humanity at large. They often require collective efforts and solutions to address them effectively. General examples would be poverty or inequality.

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<sup>43</sup> INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN), 2016. WCC-2016-Res-069-EN: Defining Nature-based Solutions. Resolution adopted at the IUCN World Conservation Congress, Honolulu, Hawaii, USA. Available at: <https://portals.iucn.org/library/node/46456>

<sup>44</sup> Seddon N, Chausson A, Berry P, Girardin CAJ, Smith A, Turner B, 2020. Understanding the value and limits of nature-based solutions to climate change and other global challenges. *Phil. Trans. R. Soc. B* 375: 20190120. Available at: <http://dx.doi.org/10.1098/rstb.2019.0120>

<sup>45</sup> Regulation 2024/1991. Regulation (EU) 2024/1991 of the European Parliament and of the Council of 24 June 2024 on nature restoration and amending Regulation (EU) 2022/869. *Nature Restoration Regulation*. Official Journal of the European Union, L 1991. Available at: <http://data.europa.eu/eli/reg/2024/1991/oj>

<sup>46</sup> Regulation 2021/2115. Regulation (EU) 2021/2115 establishing rules on support for strategic plans under the Common Agricultural Policy (CAP Strategic Plans). Official Journal of the European Union, L 435, 1–186. Available at: <http://data.europa.eu/eli/reg/2021/2115/oj>

<sup>47</sup> Directive 2000/60/EC. Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy. *Water Framework Directive*. L 327, 1-73. Available at: <https://eur-lex.europa.eu/eli/dir/2000/60/oj/eng>

*Nature-based Solutions (NbS)* are defined as strategic actions that protect, sustainably manage, and restore natural or modified ecosystems to address societal challenges. In the current case study of floodplains, this would target more specifically climate change, disaster risk, water and food security, and public health. While at the same time biodiversity and human well-being are being enhanced as well.<sup>48, 49, 50</sup>

Unlike conventional engineering solutions (e.g. dams or concrete barriers), NbS rely on natural processes. For instance, restoring wetlands or riparian forests can offer flood protection while supporting biodiversity, sequestering carbon, and providing recreation. Compared to grey infrastructure, such interventions often deliver greater ecosystem services and long-term adaptability<sup>51</sup>.

*Ecosystem services (ES)* are the benefits that humans derive from ecosystems, encompassing a wide range of goods and services that contribute to human well-being<sup>52</sup>. They comprise of biotic/abiotic and biophysical/geophysical services that are classified in 3 main categories:

- Provisioning services (e.g. food, water, raw materials)
- Regulation & maintenance services (e.g. climate regulation, nutrient cycling, pollination)
- Cultural services (e.g. recreation, education, spiritual fulfilment)<sup>53</sup>

## Benefits of NbS

NbS offer a multifaceted approach to address environmental challenges, particularly in the context of climate change and ecosystem degradation. By enhancing carbon sequestration in e.g. wetlands, NbS contribute significantly to climate mitigation while also adapting urban areas to extreme heat through increased vegetation cover<sup>54</sup>. Moreover, they support biodiversity conservation by protecting and restoring critical habitats in terrestrial and aquatic ecosystems<sup>55</sup>. NbS also improve water quality and availability by filtering pollutants through vegetated buffers and wetlands, while simultaneously enhancing soil health through erosion control and nutrient cycling<sup>56</sup>.

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<sup>48</sup> Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). *Nature-based Solutions to address global societal challenges*. Gland, Switzerland: IUCN. xiii + 97pp.

<sup>49</sup> Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. *Nature-Based Solutions*, 2, 100009.

<sup>50</sup> Dumitru, A., & Wendling, L. (2021). *Evaluating the impact of nature-based solutions: A handbook for practitioners*. European Commission EC.

<sup>51</sup> Turkelboom, F., Demeyer, R., Vranken, L. et al. How does a nature-based solution for flood control compare to a technical solution? Case study evidence from Belgium. *Ambio* 50, 1431–1445 (2021). <https://doi.org/10.1007/s13280-021-01548-4>

<sup>52</sup> Grima, N., Jutras-Perreault, M. C., Gobakken, T., Ørka, H. O., & Vacik, H. (2023). Systematic review for a set of indicators supporting the Common International Classification of Ecosystem Services. *Ecological Indicators*, 147, 109978.

<sup>53</sup> Haines-Young, R. (2023): *Common International Classification of Ecosystem Services (CICES) V5.2 and Guidance on the Application of the Revised Structure*.

<sup>54</sup> Griscom, B. W., et al. (2017). Natural climate solutions. *Proceedings of the National Academy of Sciences*, 114(44), 11645–11650.

<sup>55</sup> Seddon, N., et al. (2020). *Understanding the value and limits of nature-based solutions to climate change and other global challenges*. *Philosophical Transactions of the Royal Society B*, 375(1794), 20190120.

<sup>56</sup> Brauman, K. A., Daily, G. C., Duarte, T. K., & Mooney, H. A. (2007). *The nature and value of ecosystem services: an overview highlighting hydrologic services*. *Annual Review of Environment and Resources*, 32, 67–98.

Beyond ecological gains, NbS deliver social benefits as well, which improve human well-being and community resilience. Green infrastructure, such as parks and urban forests, reduces stress, enhances mental health, and promotes physical activity<sup>57</sup>. NbS also buffer the impacts of natural disasters by restoring natural floodplains and stabilizing slopes, reducing the risk of floods and landslides<sup>58</sup>. Importantly, many NbS projects are participatory, involving local communities in planning and maintenance, which fosters social cohesion and a sense of ownership<sup>59</sup>.

Economically, NbS provide cost-effective alternatives to traditional technology-based solutions while generating green jobs and supporting sustainable agriculture. They reduce long-term infrastructure costs by minimizing the need for expensive engineered solutions. Restoration and conservation work also drives employment in sectors like forestry, agriculture, and ecotourism. Furthermore, integrating agroecological practices improves soil and water management, leading to higher and more sustainable agricultural productivity<sup>60</sup>.

### 4.2.3. Relevant guidelines and documents

To support the systematic planning, implementation and evaluation of NbS in the WB6, a range of European and international frameworks and guideline documents are available. These frameworks provide conceptual definitions, methodological standards and practical tools to assess the condition of the targeted ecosystems, ecosystem services and the effectiveness of NbS interventions. Together, they ensure coherence with EU and global biodiversity and restoration policies, enable evidence-based decision-making and support the translation of strategic objectives into measurable, site-specific actions.

#### **IUCN Global Standard for Nature-based Solutions<sup>61</sup>**

The IUCN Global Standard for Nature-based Solutions provides a structured framework to support the effective design, implementation and evaluation of NbS. Developed by IUCN, it defines eight criteria and 28 indicators on key aspects such as biodiversity outcomes, ecosystem integrity, trade-offs, stakeholder involvement and adaptive management. The document ensures that NbS address major societal challenges (e.g. climate change, biodiversity loss and disaster risk) while delivering measurable and sustainable benefits for both people and nature. By promoting scientifically robust and socially inclusive approaches, it supports scalable, economically viable and policy-relevant solutions that strengthen ecosystem health, human well-being and long-term resilience.

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<sup>57</sup> Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. *Annual Review of Public Health*, 35, 207–228.

<sup>58</sup> Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-based solutions to address global societal challenges*. IUCN.

<sup>59</sup> Raymond, C. M., et al. (2017). *A framework for assessing and implementing the co-benefits of nature-based solutions in urban areas*. *Environmental Science & Policy*, 77, 15–24.

<sup>60</sup> Titttonell, P. (2014). *Ecological intensification of agriculture—sustainable by nature*. *Current Opinion in Environmental Sustainability*, 8, 53–61.

<sup>61</sup> International Union for the Conservation of Nature (IUCN). (2020a). *IUCN Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of Nature-based Solutions (1st ed.)*. IUCN.

<https://doi.org/10.2305/IUCN.CH.2020.08.en>

In addition, it should also be mentioned, that the IUCN provides many more reports, policy briefs and other supporting documents on NbS. Some of the most relevant for the cause of the projects work are the following:

- IUCN Global Standards for Nature-based Solutions<sup>62</sup>
- Nature-based Solutions for climate: A compendium of best practices in the Western Balkans<sup>63</sup>
- Nature-based Solutions in the Post-2020 Global Biodiversity Framework Targets<sup>64</sup>

### **Alignment with the Post-2020 Global Biodiversity Framework<sup>65</sup>**

The Kunming–Montreal Global Biodiversity Framework defines 23 global targets for 2030, including the protection and restoration of 30 % of land and seas and the sustainable use of natural resources. NbS provide a practical path to implement these targets, particularly those related to ecosystem restoration, climate resilience, sustainable land use and nature’s contributions to people. By translating global goals into locally adapted, multifunctional measures, NbS help bridge biodiversity, climate and development agendas and increase the feasibility, acceptance and impact of GBF implementation in the Western Balkans.

### **EU4Green: Guidance document on NbS: riparian buffer zones**

The guidance document provides an overview of relevant principles and approaches for the planning, implementation, and monitoring of riparian buffer zones as a key NbS along rivers and floodplains in the WB6. While the main concepts and methodological foundations are described in the respective chapter of this summary report, the detailed guidance and concrete steps are addressed in depth and in the dedicated EU4Green deliverable.

### **Catalogue of NbS for Water Management in the Eastern Partnership Countries<sup>66</sup>**

This catalogue provides a comprehensive overview of 34 NbS relevant to water management at the river basin scale, with applicability also to the WB6. Each factsheet combines documented case studies, technical references and indicative cost information, supporting informed decision-making by practitioners, authorities and planners. Within EU4Green

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<sup>62</sup> International Union for the Conservation of Nature (IUCN). (2020a). IUCN Global Standard for Nature-based Solutions: A user-friendly framework for the verification, design and scaling up of Nature-based Solutions (1st ed.). IUCN. <https://doi.org/10.2305/IUCN.CH.2020.08.en>

<sup>63</sup> IUCN (2021). *Nature-based Solutions for Climate: A Compendium of Best Practices in the Western Balkans*. Gland, Switzerland: International Union for Conservation of Nature (IUCN). [https://iucn.org/sites/default/files/2023-12/nbs-compendium-western-balkans\\_finale.pdf](https://iucn.org/sites/default/files/2023-12/nbs-compendium-western-balkans_finale.pdf)

<sup>64</sup> IUCN (2020). *Nature-based Solutions in the Post-2020 Global Biodiversity Framework Targets*. Gland, Switzerland: International Union for Conservation of Nature (IUCN). <https://iucn.org/sites/default/files/2022-11/nbs-in-gbf-targets-brief-november-2022.pdf>

<sup>65</sup> Convention on Biological Diversity (CBD). (2022). Kunming-Montreal Global Biodiversity Framework. CBD COP15, Montreal.

<sup>66</sup> EU4Environment – Water Resources and Environmental Data. (2024). Catalogue of Nature-based Solutions for the water sector in the Eastern Partnership countries (Sept. 2024, Version Final). EU4Environment. [https://eu4waterdata.eu/images/pdf/library/EU4ENVWaterData\\_NbSCatalogue-water-EaP\\_%20Sept24\\_VF.pdf](https://eu4waterdata.eu/images/pdf/library/EU4ENVWaterData_NbSCatalogue-water-EaP_%20Sept24_VF.pdf)

Biodiversity activities, a targeted selection of these NbS forms the analytical basis for defining NbS objectives and measures in the three pilot study areas.

**Voluntary Guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction and supplementary information<sup>67</sup>**

The CBD voluntary guidelines provide support to governments, organisations, and communities for designing and implementing ecosystem-based approaches to climate change adaptation and ecosystem-based disaster risk reduction. It emphasizes the use of biodiversity and ecosystem services as sustainable, cost-effective, and inclusive strategies to reduce vulnerability to climate hazards while enhancing human and ecological resilience. The guidelines outline principles and practical steps for embedding NbS into policies and projects, highlighting co-benefits such as improved livelihoods, food security, and cultural values. Supplementary case studies and tools illustrate how ecosystem restoration, conservation, and sustainable management can function as NbS that simultaneously address climate risks, safeguard biodiversity, and support long-term development goals.

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<sup>67</sup> Secretariat of the Convention on Biological Diversity (2019). Voluntary guidelines for the design and effective implementation of ecosystem-based approaches to climate change adaptation and disaster risk reduction and supplementary information. Technical Series No. 93. Montreal, 156 pages.

## 4.3. Material and methods

### 4.3.1. Literature research

As basis for all further activities, the first step consisted of screening existing literature. In combination with expert's knowledge, the aim was to get an overview of the most relevant NbS for societal challenges typically related to floodplains and other riparian ecosystems. As main references for this preliminary work, the CICES nomenclature<sup>68</sup> on ecosystem services was used together with the systematic review on ecosystem services of Grima et al.<sup>69</sup>. Within EU4Green, we created a first selection by linking the relevant societal challenges with the corresponding NbS and suggested indicators.

### 4.3.2. Workshops with local experts

Together with the biodiversity experts of each pilot region, who were already involved in a close cooperation for the assessment of the Natura 2000 features, a participative workshop on NbS was held. The workshop started with a theoretical part, giving input on definitions and examples of SC & NbS. In the following participative working sessions, the plenum of experts was consulted on their estimations of the regional and local circumstances of each study area. With their active involvement, questionnaires on currently pressing SC and potential NbS for the areas were filled out to complement the preselected list of key challenges and potential measures. Each assessment was followed by a prioritization of the elaborated SC and NbS lists for each pilot area.

The ranked collection was evaluated and constituted the final selection of SC & NbS for the subsequent outputs, such as the NbS matrix and the guidance document on NbS.

### 4.3.3. NbS matrix

The NbS matrix was compiled as key output subsequently to the expert workshop, combining the outputs of the participative session with further findings from literature. The resulting list was then extended by linking ecosystem services and suitable indicators according to Grima et al.<sup>56</sup>.

As additional information, the ranked priority for societal challenges and NbS in each economy was integrated as well. Since data availability is a significant issue for the WB6, valuable information on existing data sources was added.

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<sup>68</sup> Haines-Young, R. (2023): Common International Classification of Ecosystem Services (CICES) V5.2 and Guidance on the Application of the Revised Structure.

<sup>69</sup> Grima, N., Jutras-Perreault, M. C., Gobakken, T., Ørka, H. O., & Vacik, H. (2023). Systematic review for a set of indicators supporting the Common International Classification of Ecosystem Services. *Ecological Indicators*, 147, 109978.

## 4.4. Results and discussion

### 4.4.1. NbS matrix

The NbS matrix represents the condensed output of the literature review, expert workshops and questionnaires as well as data acquisition process carried out within the project. It provides a structured overview linking societal challenges (SC) identified in the study areas with potential NbS, their associated ecosystem services (ES), suitable indicators, and exemplary data sources. The matrix thus serves as an integrative tool to connect pressures, responses and measurable outcomes in a transparent and comparable manner.

For Serbia, societal challenges were identified and ranked based on expert input, reflecting their relative importance at the regional level. Corresponding NbS measures were then assigned to each challenge and flagged as NbS or non-NbS based on expert judgement and alignment with established NbS definitions. Where applicable, an NbS ranking was included to reflect the perceived relevance or effectiveness of the measure in addressing the specific challenge.

The matrix further links each NbS to relevant ecosystem services, such as biodiversity conservation or enhancement, and proposes potential indicators (e.g. number of species,  $\alpha$ -/ $\beta$ -diversity) to support monitoring and evaluation. Exemplary data sources, including zoological and botanical surveys, are referenced to indicate how these indicators could be operationalised in practice.

The full NbS matrix, including detailed rankings and data references, is provided in Annex V.

### 4.4.2. Guidance document on NbS

The elaborated guidance document on NbS: riparian buffer zones focused on an impactful and highly relevant NbS for floodplains within the Western Balkan pilot sites. Riparian buffer zones represent a powerful NbS to address pressing environmental and societal challenges associated with floodplains. As linear habitat structures along rivers and floodplains, they provide multiple benefits: reducing flood risk, improving water quality, conserving biodiversity, and enhancing ecosystem services for local communities.

The key elements covered in the guidance document encompass:

- An overview of the concept and benefits of NbS, aligned with international standards.
- Practical guidance on the design, management, and integration of riparian buffer zones into broader conservation and land-use strategies.
- A focus on indicators and monitoring approaches that enable administrations to track effectiveness, adapt management, and demonstrate outcomes.
- A designated chapter by Green Finance experts that outlines potential finance and funding opportunities available for NbS projects in the WB6.

While the proposed NbS offer significant opportunities, implementation in the region still faces barriers such as limited data availability, financial constraints, fragmented governance, and competing land-use interests. Addressing these challenges requires cross-sectoral cooperation, long-term commitment, and investment in knowledge and capacity building.

For protected area administrations, this guidance provides a practical tool to strengthen floodplain resilience, enhance biodiversity conservation, and contribute to EU environmental objectives. By adopting evidence-based and participatory approaches, administrations can ensure that riparian buffer zones deliver sustainable, multifunctional benefits for both people and nature.

## **4.5. Conclusions**

The development of the NbS matrix and the guidance document on riparian buffer zones highlighted both the opportunities for various fields of action and also constraints of applying NbS in the study area of Serbia. While the availability of harmonised geospatial datasets enabled a consistent analysis across ecosystems, limitations in site-specific data – particularly on land ownership, agricultural practices and detailed management regimes, but also a higher thematical resolution of the habitat types beyond the core study area of the project – remain a key challenge for implementation-oriented planning. These gaps underline the need for complementary field assessments and locally maintained databases to refine the definition of priorities and measures.

Effective implementation will depend on strong partnerships and participatory governance. Special Nature Reserve authorities play a central role as coordinators and facilitators, but successful NbS deployment also requires early involvement of municipalities, landowners, farmers and the wider public. On a higher political level, decision-makers need to be brought on board, and awareness needs to be raised. This is crucial for the mobilisation of financial resources and securing fundings on the short and long term. Strengthening cross-sectoral cooperation, clarifying land-use and ownership conditions, and embedding NbS into management plans and local development strategies will be essential next steps to translate the future measures and guidance into sustainable and effective practice and actions.

The project outputs, with their strong practical and implementation-oriented focus for the WB6 context, together with the wide range of international guidelines and standards on NbS, provide a well-founded basis for the future implementation of NbS measures in the Danube River floodplains.