EU4GREEN

PROJECT SUMMARY FOR UNA RIVER NATIONAL PARK, BOSNIA AND HERZEGOVINA

EU4Green: 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

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CONTENT

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ABBREVIATIONS

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

[1] 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.

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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[1], 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)[2]. 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[3,4]. 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 the 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 Bosnia and Herzegovina (BiH). 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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[2] 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

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

[4] 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 BOSNIA AND HERZEGOVINA

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

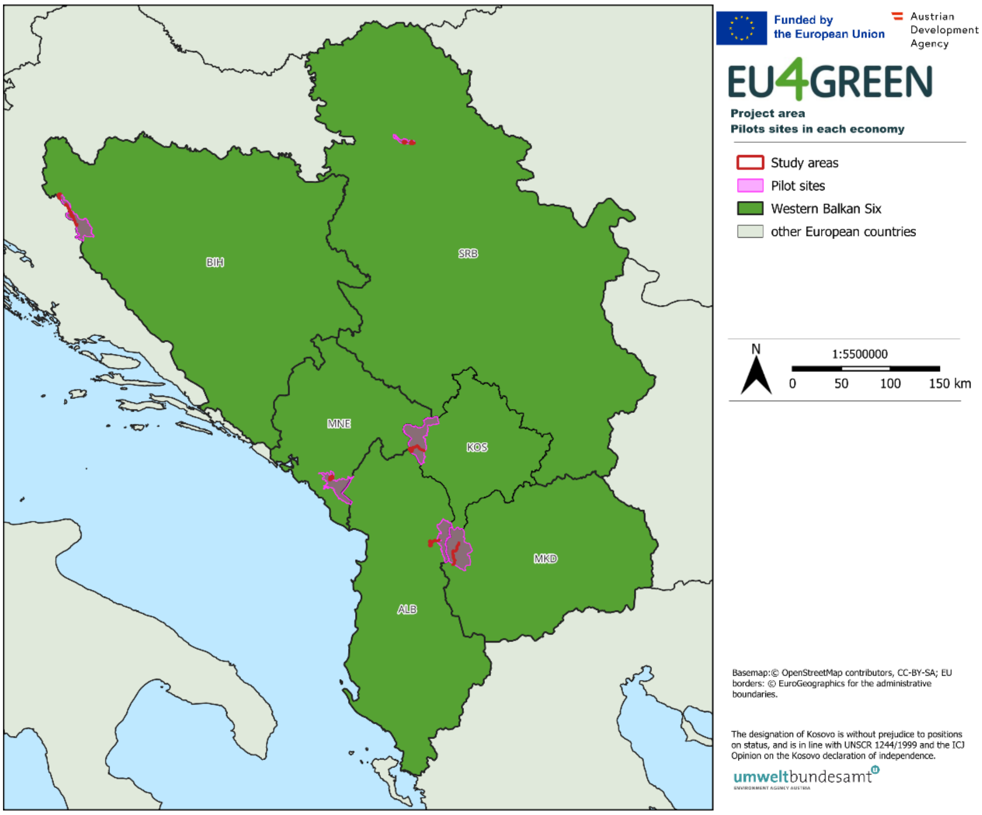

Figure 1: The six pilot sites in the economies of the Western Balkans.

In BiH, the Una River National Park (Nacionalni Park Una) was chosen. Established in 2008, it encompasses the Upper Una River as well as its tributaries, Krka and Unac. With an area of 198 km^2, it is the largest of BiH's four national parks, located in the territory of the Federation of Bosnia and Herzegovina (FBiH). As in many other areas of BiH (both in FBiH and in Republika Srpska), the Una River often marks the border between BiH and Croatia, before it feeds into the Sava River.

The Upper Una River stretches from its source near the village Donja Suvaja in Croatia to the city of Bihać, the largest city along the Una River, shortly downstream from the Una River National Park. The section features both meandering parts and river islands as well as magnificent cascades, waterfalls and canyons. The Upper Una River is relatively unpolluted, however, entry of untreated sewage and fertilizers and pesticides from adjacent agricultural land may affect water quality. The Una River National Park aims to protect the Una and its tributaries. It also harbours precious biodiversity along the rivers as well as in the adjacent agricultural lands and hilly woodlands. Rare and endemic plant species, pristine habitats and a wide range of animal species are found within the national park. The Una River National Park is managed by the Public company National Park Una d.o.o, which carries out protection, maintenance and promotion measures.

Because each thematic field of EU4Green Biodiversity activities requires its own appropriate spatial scale, the analyses of the local activities carried out under EU4Green are conducted at different spatial extents. This ensures that the applied methods remain feasible and that the conclusions drawn from the elaborated outcomes are meaningful. As a result, each chapter refers to a specific spatial extent (Figure 2).

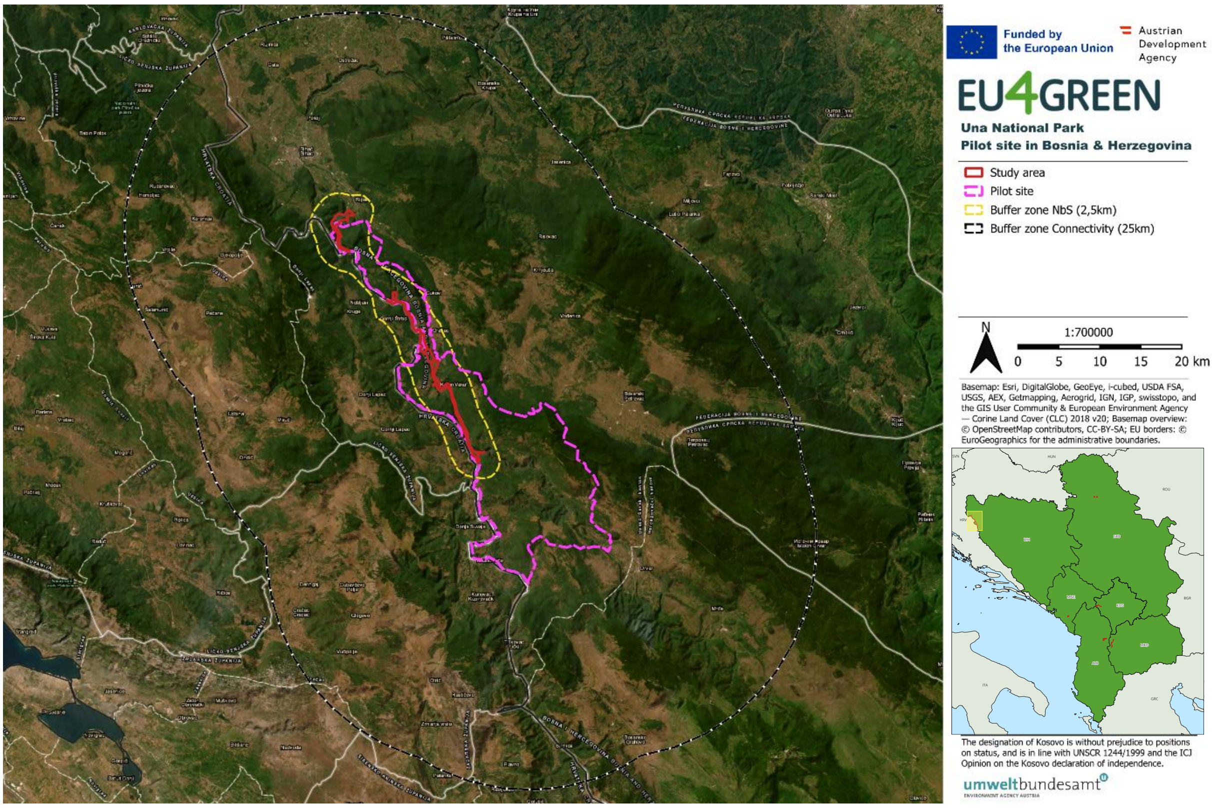

Figure 2: The different spatial extents of the local activities carried out in and around Una River National Park (depicted in pink). The core study area for mapping species and habitats of Natura 2000 sites (chapter 3, depicted in red) stretches along the river floodplain. The study area for Nature-based Solutions (chapter 4, depicted in yellow) was derived by adding a buffer around the core study area. The area assessed for connectivity (chapter 2, depicted in black) was derived by adding a buffer around the national park's borders.

2. CONNECTIVITY

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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 Una River National Park in Bosnia and Herzegovina 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 across the landscape, while Natural grasslands are less common but still form a network of corridors in the southern part of the region. Conservation priorities include maintaining existing corridors and promoting land-use practices that sustain connectivity. 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 and cross-border collaboration 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[5]. 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[6]. 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[7]. 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[8].

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[8,9,10]. 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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[5] 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
[6] 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
[7] 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
[8] 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
[9] 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
[10] 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[11]. Each CORINE land cover class[12] 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).

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

[11] CORINE Land Cover. [Retrieved November 12, 2025] https://land.copernicus.eu/en/products/corine-land-cover
[12] CLC Nomenclature EN. [Retrieved November 12, 2025] 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

Una River National Park was chosen as the pilot site to test the connectivity model in Bosnia and Herzegovina (see also chapter 1EU4Green's pilot site in Bosnia and Herzegovina). To assess the ecological connectivity, 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[13]. 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.

[13] 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 Una River National Park is a relatively rural and natural area. Our focus land cover classes of Broad-leaved forests and Natural grasslands cover 57 % and 2 %, respectively, of the pilot site. Broad-leaved forests are very well connected over the whole study area, whereas Natural grasslands only occur in the southern part but are still relatively well connected. Conserving the natural state of this well-connected landscape should be a priority in conservation planning.

2.4.1. Natural grasslands

Large patches of Natural grasslands are relatively rare in this study area and primarily situated only in the south of the study area (Figure 3Figure 3). However, those patches form a well-connected arch around the southern boundaries of national park. Only one small patch of Natural grasslands lies within the national park itself, but it is well connected to other patches in the south-east (Figure 3Figure 3, A). Corridors to the west are longer, passing through a complex mosaic of farmland, forest, and grassland (Figure 3Figure 3, B). Conservation action in this area should focus on maintaining the existing corridors by promoting small-scale farming in the southern part of the pilot site - a practice, which is even more important to preserve under economic development, and was lost in large parts of Europe.

2.4.2. Broad-leaved forest

Broad-leaved forests are very well connected in the study area (Figure 4Figure 4). Most of the patches of Broad-leaved forest are surrounded by Mixed Forests facilitating movement of shy mammals across the landscape. The mosaic of larger patches and smaller, well-connected corridors of Broad-leaved forests make this a landscape of very high natural value. Conserving the continuous Broad-leaved forest corridor along the border toward the north-west ensures the connectivity to the Plitvička Jezera National Park in Croatia (Figure 4, A).

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[14]. The spatial extent of the study area and resolution (pixel size) highly influences the output of the algorithm[15]. The used CORINE land cover data set is from 2018. Land use changes since 2018 have therefore not been accounted for. The next

[14] 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.

[15] 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

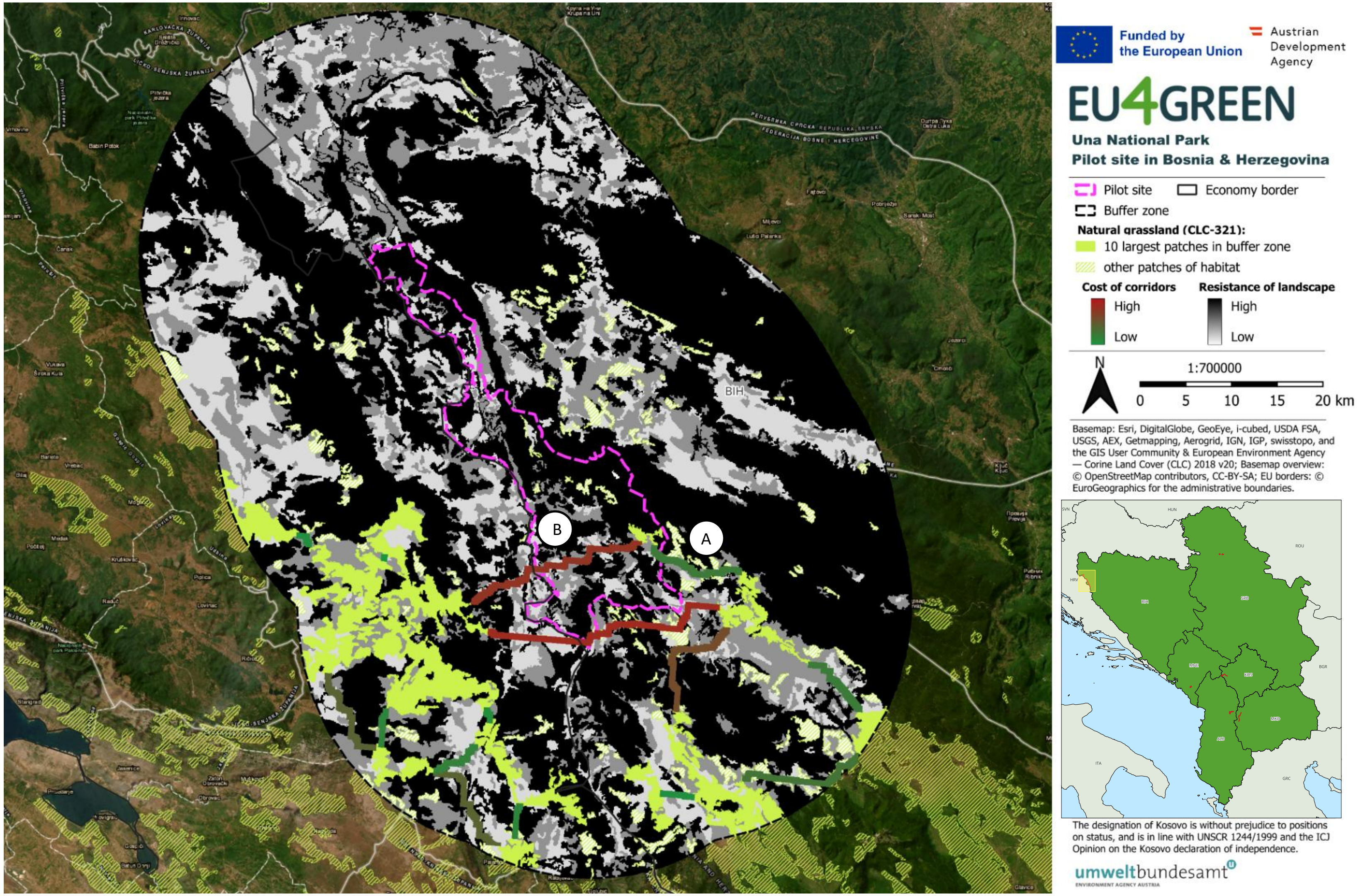

Figure 3: Connectivity of Natural grasslands in the buffer zone around Una River National Park, Bosnia and Herzegovina. The grayscale background map shows landscape resistance values (from 1 = white = low resistance to 8 = black = high resistance), green areas show the Natural grasslands. The corridors 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 = 2 to red = 2022). The thickness of the corridors has been enhanced for better visibility. The letters highlight corridors or large patches mentioned in the text.

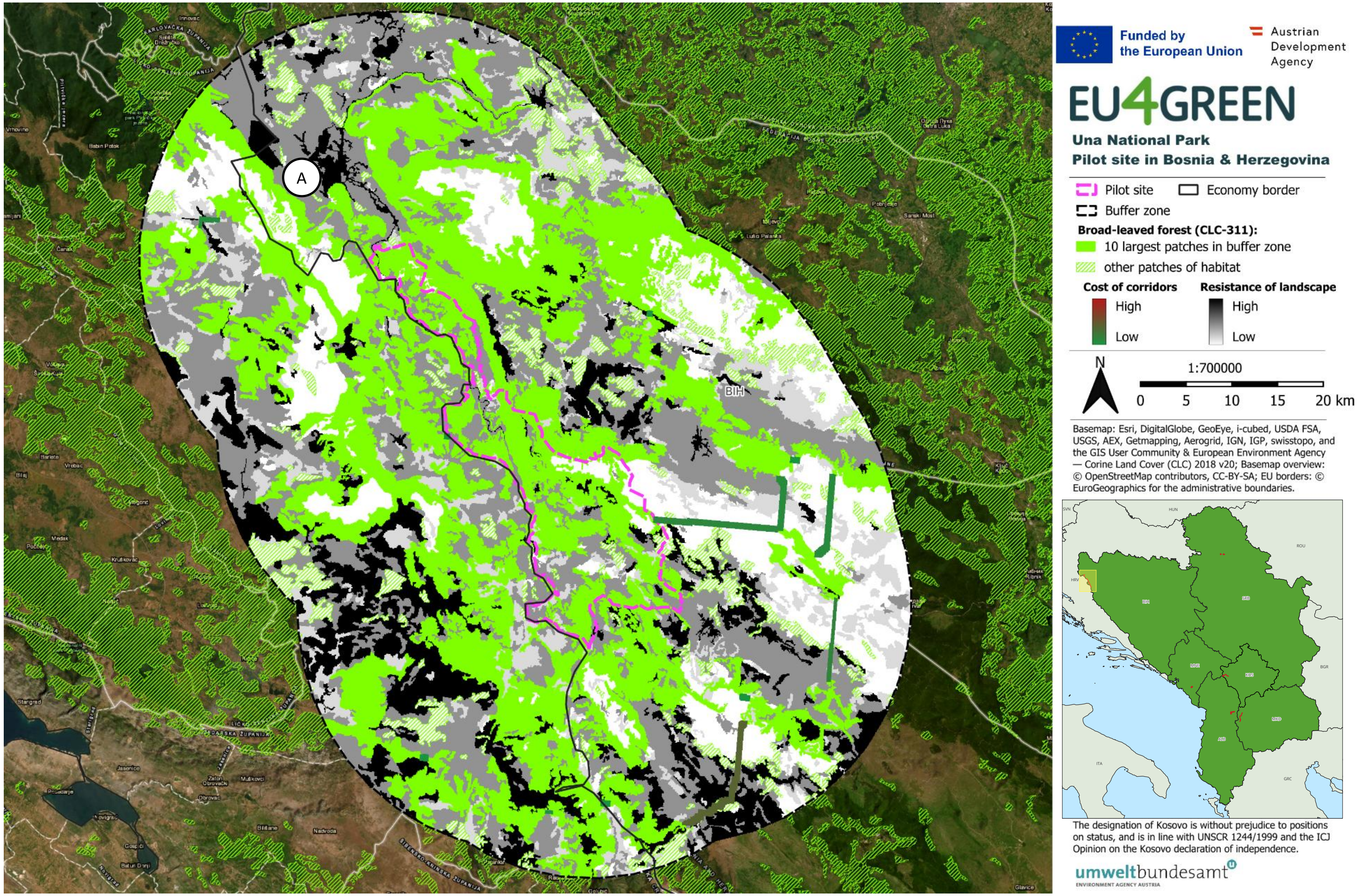

Figure 4: Connectivity of Broad-leaved forests in the buffer zone around Una River National Park, Bosnia and Herzegovina. The grayscale background map shows landscape resistance values (from 1 = white = low resistance to 8 = black = high resistance), green areas show the Broad-leaved forests. The corridors 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 = 4 to red = 540). The thickness of the corridors has been enhanced for better visibility. The letters highlight corridors or large patches mentioned in the text.

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[16]. The analysis could be taken further by verification of results through movement data, in-situ studies or expert knowledge.

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 for connectivity in the study area of Una River National Park will be primarily to protect the already existing corridors between the patches of target land cover classes and to preserve the small patches of Natural grasslands.

The results highlight the need for well-informed and anticipatory spatial planning in the surroundings of the Una River National Park, 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.

Nature conservation areas in cross-border regions highly profit from transnational collaboration. This is especially true for the topic of connectivity where the natural values of protected areas can be impacted if corridors for connectivity are lost.

[16] 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.

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

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With contributions from: EU4Green contracted biodiversity experts (Sabina Trakić, Tarik Dervović and Adla Kahrić), 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[17]. 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[18]. In this context, the GAWB calls upon the WB6 to align their policies to the EU Biodiversity Strategy for 2030[19].

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 _ $_{\text{ex 79/409}}$) 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[20]. Accession candidates are required to prepare their future Natura 2000 sites, using the framework of the Emerald Network[21].

3.2.2. Standard Data Forms

For each Natura 2000 site, Member States fill a Standard Data Form (SDF)[22], thereby providing information on area, location, characteristics and management, as well as ecological information on its habitat types and species[23]. As the EC uses the SDFs to review

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[17] 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

[18] 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

[19] 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, p. 1 – 22.

[20] 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

[21] 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.

[22] The European Commission updated the format of the Standard Data Form in 2023; its use is required from February 2025 onwards.

[23] C/2023/8623. ABl L, 2023/8623. Available at: 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[23]. 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 2Table 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[23].

<table>
<tr><th>Section</th><th>Requirement</th></tr>
<tr><td>1. Site identification</td><td rowspan="2">Required for each Natura 2000 site</td></tr>
<tr><td>2. Site area and location</td></tr>
<tr><td>3. Ecological information</td><td></td></tr>
<tr><td>3.1 Habitat types</td><td rowspan="3">Required for each Annex I habitat type present within the Natura 2000 site</td></tr>
<tr><td>3.1.a Essential information</td></tr>
<tr><td>3.1.b Site assessment & Degree of Conservation</td></tr>
<tr><td>3.2 Species</td><td rowspan="3">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</td></tr>
<tr><td>3.2.a Essential information</td></tr>
<tr><td>3.2.b Site assessment & Degree of Conservation</td></tr>
<tr><td>3.3 Other species</td><td>Optional</td></tr>
<tr><td>Site description</td><td rowspan="3">Required for each Natura 2000 site</td></tr>
<tr><td>Site management</td></tr>
<tr><td>Geospatial representation</td></tr>
</table>

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[24]. 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.

[24] 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 is linked to 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[25]. 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).

[25] 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.

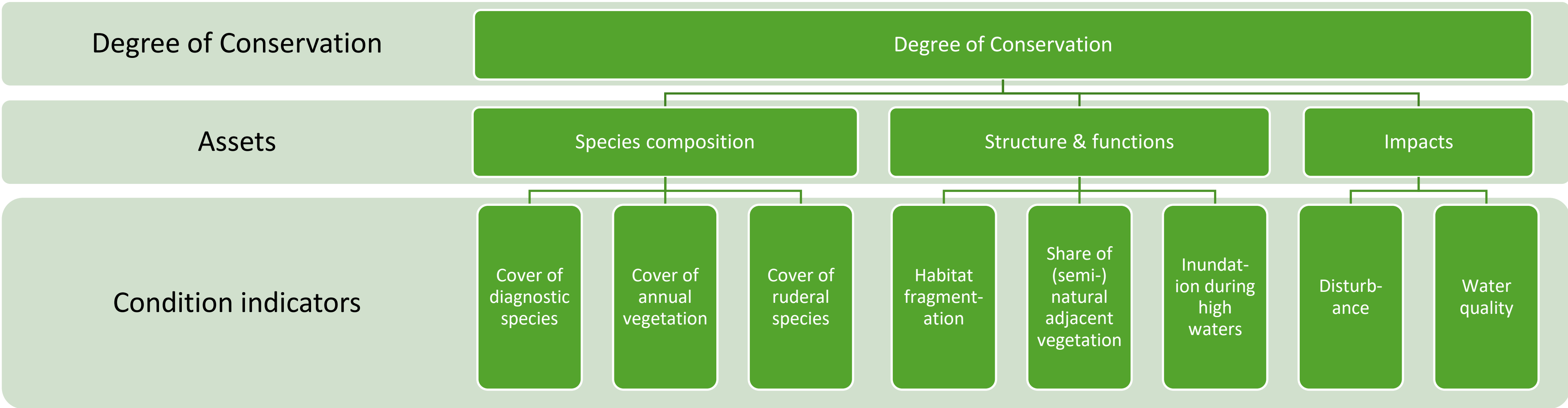

Figure 5: Exemplary illustration of the Degree of Conservation for habitat type '3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoeto-Nanojuncetea*' (wording of indicators was simplified for understandability). The Degree of Conservation 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.

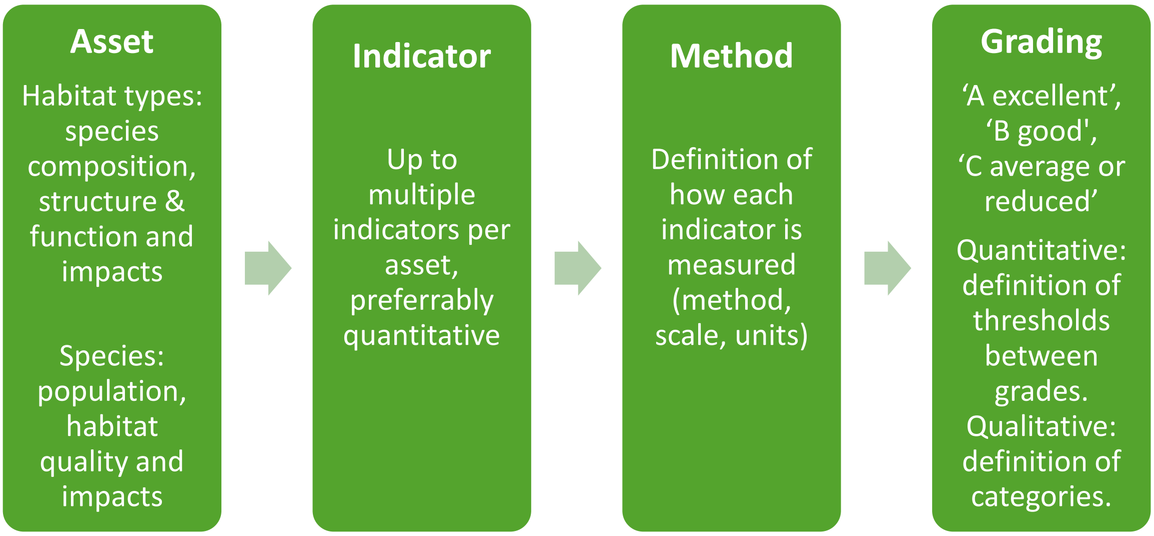

Figure 6: Procedure for defining condition indicators.

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[26].

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.

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[26] 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 application of the methods, a case study was established (Figure 7). The study area was delineated by the biodiversity experts, measures approx. 10 km^2 in size and has two parts. The larger part is located along the Una River, approximately between Martin Brod and the Štrbački buk waterfall, covering the confluences with the tributaries Unac and the smaller Ostrovica, the river bends and meanders west and north of Kulen Vakuf and the rapids and waterfalls before the Štrbački buk. The smaller part is located around Lohovo, including the waterfall Lohovo slapovi.

By splitting the study into subareas (approx. 1 km^2 each), the parallel assessment of the target features (habitats, birds, fish) in corresponding areas was facilitated.

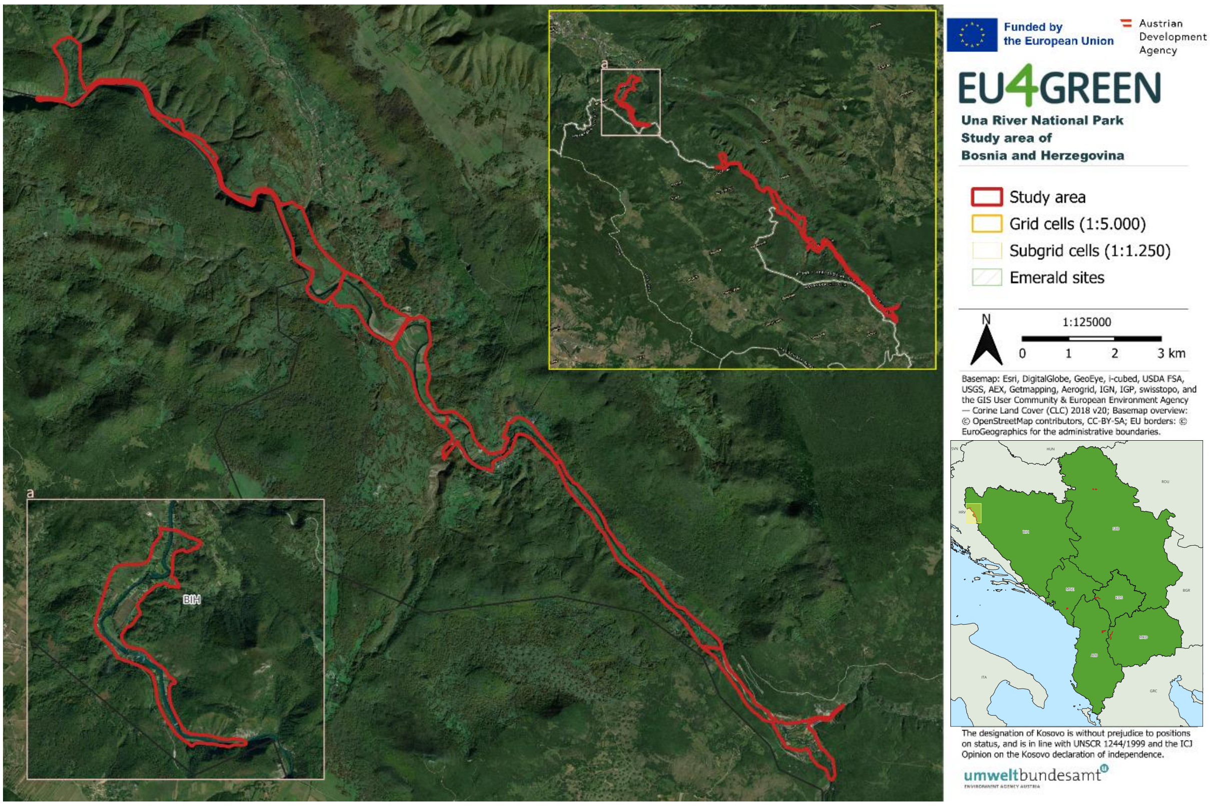

Figure 7: Subdivided study area at Una River National Park, Bosnia and Herzegovina.

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 all three groups of 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), fish and habitats as groups of target features that acted as examples, outlining the process behind the conservation assessments. The features sampled in BiH can be found in Table 3.

Table 3: Assessed species and habitats for the study area of Bosnia and Herzegovina.

Group	Code	Feature
Fish	1163	*Cottus gobio*
Fish	1105	*Hucho hucho*
Birds	A238	*Dendrocopos (Leicopicus) medius*
Birds	A236	*Dryocopos martius*
Birds	A321	*Ficedula albicollis*
Birds	A338	*Lanius collurio*
Birds	A234	*Picus canus*
Habitat types	3140	Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.*
Habitat types	3220	Alpine rivers and the herbaceous vegetation along their banks
Habitat types	3240	Alpine rivers and their ligneous vegetation with *Salix elaeagnos*
Habitat types	3260	Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
Habitat types	32A0	Tufa cascades of karstic rivers of the Dinaric Alps
Habitat types	6430	Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
Habitat types	9180	Tilio-Acerion forests of slopes, screes and ravines
Habitat types	91E0	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)

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, this process was guided and quality checked by EAA experts as well. 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
Fact File	
Code and name	In accordance with Annex I of the Habitats Directive; names in English and in local languages.
Short profile	Summary of most significant features of the habitat type.
Cross-references to classification systems	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 (#).
Coenosis	Typical plant species (characteristic, dominant, indicative species), typical other species.
Ecology	Ecological requirements regarding soil (soil type, acidity, nutrients), water regime, climatic condition, elevation.
Structure	Horizontal and vertical structure (e.g. zonation, patchiness, life forms, vegetation layers), structural components (e.g. dead wood).
Dynamics	Vegetation phases, ecological cycles.
Dependency on maintenance	If human maintenance is required, specification of required type of utilization, intensity of use, etc.
Threats and pressures	Future threats and present pressures, Red List status, typical impacts.
Typical conservation measures	Regularly applied conservation measures.
Distribution	Description and/or distribution maps.
Assessment of Degree of Conservation	
Species composition indicators	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.
Structure and functions indicators	Indicators for assessing the determinative structural, dynamic or ecological factors. Assigned with thresholds for excellent, good or average/reduced condition.
Impact indicators	Indicators for assessing the most important pressures and impacts (natural and anthropogenic). Assigned with thresholds for excellent, good or average/reduced condition.
Species observations during fieldwork	Overview of observations made during field work.
Aggregation Scheme	Scheme for aggregating population, habitat and impact indicators.

Table 5: Fact file structure for a species.

Section	Content
Code and name	In accordance with Habitats or Birds Directive; names in English and in local languages.
Short profile	Summary of most significant features of the species.
Characteristics for species identification	Characteristics in size, coloration, behaviour, etc., including sex and age differences as well as comparison to other, similar species.
Biology	Details on reproduction, feeding, resting.
Population ecology	Data regarding reproduction rate, mortality and migration, preferably numeric.
Habitat for the species	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).
Threats and pressures	Future threats and present pressures, Red List status, typical impacts.
Species protection measures	Regularly applied conservation measures.
Distribution	Description and/or distribution maps.
Assessment of Degree of Conservation	
Population indicators	Indicators for assessing the reproduction, mortality or population density. Assigned with thresholds for excellent, good or average/reduced condition.
Habitat indicators	Indicators for assessing the habitat quantity and quality. Assigned with thresholds for excellent, good or average/reduced condition.
Impact indicators	Indicators for assessing the most important pressures and impacts (natural and anthropogenic). Assigned with thresholds for excellent, good or average/reduced condition.
Species observations during fieldwork	Overview of observations made during field work.
Aggregation scheme	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 fish and bird species, a raster-based approach with pre-defined grid cells (1:5.000) was used. The fish experts sampled the river stretches and water bodies using electrofishing and measured condition indicators for population, habitat and impact in each grid cell. 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-c. All mappings were carried out between April and September 2024 (Table 6).

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

Feature group	Mapping period	Fieldwork days
Birds	June 2024	8
Fish	September 2024	4
Habitat types	June 2024	8
Total	June – September 2024	20

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^2 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 (Annex IV).The grading system is designed in a way that condition indicators with low grading have a significant effect on the aggregated grade (Figure 8Figure 8).

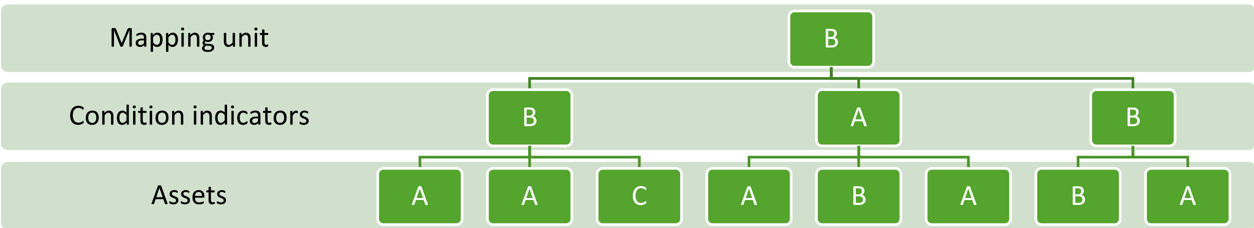

Figure 8: Exemplary illustration of the aggregation from the grades of condition indicators to the grades of the assets within each mapping unit.

For habitats, all three assets were then aggregated to receive the overall grade for each habitat polygon. For species, the habitat and impact assets were aggregated in each grid cell, while the population asset (where available) was kept separate. This is because Degree of Conservation and Area in Good Condition relate to the species' habitat, not population.

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

As last step, the mapping units within the entire pilot site were aggregated for each species or habitat type. The area of all relevant mapping units with identical aggregated grade was calculated. For the categorized Degree of Conservation, thresholds were applied:

- If ≥ 70% of the habitat area within the pilot site is graded A, the categorized Degree of Conservation is A.
- If ≥ 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[27] 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[28] as well as R version 4.3.1[29].. Statistical analysis was carried out with Microsoft ® Excel ® 2016 and R version 4.3.1.

[27] 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.
[28] QGIS Development Team. (2025). QGIS Geographic Information System (Version 3.40). QGIS Association. https://www.qgis.org
[29] 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 eight recorded habitat types under the Habitats Directive, the study area at the Una River National Park is impressively rich in 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; see Annex V for more detailed maps). The habitat patches (= occurrences) are rather small and located along the entire river stretch.

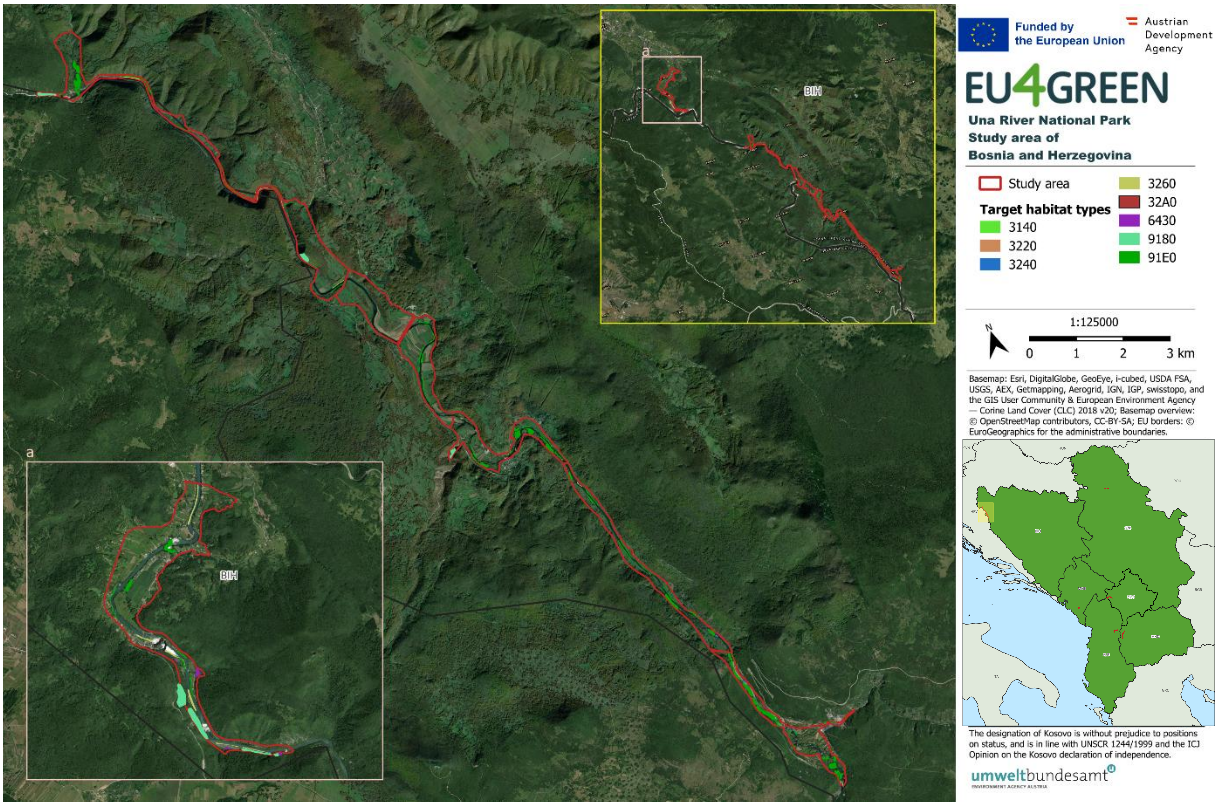

Figure 9: Distribution of the assessed Natura 2000 habitat types in the Una River National Park study area.

Most of the habitat types are extraordinarily well-preserved, as the overall condition of most habitat types is graded as ‘B good’ or even ‘A excellent’ (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 9,Table 8Table 9 Table 10).

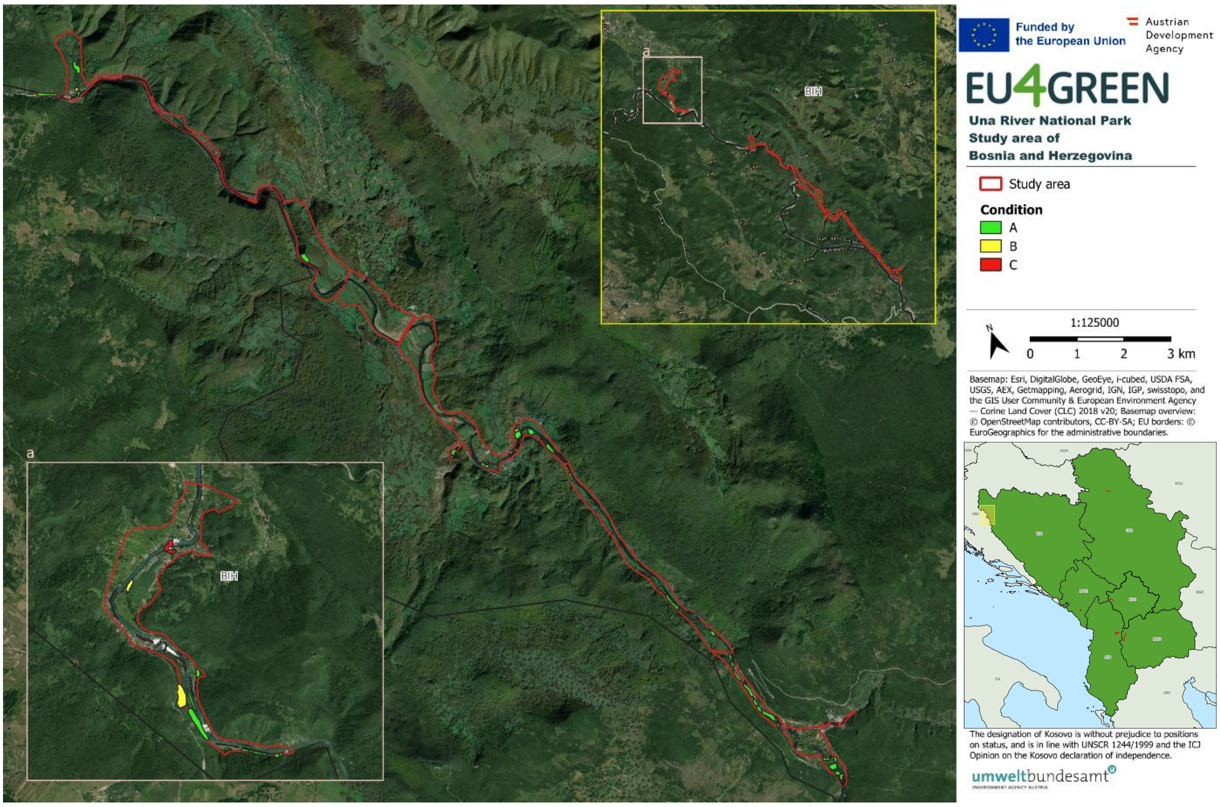

Figure 10: Condition of the assessed Natura 2000 habitat types in the Una River National Park study area.

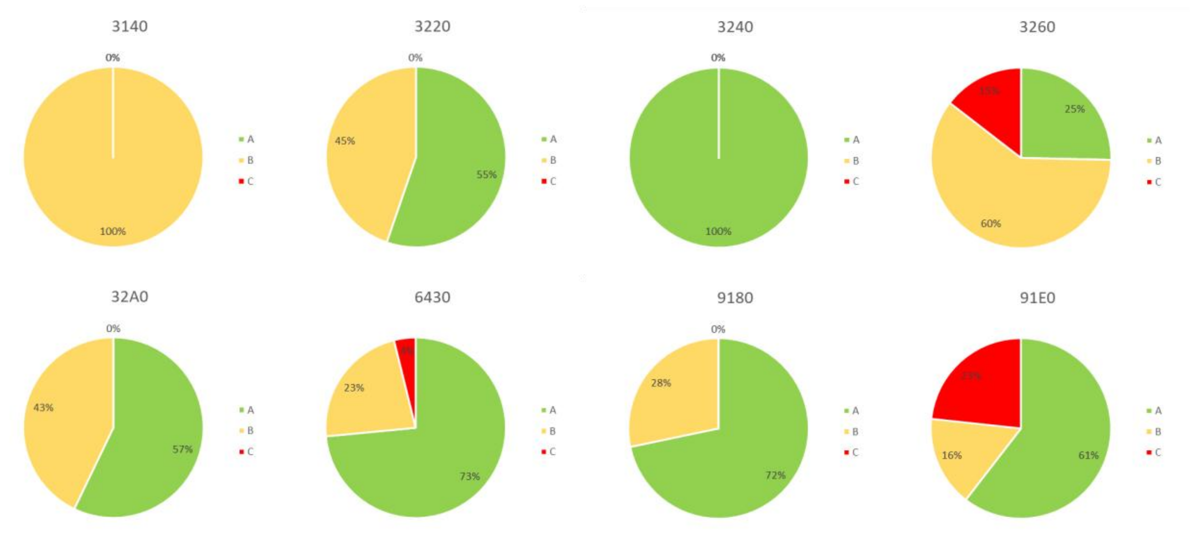

Figure 11: Condition of the assessed habitat types in the Una River National Park study area.

Potential for improvement exists for the following habitat types:

- '3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp.'*: with just one occurrence of 0.1 ha within the study area, the overall condition is defined by the status of this single record. A good condition can be observed throughout each parameter, except the flotant vegetation, which could be assessed as excellent with a cover of >10 %. For the other parameters as well as the three main condition indicators were assessed as 'B', holding a potential in further approvement regarding species composition (coverage of Charophytes), Structure and function (cover of submerse aquatic macrophytes and overshadowing riparian vegetation) as well as impacts (turbidity, eutrophication and siltation).
- '3260 Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation': 15 % of the total area of 8.1 ha were assessed as 'C average or degraded'. The underlying parameters define a low coverage of diagnostic macrophytes for the habitat type, but also several structural indicators, such as only one developed vegetation stratus, profoundly modified bank structures as well as riparian buffer zones that are very narrow to non-existing. Impacts through eutrophication and the expansion of invasive alien species play also a crucial role in the degradation of these habitat types. Buffer zones, specifically, are also a major issue for this habitat type with an overall condition of 'B'.
- '91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)': 23 % of the total area of 53.8 ha were assessed as 'C average or degraded'. These sites show a low cover (<30%) of diagnostic species and high cover (>10%) of light loving species. Their structural and functional condition is defined by underdeveloped vertical structures, high usage intensity, with the presence of coppiced stems, and anthropogenic vegetation or landcover in the bordering areas. Anthropogenic disturbances, such as logging or grazing, also affect the habitat types negatively. In general, the pressure through the naturalness of adjacent areas and intensity of coppice usage were also detected in forests of 91E0 of good and excellent condition.

The improvements for '32A0 Tufa cascades of karstic rivers of the Dinaric Alps' were elaborated in greater details through SSCOs by Sabina Trakić. At the national level, a cadastre of tufa cascades was compiled in 2019, covering several rivers within the Una River watershed. This dataset provides a spatial overview of known occurrences but does not include an assessment of conservation status (e.g. favourable vs. unfavourable condition) for the individual sites. To complement this information, SDFs from the Natura 2000-related assessments – if available – were reviewed. Some SDFs contain qualitative and quantitative evaluations of habitat condition but coverage is incomplete and discrepancies between sources were identified regarding location, extent and status classification of the habitat. In addition, documented information on destroyed or severely degraded tufa cascades, particularly in areas affected by hydropower development, was incorporated into the analysis. These losses 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 32A0 in Bosnia and Herzegovina was estimated at approximately 38.5 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 11 and formed the basis for developing SSCOs for habitat type 32A0 for Una River National Park.

Una River National Park offers no significant opportunities for restoration of destroyed areas, but currently features 1.2 ha of habitat area in good condition, with 0.7 ha in condition A and 0.5 ha in condition B. Therefore, the following SSCOs are recommended:

- Maintenance of 1.2 ha of habitat type 32A0.
- Maintenance of 0.7 ha of habitat type 32A0 in condition A.
- Improvement of condition of 0.5 ha from condition B to condition A.
- Improvement of water quality of Una River at pilot site.

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

- Strong protection regime that prohibits destroying existing occurrences, reinforced by rangers in the field.
- Reduction of negative impacts of trampling by installing information plate that prohibit trampling nearby the localities.
- Implementation of sewage water treatment before entering Una River.
- Reduction of entry of fertilizers and pesticides by establishment of buffer zones between agricultural areas and Una River.

Table 7: Ecological information for '3140 - Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp*.' and '3220 - Alpine rivers and the herbaceous vegetation along their banks' at the Una River National Park study area (10 km^2).

Information	Habitat 1	Habitat 2
3.1a Essential information (habitat type)		
3.1.1 Habitat type code	3140	3220
3.1.2 Priority form	not applicable	not applicable
3.1.3 Non-presence	not applicable	not applicable
3.1.4 Cover	0.11 ha	0.38 ha
3.1.5 Caves	not assessed	
3.1.6 Method used for cover	complete survey or a statistically robust estimate	complete survey or a statistically robust estimate
3.1.7 Period of last data collection	not assessed	
3.1b Site assessment (habitat type)		
3.1.8 Significance	significant	significant
3.1.9 Representativity	B: good	B: good
3.1.10 Relative surface	C: 2% ≥ p > 0%	B: 15% ≥ p > 2%
3.1.11 Relative surface explanations (optional)		
3.1.12 Degree of conservation		
3.1.12.1 Degree of conservation – categorised	B: good	A: excellent
3.1.12.2 Degree of conservation – area	Good condition: 0,11 ha Not-good condition: 0 ha	Good condition: 0.38 ha Not-good condition: 0 ha
3.1.12.3 Degree of conservation – method used	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
3.2.19 Global	C: significant value	B: good value
3.2.20 Update date	January 2025	January 2025

Table 8: Ecological information for ‘3240 - Alpine rivers and their ligneous vegetation with *Salix elaeagnos’* and ‘3260 - Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation’ at the Una River National Park study area (10 km^2).

Information	Habitat 3	Habitat 4
3.1a Essential information (habitat type)		
3.1.1 Habitat type code	3240	3260
3.1.2 Priority form	not applicable	not applicable
3.1.3 Non-presence	not applicable	not applicable
3.1.4 Cover	1.21 ha	7.12 ha
3.1.5 Caves	not assessed	
3.1.6 Method used for cover	complete survey or a statistically robust estimate	complete survey or a statistically robust estimate
3.1.7 Period of last data collection	not assessed	
3.1b Site assessment (habitat type)		
3.1.8 Significance	Significant	Significant
3.1.9 Representativity	C: significant	B: good
3.1.10 Relative surface	C: 2% ≥ p > 0%	B: 15% ≥ p > 2%
3.1.11 Relative surface explanations (optional)		
3.1.12 Degree of conservation		
3.1.12.1 Degree of conservation – categorised	A: excellent	B: good
3.1.12.2 Degree of conservation – area	Good condition: 1.21 ha Not-good condition: 0 ha	Good condition: 6.07 ha Not-good condition: 1.05 ha
3.1.12.3 Degree of conservation – method used	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
3.2.19 Global	C: significant value	B: good value
3.2.20 Update date	January 2025	January 2025

Table 9: Ecological information for '32A0 - Tufa cascades of karstic rivers of the Dinaric Alps' and '6430 - Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels' at the Una River National Park study area (10 km^2).

Information	Habitat 5	Habitat 6
3.1a Essential information (habitat type)		
3.1.1 Habitat type code	32A0	6430
3.1.2 Priority form	not applicable	not applicable
3.1.3 Non-presence	not applicable	not applicable
3.1.4 Cover	1.2 ha	1.82 ha
3.1.5 Caves	not assessed	
3.1.6 Method used for cover	complete survey or a statistically robust estimate	complete survey or a statistically robust estimate
3.1.7 Period of last data collection	not assessed	
3.1b Site assessment (habitat type)		
3.1.8 Significance	Significant	Significant
3.1.9 Representativity	A: excellent	B: good
3.1.10 Relative surface	C: 2% ≥ p > 0%	C: 2% ≥ p > 0%
3.1.11 Relative surface explanations (optional)		
3.1.12 Degree of conservation		
3.1.12.1 Degree of conservation – categorised	A: excellent	B: good
3.1.12.2 Degree of conservation – area	Good condition: 1.2 ha Not-good condition: 0 ha	Good condition: 1.74 ha Not-good condition: 0.08 ha
3.1.12.3 Degree of conservation – method used	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
3.2.19 Global	A: excellent value	B: good value
3.2.20 Update date	January 2025	January 2025

Table 10: Ecological information for '91E0 - Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)' and '9180 - Tilio-Acerion forests of slopes, screes and ravines' at the Una River National Park study area (10 km^2).

Information	Habitat 7	Habitat 8
3.1a Essential information (habitat type)		
3.1.1 Habitat type code	91E0	9180
3.1.2 Priority form	not applicable	not applicable
3.1.3 Non-presence	not applicable	not applicable
3.1.4 Cover	52.71 ha	17.51 ha
3.1.5 Caves	not assessed	
3.1.6 Method used for cover	complete survey or a statistically robust estimate	complete survey or a statistically robust estimate
3.1.7 Period of last data collection	not assessed	
3.1b Site assessment (habitat type)		
3.1.8 Significance	Significant	Significant
3.1.9 Representativity	B: good	A: excellent
3.1.10 Relative surface	B: 15% ≥ p > 2%	C: 2% ≥ p > 0%
3.1.11 Relative surface explanations (optional)		
3.1.12 Degree of conservation		
3.1.12.1 Degree of conservation – categorised	B: good	A: excellent
3.1.12.2 Degree of conservation – area	Good condition: 40.18 ha Not-good condition: 12.53 ha	Good condition: 17,51 ha Not-good condition: 0 ha
3.1.12.3 Degree of conservation – method used	Based mainly on extrapolation from a limited amount of data (expert judgement)	Based mainly on extrapolation from a limited amount of data (expert judgement)
3.2.19 Global	C: significant value	A: excellent value
3.2.20 Update date	January 2025	January 2025

Table 11: Restoration and conservation objectives for '32A0 - Tufa cascades of karstic rivers of the Dinaric Alps' on national level, compiled for deduction of SSCOs for Una River National Park study area. For the parameter area, the target Favourable Reference Area (FRA) is derived from a survey of existing and destroyed Tufa cascades of Bosnia and Herzegovina by Sabina Trakić, 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	38.5	ha	Survey of existing Tufa cascades	38.4	ha in good condition	99.74 %	in good condition	Survey of existing Tufa cascades
				0.1	ha in not-good condition	0.26 %	in not-good condition	
Target	45.3	ha	Total area of existing and destroyed Tufa cascades					
FRVs	11-25 % < FRA		Current value is 15 % under FRA	40.77	ha in good condition	90 %	in good condition	application of 90 % goal of the Nature Restoration Regulation
				4.53	ha in not-good condition	10 %	in not-good condition	
Difference to FRVs	**6.8**	**ha**	Increase of 6. 8 ha in area needed	**2.37**	**ha more in good condition**	Increase towards good condition for 2.37 ha needed.		

3.4.2. Birds

At the Una River National Park study area, five bird species were studied. Four of them require forested areas for reproduction (*Dryocopus martius, Dendrocopos medius, Ficedula albicollis* and *Picus canus*) and are hereafter referred to as forest bird species. As grassland bird species, *Lanius collurio* was studied.

In total, about 22 % of the 10 km^2 study area are forested, equalling a total area of forest habitats of 216.8 ha. Both habitat condition (Figure 12) and overall condition (Figure 13) of forest birds were not as good as for habitat types.

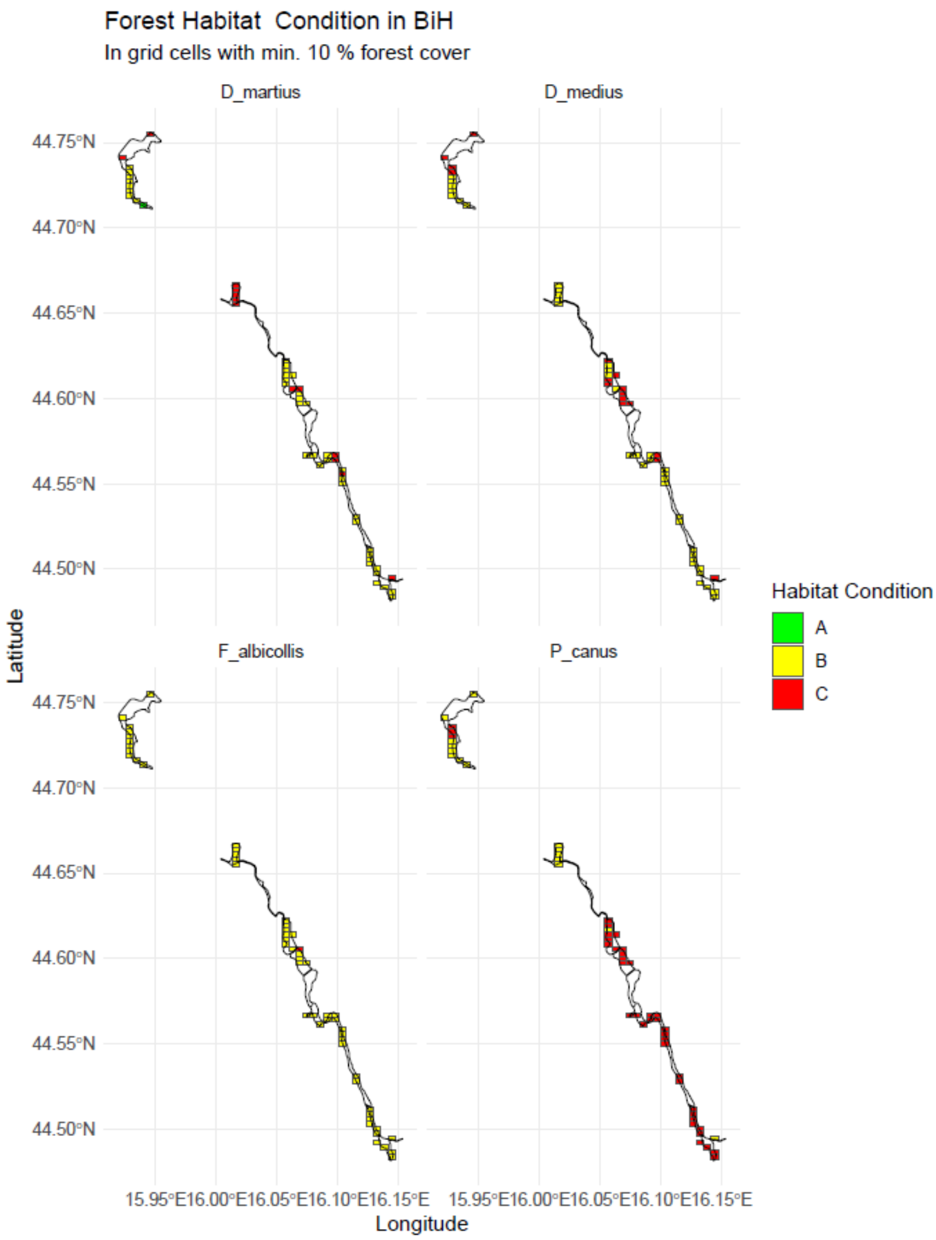

Figure 12: Maps of the sub-grid cells with the assessed conditions in the Una River National Park study area for the forest bird species *Dryocopus martius, Dendrocopos medius, Ficedula albicollis* and *Picus canus.*

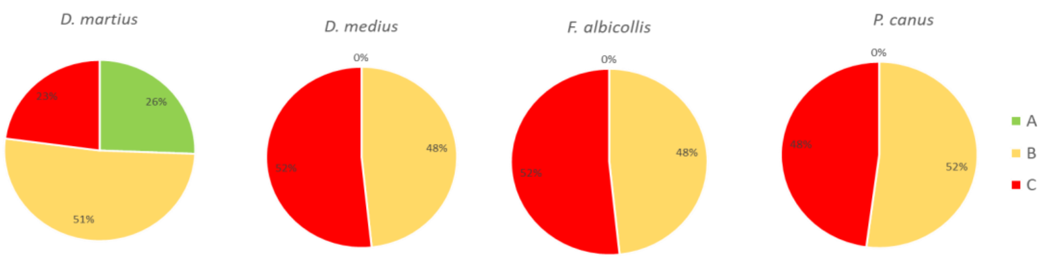

Figure 13: Condition of the assessed forest birds in the Una River National Park study area.

Best results were found for the Black Woodpecker *Dryocopus martius*, with 26 % in condition ‘A excellent’ and only 23 % in condition ‘C average or reduced. Grid cells with a grading of ‘C average or reduced’ received this grading primarily because of lack of standing deadwood combined with high levels of human disturbance. The other three forest species lack sub-grid cells in condition ‘A excellent’, and the fraction of assessments with ‘C average or reduced’ ranges between 48-54 %. The main factors in these grading are a lack of old forest stands and, again, relevant levels of human disturbance.

Regarding grassland habitats, a total of 193.6 ha (or 19 % of the study area) are available, but both the condition of the habitat and the overall condition are rather low (Figure 14). It appears that most open areas do not meet the habitat requirements of this species, which require open, flat or gently sloping terrain with bushes, particularly thorn hedges, and sometimes also single tall trees. However, it is also common in agricultural farmland. Since *Lanius collurio* does indeed occur and reproduce in this area, this indicates that the condition indicators require further adaptation before large-scale application in Bosnia and Herzegovina.

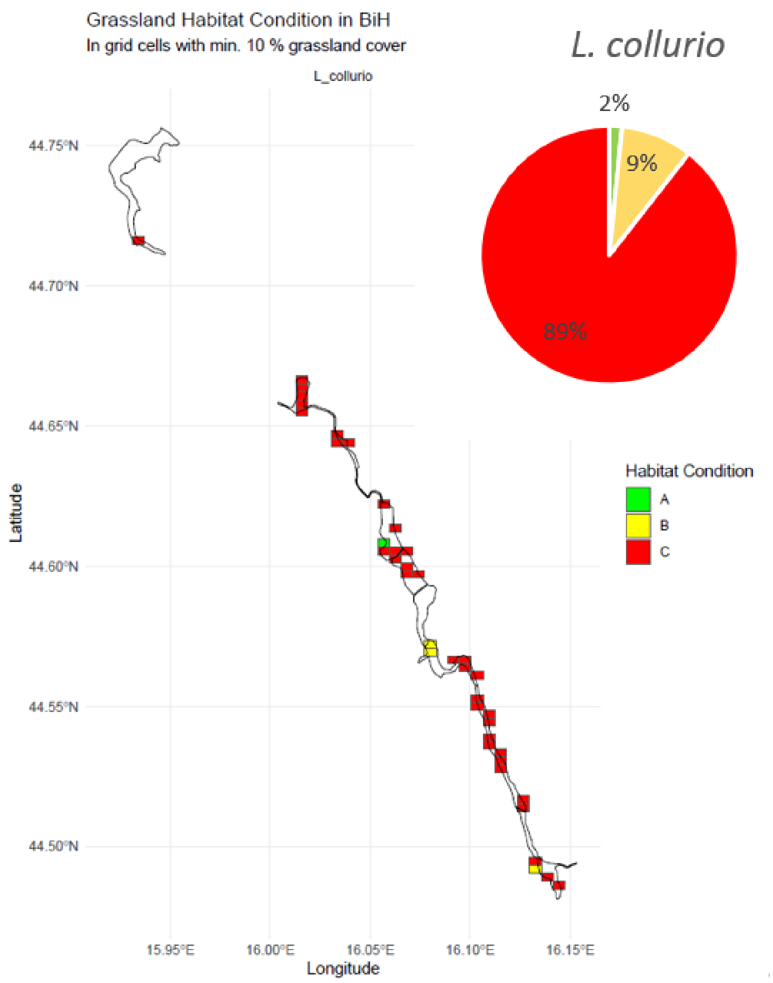

Figure 14: Maps of the sub-grid cells with grassland habitat and the assessed habitat condition in the Una River National Park study area for *Lanius collurio* and its overall condition as diagram.

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

The improvements for *Picus canus* were elaborated in greater details through SSCOs by Tarik Dervović. At the national level, the data input of BiH for the European Red List of Birds compiled in 2021 was used for the estimation of the Population parameter. For the Habitat of the species on the national level, the data was derived from the Second National Forest Inventory of Bosnia and Herzegovina. Based on the consolidation of all available sources the population size and area of the habitat for the species *Picus canus* in Bosnia and Herzegovina was estimated at approximately 2000 pairs and 22.619,0 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 *Picus canus* for Una River National Park.

Una River National Park offers significant opportunities for restoration of destroyed areas, currently featuring a total of 216.8 ha of habitat for the species, with 113 ha in good condition (B only) and 103.9 ha in not-good condition. Therefore, the following SSCOs are recommended:

- Maintenance of at least 113 ha of habitat for the species in good condition (B) and/or possibly improvement of 113 ha from B to A.
- Improvement of 81 ha of habitat for the species from C to B and/or A condition.
- Improvement of the habitat quality of meadows for foraging of the species at pilot site.

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

- Increase the number of large trees in forest stands – trees that are approximately 25 m in height, around 120 years old and roughly 60 cm in diameter at breast height
- Strong protection regime that prohibits the destruction of existing occurrences (cutting wood, removing deadwood), reinforced by rangers in the field.
- Controlled grazing or scything of meadows.

Table 12: Ecological information for *Picus canus, Dryocopus martius* and *Dendrocopos medius* at the Una River National Park study area (10 km²).

Information	Species 1	Species 2	Species 3
3.2a Essential information (species)			
3.2.1 Species group	B = Birds	B = Birds	B = Birds
3.2.1 Species code	A234	A236	A238
3.2.3 Scientific name	*Picus canus*	*Dryocopus martius*	*Dendrocopos medius*
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	Permanent	Permanent
3.2.7 Population size and unit			
3.2.7.1 Population size	5-10	5-10	10-15
3.2.7.2 Population unit	i = individuals	i = individuals	i = individuals
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	
3.2b Site assessment (species)			
3.2.11 Significance	Significant		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%
3.2.13 Population – explanations (optional)			
3.2.15 Degree of conservation			
3.2.15.1 Degree of conservation – categorised	B: good	B: good	C: reduced
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 113.0 ha (52 %) Non-sufficient quality: 103.9 ha (48 %)	Sufficient quality: 167.3 ha (77 %) Non-sufficient quality: 49.6 ha (23 %)	Sufficient quality: 104.8 ha (48 %) Non-sufficient quality: 112,1 ha (52 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 51-75 % Non-sufficient quality: 26-50 %	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %	Sufficient quality: 26-50 % Non-sufficient quality: 51-75 %
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* and *Lanius collurio* at the Una River National Park study area (10 km^2).

Information	Species 4	Species 5
3.2a Essential information (species)		
3.2.1 Species group	B = Birds	B = Birds
3.2.1 Species code	A321	A338
3.2.3 Scientific name	*Ficedula albicollis*	*Lanius collurio*
3.2.4 Sensitivity of species data	not assessed	
3.2.5 Non-presence	not applicable	not applicable
3.2.6 Population type	Reproducing	Reproducing
3.2.7 Population size and unit		
3.2.7.1 Population size	-	30-50
3.2.7.2 Population unit		i = individuals
3.2.8 Abundance category	Rare	Common
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	
3.2b Site assessment (species)		
3.2.11 Significance	not assessed	Significant
3.2.12 Species meeting ornithological criteria for SPA classification	not assessed	
3.2.13 Population	-	C: 2% ≥ p > 0%
3.2.13 Population – explanations (optional)	Population on site unknown and fraction in total population unknown.	
3.2.15 Degree of conservation		
3.2.15.1 Degree of conservation – categorised	C: degraded	C: degraded
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 104.8 ha (48 %) Non-sufficient quality: 112,1 ha (52 %)	Sufficient quality: 20.5 ha (11 %) Non-sufficient quality: 174.1 (89 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 26-50 % Non-sufficient quality: 51-75 %	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %
3.2.18 Isolation	B: population not isolated, but on margins of area of distribution	B: population not isolated, but on margins of area of distribution
3.2.19 Global	B: good value	B: good value
3.2.20 Update date	December 2024	December 2024

Table 14: Restoration and conservation objectives for *Picus canus* on national level, compiled for deduction of SSCOs for the Una River National Park study area. For the parameter population, the target Favourable Reference Population (FRP) is derived from the European Red List of Birds 2021[30] for Bosnia and Herzegovina by Tarik Dervović, 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 data from the Second National Forest Inventory of Bosnia and Herzegovina.

	Population		Population (source)	Habitat for the species (absolute area)		Habitat for the species (relative area)		Habitat for the species (source)
Status	2,000	pairs	European Red List of Birds 2021 data input Bosnia and Herzegovina	11,558.32	km² in good condition	51 %	in good condition	Second National Forest Inventory of Bosnia and Herzegovina
				11,060.70	km² in not-good condition	49 %	in not-good condition	
Target	4,545	pairs						
FRVs	51-100 % < FRA		Current value is 56 % below the FRP	20,358.01	km² in good condition	90 %	in good condition	application of 90 % goal of the Nature Restoration Regulation
				2,262.00	km² in not-good condition	10 %	in not-good condition	
Difference to FRVs	**2,545**	**pairs**	Increase of 2,545 pairs needed	**8,799.69**	**km² more in good condition**	Increase towards good condition for 8,799,69 km² needed.		

[30] BirdLife International (2021) European Red List of Birds. Luxembourg: Publications Office of the European Union

3.4.3. Fish

At the Una River National Park study area, two fish species were studied: the European bullhead *Cottus gobio* and the Danube salmon *Hucho hucho.* For *Cottus gobio*, habitats were found in seven to eight different locations, and good results good results were recorded, with 60 % of habitat being in 'B good' and 40 % in 'A excellent' condition (Figure 15). The difference between 'B good' and 'A excellent' assessments stemmed from the habitat condition indicators, especially because the velocity of the river flow was impaired in several places.

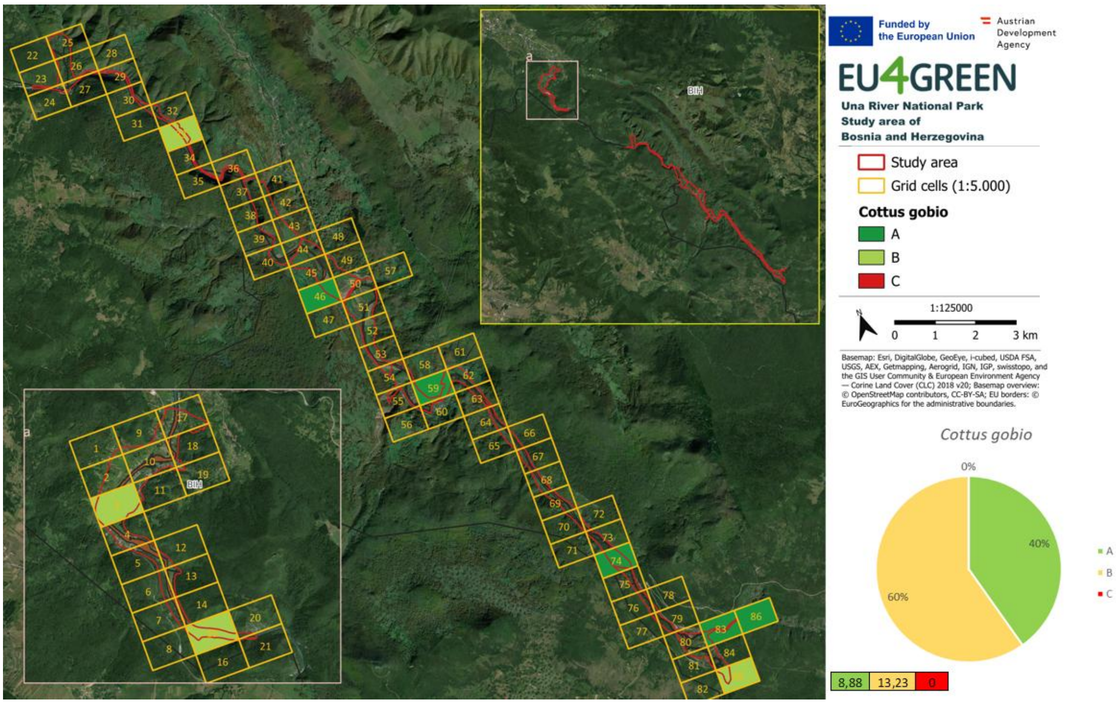

Figure 15: Distribution and condition of *Cottus gobio* in the Una River National Park study area.

Given the good condition in population and impact indicators, but certain lacks in habitat condition, *Cottus gobio* served as an illustrative example for the development of SSCOs and conservation measures. The estimates of population numbers were derived by combining published literature with data from field surveys conducted between 2019 and 2025. For riverine habitats, a reach-based approach was applied using standard 500 m river segments and estimated stream widths (small: 3 m, medium: 6 m, large: 20 m). The habitat area was calculated as reach length multiplied by estimated width and converted to hectares. For habitats associated to lakes, such as Pecka Lake, surface areas were measured directly using satellite imagery.

The total potential habitat for the target species *Cottus gobio* in Bosnia and Herzegovina was estimated by summing all river sections reported in the literature as ecologically suitable, resulting in approximately 450 km of river length. Confirming the habitat presence was possible through literature, but population data could not be provided via this approach. For the average densities, the recorded values of recent surveys were extrapolated to the estimated total habitat area (ca. 450 ha) to derive population-level estimates.

Favourable Reference Values (FRVs) were calculated using reference data from 2012 collected within Una River National Park (9 ha across nine sites, 201 individuals). The same estimate of the total suitable river habitat area was applied. To account for spatial variability, three stream-width scenarios were assessed, and an average width of 10 m was used as a conservative basis for converting river length to habitat area. The density derived from the 2012 reference data was then extrapolated to the total estimated habitat area to obtain the FRV population value.

The results for *Hucho hucho* were less ideal (Figure 16): 89 % of assessments were graded as ‘B good’ and 11 % as ‘C average or reduced’. Despite good habitat condition and no negative impacts on site, not a single individual was recorded. Therefore, population condition was always graded as C.

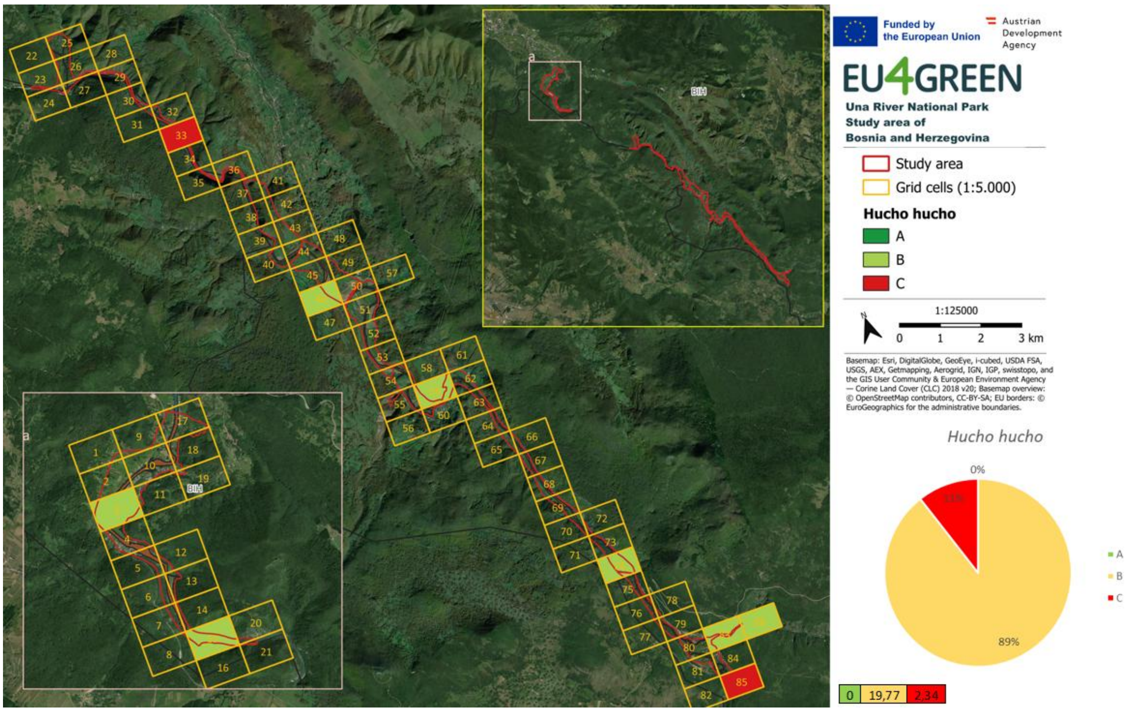

Figure 16: Distribution and condition of *Hucho hucho* in the Una River National Park study area.

Since the species was not found, interviews with locals were carried out, who confirmed the absence of the species. Nevertheless, fish stock data from 2012 indicate the presence of this species. Compared to previous assessments carried out in Una River National Park, a decline in the population of both target species was registered. Considering this decline, further research is essential to better understand their status and trend, and ensure effective conservation, especially given the complexity of field studies and budget constraints. Continued monitoring and detailed studies should be implemented to assess population dynamics, habitat requirements, and threats.

Based on the information gathered during fieldwork, the ecological information for the SDF’s were compiled (Table 15).

The improvements for *Cottus gobio* were elaborated in greater details through SSCOs by Adla Kahric. At the national level, the data of the N2K assessment in study area was extrapolated in combination with available data in literature (2019-2025). For the Habitat of the species on the national level, the data was derived from recent literature (2019-2025) and also direct GIS assessment in Google Earth. Based on the consolidation of all available sources the population size and area of the habitat for the species *Cottus gobio* in Bosnia and Herzegovina was estimated at approximately 185.017 individuals and 168.198 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 16 and formed the basis for developing SSCOs for *Cottus gobio* for Una River National Park.

Una River National Park offers no significant opportunities for restoration of destroyed areas, but currently features 21.1 ha of habitat of the species in good condition, with 8.9 ha in condition A and 13.2 ha in condition B. Therefore, the following SSCOs are recommended:

- Maintenance of 21.1 ha of habitat for the species in good condition (A) and/or possibly improvement of 13.2 ha from B to A.
- Increase of population density in all habitats to a sustainable level of 1.2 to 1.6 individuals per ha
- Reduce negative anthropogenic impacts, including water pollution, habitat modification, and disturbance.
- Enhance habitat connectivity among river sections to prevent population fragmentation.

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

- Establishment of standardized annual monitoring of *Cottus gobio* populations and habitat quality using standardized field studies and environmental surveys.
- Restoration of riparian vegetation and in-stream substrates in degraded (B-condition) river sections, with targeted interventions to improve habitat composition essential for spawning and juvenile sheltering.
- Regulation and restriction of hydrological modifications (dams, channelization) in priority habitats (focused on A condition habitats)
- Reduce agricultural pollutants (fertilizers, pesticides), and implementing measures to minimize plastic waste along riverbanks and within river channels.
- Enforcement of wastewater management measures in rural settlements to ensure that untreated sewage does not enter small tributaries inhabited by *Cottus gobio*
- Strengthening cooperation among key institutions, including protected areas (NP Una, regional/municipal protected areas), ministries, scientific communities, inspection authorities, local NGOs, and water management agencies, to ensure integrated data, and coordinated conservation actions

Table 15: Ecological information for *Cottus gobio* and *Hucho hucho* at the Una River National Park study area (10 km^2).

Information	Species 1	Species 2
3.2a Essential information (species)		
3.2.1 Species group	F = Fish	F = Fish
3.2.1 Species code	1163	1105
3.2.3 Scientific name	*Cottus gobio*	*Hucho hucho*
3.2.4 Sensitivity of species data	not assessed	
3.2.5 Non-presence	not applicable	not applicable
3.2.6 Population type	Permanent	-
3.2.7 Population size and unit		
3.2.7.1 Population size	3817	0
3.2.7.2 Population unit	i = individuals	i = individuals
3.2.8 Abundance category	Common	Rare
3.2.9 Method used for population size	based mainly on extrapolation from a limited amount of data	based mainly on extrapolation from a limited amount of data
3.2.10 Period of last data collection	not assessed	
3.2b Site assessment (species)		
3.2.11 Significance	significant	-
3.2.12 Species meeting ornithological criteria for SPA classification	not assessed	
3.2.13 Population	B: 15% ≥ p > 2%	C: 2% ≥ p > 0%
3.2.13 Population – explanations (optional)	Share in total population estimated from literature.	Fieldwork could not confirm any previous population of *Hucho hucho* within the study area.
3.2.15 Degree of conservation		
3.2.15.1 Degree of conservation – categorised	B: good	C: degraded
3.2.15.2 Degree of conservation – occupied area	Sufficient quality: 21.1 ha (100 %) Non-sufficient quality: 0 ha (0 %)	Sufficient quality: 19.8 ha (90 %) Non-sufficient quality: 2.3 ha (10 %)
3.2.15.3 Degree of conservation – occupied percentage classes	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %	Sufficient quality: 76-100 % Non-sufficient quality: 0-25 %
3.2.18 Isolation	C: population within distribution range	-
3.2.19 Global	A: excellent value	B: good value
3.2.20 Update date	December 2024	December 2024

Table 16: Restoration and conservation objectives for *Cottus gobio* on national level, compiled for deduction of SSCOs for the Una River National Park study area. For the parameter population, the target Favourable Reference Population (FRP) is extrapolated using the data of the N2K assessment in study area combined with available data in literature (2019-2025) by Adla Kahric, 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 data from in literature (2019-2025) and direct GIS assessment in Google Earth.

	Population		Population (source)	Habitat for the species (absolute area)		Habitat for the species (relative area)		Habitat for the species (source)
Status	185,017	Individuals	Extrapolation of N2K assessment in study area (approx. 1.1 individuals per ha) combined with available data in literature (2019-2025)	138,720	ha in good condition	83 %	in good condition	Available data in literature (2019-2025) and direct GIS assessment in Google Earth
				29,478	ha in not-good condition	17 %	in not-good condition	
Target	208,080-277,440	Individuals						
FRVs	10-33 % < FRA		Current value is 10-33 % below the FRP	156,060	ha in good condition	90 %	in good condition	application of 90 % goal of the Nature Restoration Regulation
				17,340	ha in not-good condition	10 %	in not-good condition	
Difference to FRVs	**23,063-92,423**	**Individuals**	Increase of 23,063-92,423 individuals needed	**17,340**	**ha more in good condition**	Increase towards good condition for 17,340 ha needed.		

3.5. Conclusions

The fieldwork conducted within Una River National Park 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*) and the European bullhead (*Cottus gobio*). 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 National Park. 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 Una River National Park. They also gathered important knowledge to support the development of a general methodology to map potential future Natura 2000 sites in Bosnia and Herzegovina.

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 and the Una River National Park Administration

4.1. Summary

EU4Green aimed to highlight the potential of innovative Nature-based Solutions (NbS) at the Una River National Park in Bosnia and Herzegovina. 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 and the National Park Administration.

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. Ten NbS objectives were defined across five fields of action: sustainable agricultural landscapes, forests and wooded ecosystems, riparian ecosystem restoration, protection of high-value ecosystems and soil desealing. Priority measures include conservation agriculture, grassland restoration, ecological forest management, afforestation of steep slopes, riparian buffer zones, floodplain restoration, river connectivity measures, protection of sensitive Natura 2000 habitats and permeable surfaces in built-up areas. The results demonstrate both the high potential of NbS in the Una River valley and key challenges, including limited site-specific data, competing land uses, existing riverbank constructions and complex land ownership patterns. Successful implementation will require strong partnerships with National Park authorities as central coordinators supported by municipalities, landowners, farmers and the wider public. 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.[31, 32]

Furthermore, NbS are promoted as valuable tool by the GAWB[2] and explicitly mentioned in many other major EU frameworks and strategies, such as the EU Biodiversity Strategy 2030[18], the EU Nature Restoration Regulation[33], the Common Agricultural Policy[34] and the Water Framework Directive[35]. 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.

Ultimately, the concept was also expanded to the pilot sites, with the aim to narrow down and target the crucial societal challenges and define potential NbS to improve the situation effectively and sustainably. This process was conducted in consultation with local experts and relevant stakeholders such as protected areas administrations, taking into account the relevant data and knowledge already gathered on the pilot site.

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[31] INTERNATIONAL UNION FOR CONSERVATION ONF 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

[32] 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. B375: 20190120. Available at: http://dx.doi.org/10.1098/rstb.2019.0120

[33] 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

[34] 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

[35] 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

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.

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. [36, 37, 38]

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 [39].

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[40]. 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)[41]

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[36] 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.
[37] Sowińska-Świerkosz, B., & García, J. (2022). What are Nature-based solutions (NBS)? Setting core ideas for concept clarification. Nature-Based Solutions, 2, 100009.
[38] Dumitru, A., & Wendling, L. (2021). Evaluating the impact of nature-based solutions: A handbook for practitioners. European Commission EC.
[39] 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
[40] 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.
[41] Haines-Young, R. (2023): Common International Classification of Ecosystem Services (CICES) V5.2 and Guidance on the Application of the Revised Structure.

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[42]. Moreover, they support biodiversity conservation by protecting and restoring critical habitats in terrestrial and aquatic ecosystems [43]. 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 [44].

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 [45]. NbS also buffer the impacts of natural disasters by restoring natural floodplains and stabilizing slopes, reducing the risk of floods and landslides[46]. Importantly, many NbS projects are participatory, involving local communities in planning and maintenance, which fosters social cohesion and a sense of ownership[47].

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 [48].

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.

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[42] Griscom, B. W., et al. (2017). Natural climate solutions. Proceedings of the National Academy of Sciences, 114(44), 11645–11650.
[43] 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.
[44] 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.
[45] Hartig, T., Mitchell, R., de Vries, S., & Frumkin, H. (2014). Nature and health. Annual Review of Public Health, 35, 207–228.
[46] Cohen-Shacham, E., Walters, G., Janzen, C., & Maginnis, S. (2016). *Nature-based solutions to address global societal challenges*. IUCN.
[47] 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.
[48] Tittonell, P. (2014). *Ecological intensification of agriculture—sustainable by nature*. Current Opinion in Environmental Sustainability, 8, 53–61.

IUCN Global Standard for Nature-based Solutions[49]

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.

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[50]
- Nature-based Solutions for climate: A compendium of best practices in the Western Balkans[51]
- Nature-based Solutions in the Post-2020 Global Biodiversity Framework Targets[52]

Alignment with the Post-2020 Global Biodiversity Framework[53]

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.

[49] 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
[50] 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
[51] 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_finalo.pdf
[52] 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
[53] Convention on Biological Diversity (CBD). (2022). Kunming-Montreal Global Biodiversity Framework. CBD COP15, Montreal.

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[54]

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 Biodiversity activities, a targeted selection of these NbS forms the analytical basis for defining NbS objectives and measures in the five 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[55]

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.

[54] 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

[55] 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[56] on ecosystem services was used together with the systematic review on ecosystem services of Grima et al. [57]. 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.[56].

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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[56] Haines-Young, R. (2023): Common International Classification of Ecosystem Services (CICES) V5.2 and Guidance on the Application of the Revised Structure.

[57] 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.

4.3.4. NbS objectives

Study area

The selection of the case study sites was primarily guided by the explicit interest of the beneficiary in the development of NbS objectives for EU4Green's pilot site, Una River National Park, which highlighted a demand to explore NbS as a tool to address local challenges and support alignment with EU standards. The choice also reflected each economy's progress in implementing the GAWB and built on earlier work of EU4Green on Natura 2000 preparation.

For the analyses, the study area mapped for Natura 2000 features was extended by a 2.5 km buffer. This scope was chosen to capture the most relevant surrounding landscape and integrate additional data beyond the core Natura 2000 assessments.

Data basis

To identify suitable NbS measures for the pilot region, core datasets from the EU4Green project were combined with selected external sources to provide a robust data basis for regional decision-making. The analysis relied largely on harmonised remote-sensing data available for the entire WB6, including data from CLC+ Backbone[58,59] and Copernicus DEM[60], meaning that the resulting maps indicate priority areas for action and may include generalisations or artefacts inherent to the spatial resolution and thematic limits of the datasets.

Key inputs for the further analysis included Natura 2000 habitat assessments from EU4Green (chapter 3), which document Annex I habitat types and other relevant land cover classes within the core study areas, complemented by additional data for the surrounding landscape. Land cover information was derived from the CLC+ Backbone raster (2023, 10 m resolution) and vector dataset (2018, MMU 0.5 ha), providing detailed and up-to-date insights into land cover patterns and dynamics. Topographic information was taken from the Copernicus DEM GLO-30 and processed into contour lines to support the identification of flood- and water-related NbS action areas. OpenStreetMap data[61] were used to supplement small and linear watercourses not fully captured in CLC+ datasets, due to their relatively rough resolution.

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[58] European Environment Agency & Copernicus Land Monitoring Service. (2018). CLC+ Backbone 2018 – Vector dataset. European Union. DOI: https://doi.org/10.2909/d45d5114-fb86-4265-9c5a-a7225a511f7c

[59] European Environment Agency; Copernicus Land Monitoring Service. (2025). CLCplus Backbone 2023 (Raster, 10 m). European Union. DOI: https://doi.org/10.2909/b0bd43c6-1fa1-4d88-9c45-98b13a95d0b2

[60] European Space Agency & European Commission (2022). Copernicus Digital Elevation Model (DEM) for Europea with a resolution of 30 m, derived from Copernicus Global 30 m data set. http://data.europa.eu/88u/dataset/f576cda8-d598-478c-b8fe-ad2634c927e8

[61] OpenStreetMap contributors. (2024). OpenStreetMap data on streams and rivers. OpenStreetMap Foundation. https://www.openstreetmap.org

The selection of measures was further informed by the Catalogue of Nature-based Solutions for the water sector[62]. Table 17 shows the measures for the NbS objectives within the case study area, according to the NbS catalogue. As another output developed during the EU4Green project, the NbS matrix (Annex VI) synthesises expert input from workshops and literature, linking societal challenges to suitable NbS, ecosystem services and potential indicators. It provides additional options beyond those mapped in this document.

Table 17: Selection of NbS for water management, according to the Catalogue of NbS by EU4Environment (2024), listed by main land cover categories found in the study areas.

Main Category	NbS Measures
Rivers, streams, and floodplains	Restoration of buffer strips, riparian forest and gallery forest Floodplain restoration and management Natural bank stabilisation Stream and river restoration Reconnection of oxbow lakes Removal of lateral barriers Removal of transversal barriers
Agriculture and grasslands	Agroforestry, buffer strips and hedges Conservation agriculture Conversion to meadows and pastures Restoration of existing pastures, steppes and natural grasslands Sustainable pasture management
Forests and woodlands	Adapted forestry in floodplains and wet forests Afforestation Close-to-nature forestry Coarse woody debris in rivers and streams
Settlements and built-up areas	Permeable surfaces
Cross-cutting measures	Conservation of existing high environmental value ecosystems

Definition of NbS objectives and measures

The identification of action zones in the study areas followed a systematic, data-driven approach combining ecological information, spatial analyses and remote-sensing data. Natura 2000 habitat assessments and CLC+ Backbone land-cover data formed the baseline for defining the ecological context, while Copernicus DEM data were used to capture terrain characteristics such as slope, hydrological pathways and flood-prone areas. Additional

[62] 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

spatial parameters, including buffer zones and distance analyses, helped prioritise areas with high pressure, degradation risk or potential for improved ecological connectivity.

Based on these spatial characteristics, suitable NbS were assigned to each area, ensuring that proposed measures directly address site-specific ecological and socio-environmental challenges. This process resulted in 10 recommended NbS objectives, structured across five fields of action and linked to spatial layers and 18 concrete NbS measures. The framework enables clear visualisation of priority areas and provides a solid basis for future implementation planning (see Table 18).

The five fields of action cover the following land-use and ecosystem categories: sustainable agricultural landscapes, forests and wooded ecosystems, riparian ecosystem restoration, protection of high-value ecosystems and soil desealing.

Table 18: Fields of action linked to the respective NbS Objectives, specific measures for realisation and land cover type with the used criteria.

Field of action	NbS Objective	NbS measure (according to EU4Environment, 2024)	Land cover type & criteria
Sustainable agricultural landscapes	1) Enhancement and restructuring of homogenised, agricultural landscapes	Agroforestry, buffer strips and hedges	Large coherent farmland and grassland with > 100m distance from the next landscape element (e.g. forest) below an altitude of 1500m
	2) Conservation agriculture	Conservation agriculture	All agricultural areas
	3) Grassland conversion, restoration & sustainable use	Conversion to meadows and pastures	All grassland
		Restoration of existing pastures, steppes and natural grasslands	
		Sustainable pasture management	
Forests and wooded ecosystem	4) Ecological forest management	Adapted forestry in floodplains and wet forests	All forests of the catchment area in proximity to the river
		Close-to-nature forestry	
	5) Expanding forest cover	Afforestation	Open land with moderate to steep slopes below an altitude of 1500m
Riparian ecosystem restoration	6) Restoring aquatic habitat structures	Coarse woody debris in rivers and streams	Forests within 50m proximity to the river, below an altitude of 1500m
	7) Revitalising floodplains and riparian buffer zones	Floodplain restoration and management	Forests and open land on gentle slopes within 100m proximity to the river
		Restoration of buffer strips, riparian forest and gallery forest	
	8) Restoring river dynamics and connectivity	Natural bank stabilization	Water courses buffered with 25m
		Reconnection of oxbow lakes	
		Removal of lateral barriers	
		Removal of transversal barriers	
		Stream and river restoration	
Protection of high-value ecosystems	9) Protection of high-value ecosystems	Conservation of existing high environmental value ecosystems	Assessed annex I habitat types
Soil desealing	10) Sustainable built-up areas	Permeable surfaces	Sealed or built-up surfaces > 500m²

Stakeholder involvement

To ensure the practicality and local relevance of the proposed NbS objectives and measures, regional stakeholders were consulted during the development process. Their input was crucial for validating the results on-site conditions and assessing the feasibility and compatibility of the proposed measures with existing land-use and conservation frameworks. For the Una River National Park study area in Bosnia and Herzegovina, the professional and technical services of the Una River National Park Administration provided site-specific expertise on environmental conditions, land ownership and management constraints, with feedback coordinated through email exchanges and aligned with the ongoing development of the park's management plan.

The involvement of the colleagues in the Una River National Park administration allowed feedback and clarifications regarding the given document on NbS objectives and site-specific conditions.

4.3.5. Software

Geo data compilation and spatial analysis was done in QGIS[63].

[63] QGIS Development Team. (2025). QGIS Geographic Information System (Version 3.40). QGIS Association. https://www.qgis.org

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 Bosnia and Herzegovina, 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, α-/β-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 VI.

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 und 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.

4.4.3. NbS objectives

The NbS objectives and recommended measures for floodplain landscapes are based on the Catalogue of NbS for Water Management in the Eastern Partnership Countries [64]. Together, they address key pressures on floodplain ecosystems while delivering multiple co-benefits for biodiversity, water management and climate resilience. Across all objectives, early and continuous involvement of relevant stakeholders is essential for successful implementation.

In the following, the five broader **fields of action** and their ten *objectives* are elaborated, each comprising specific **NbS measures**.

Sustainable agricultural landscapes

Objective 1 – Enhancement of homogenised agricultural landscapes

This objective addresses structurally poor agricultural landscapes lacking natural elements and habitats. Measures such as **agroforestry systems, hedges and buffer strips** introduce woody and linear landscape features into farmland and adjacent infrastructure. These measures reduce surface runoff and wind erosion, improve soil water infiltration and retention, and provide habitats for a wide range of species, including pollinators and natural pest controllers, but also serve as vital migration corridors through the most intensive parts of the agricultural landscapes.

Objective 2 – Conservation agriculture

Conservation agriculture aims to improve soil health, biodiversity and ecosystem services through reduced soil disturbance, permanent soil cover and diversified crop rotations. Practices such as no- or low-till cultivation, strip cropping, early sowing and crop diversification enhance biological processes above and below ground, increase water and nutrient efficiency and support stable long-term production. While implemented at farm

[64] 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

scale, the impacts must be assessed at watershed scale to effectively mitigate environmental pressures.

Objective 3 – Grassland conversion, restoration and sustainable use

This objective targets the loss and degradation of grasslands caused by abandonment or intensification. Measures include **converting arable land back to meadows or pastures**, **restoring degraded grasslands** through seed transfer from species-rich sites, and applying sustainable grazing or mowing regimes. These practices enhance biodiversity, carbon sequestration and ecosystem resilience while maintaining forage production.

Forests and wooded ecosystems

Objective 4 – Ecological forest management

Adapted forest management in floodplains and wet forests aims to maintain riparian forest integrity and ecosystem services. Measures include rewetting, filling drainage ditches, limiting grazing and restricting wood extraction. As another effective NbS, **close-to-nature forestry** under the umbrella of Sustainable Forest Management can be mentioned. It promotes natural structures, diverse tree species and age classes, and key habitat features such as deadwood and veteran trees.

Objective 5 – Expanding forest cover

Afforestation and reforestation restore forest cover on degraded or deforested land using native species. Implementation can follow natural succession or active planting and includes approaches such as agroforestry. These measures enhance connectivity, carbon storage and climate resilience.

Riparian ecosystem restoration

Objective 6 – Restoring aquatic habitat structures

The reintroduction of **coarse woody debris** into rivers and streams moderates flow velocity, increases local water levels and creates diverse aquatic habitats. When carefully designed, these measures contribute to the mitigation of floods and erosion and the enhancement of biodiversity without compromising river stability or species migration.

Objective 7 – Revitalising floodplains and riparian buffer zones

Floodplain restoration and the **establishment of riparian buffer zones** restore natural river dynamics and create space for flooding and sediment processes. These measures improve water retention, reduce flood and drought risks, filter pollutants and excess nutrients from agricultural runoff, and enhance habitat diversity. Buffer width varies depending on site-specific conditions.

Objective 8 – Restoring river dynamics and connectivity

This objective focuses on **stream and river restoration**, implementing NbS like reconnecting rivers with their floodplains and side channels by removing or modifying lateral and transversal barriers. Measures include **reconnecting oxbow lakes**, **removing dams or weirs**, **dismantling bank reinforcements** and applying **natural bank stabilisation** techniques to restore sediment transport, flow diversity and habitat connectivity.

Protection of high-value ecosystems

Objective 9 – Protection of high-value ecosystems

This objective supports the **conservation and improvement of existing Annex I habitat types** and other high-value ecosystems identified in Natura 2000 assessments within the study area during the project's course. Site-specific, long-term management is essential to maintain favourable conservation status and safeguard ecosystem functions such as water purification, biodiversity support and climate regulation.

Soil desealing and built-up areas

Objective 10 – Sustainable built-up areas

Permeable and porous surfaces replace sealed areas in urban and rural settings, allowing rainwater infiltration, groundwater recharge and controlled runoff. These measures are applicable to roads, farmyards and urban spaces and require regular maintenance to ensure long-term functionality.

4.4.4. Maps of the NbS objectives and measures

Based on the spatial analysis of the study area and the feedback obtained through stakeholder involvement, concrete areas of action could be delineated for each of the 10 NbS objectives. The institutional and professional input provided by the Una River National Park Administration was systematically integrated into the results, ensuring that site-specific ecological conditions, management priorities and constraints were adequately reflected in the interpretation of the findings.

The following figures present a series of maps illustrating the spatial distribution of the identified areas of action and their corresponding NbS objectives. These maps represent a synthesis of geospatial analyses and expert validation and are intended to support orientation and future planning rather than prescribe fixed interventions.

The comments from the National Park Administration were used to adjust and refine the proposed action zones by considering existing and planned management measures, land ownership patterns, recreational pressure, and other ecological or administrative constraints. This ensures that the mapped NbS objectives are consistent with the upcoming management plan for the protected area and provide a realistic, implementation-oriented basis for further prioritization and discussion.

Land cover types

As shown in Figure 17, the studied area is predominantly covered by broad-leaved forests (light green) as well as some larger and smaller patches of open land. The latter mostly consists of different grassland types (olive-green) and agriculturally used areas (yellow). Along the Una River, also several smaller settlements, Ripač, Klisa and Martin Brod, are situated within the case study area. Besides the mainstream of the Una River, a number of smaller tributaries can be found especially in the northern half of the site.

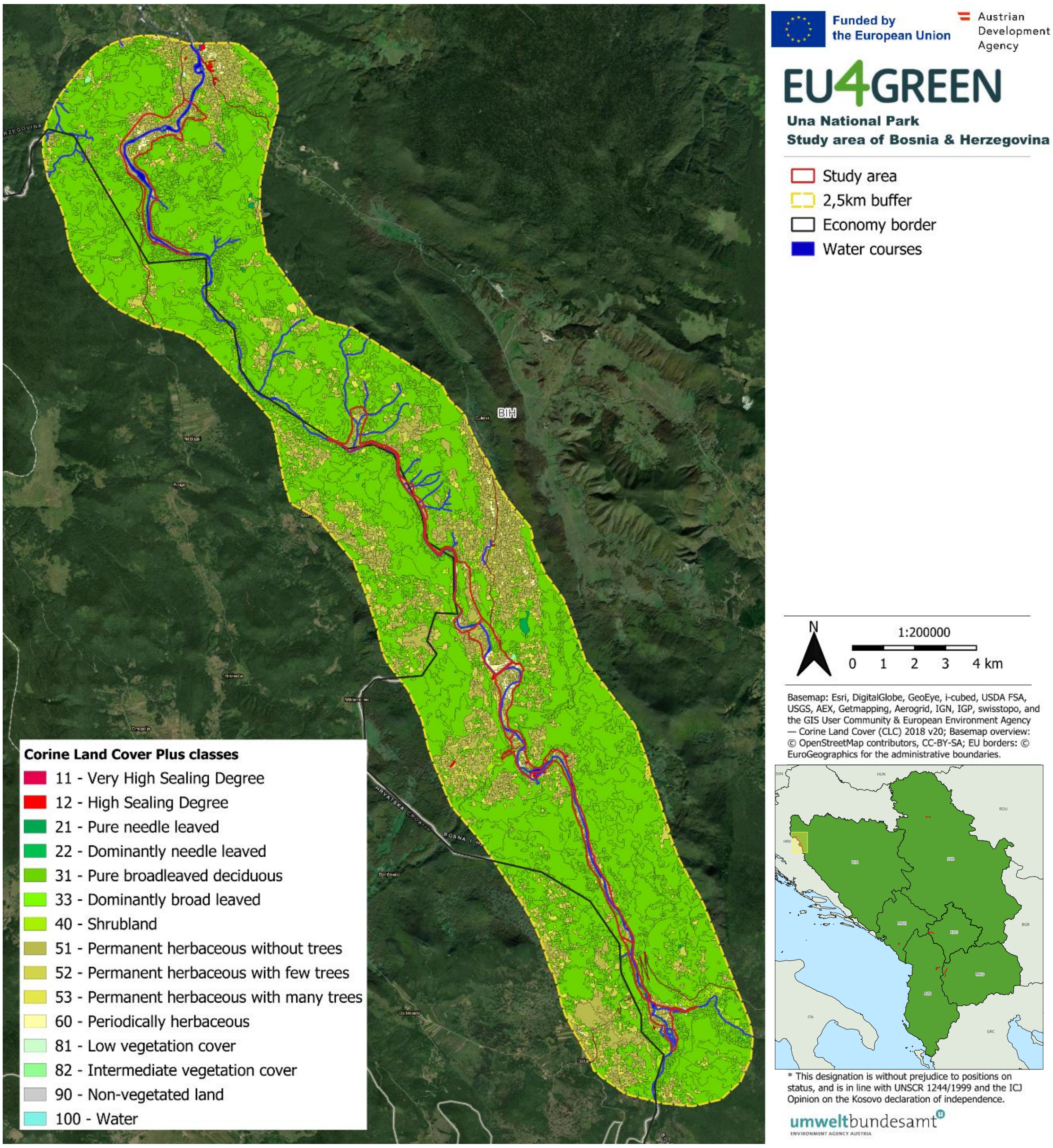

Figure 17: Land cover types according to the CLC+ Backbone raster (2023, 10 m resolution) and vector dataset (2018, MMU 0.5 ha) datasets in the Una River National Park study area, Bosnia and Herzegovina.

Sustainable agricultural landscape

Within the study area, intensive agricultural practices represent one of the most relevant pressures on riparian and aquatic ecosystems, particularly where farmland is located close to the river. Open soils, fertiliser use and the lack of buffer zones contribute to increased nutrient and pollutant runoff and to soil erosion. These pressures are most pronounced near Ripač in the most northern part of the area and in the surroundings of Klisa and Martin Brod (both located in the southern part), where agricultural land is more frequent. Consequently, the improvement of homogenised agricultural landscapes, the application of conservation agriculture and the restoration of grasslands are identified as priority NbS objectives (Figure 18).

The Una River National Park Administration highlighted important implementation constraints, including the absence of a comprehensive register of arable land within the protected area, the concentration of agricultural activities in the central part around Kulen Vakuf, and the high proportion of privately owned land across four local communities. In the southern part, arable land is small-scaled, but remains ecologically relevant, nonetheless. The forthcoming management plan for the protected area identifies pesticide use as a significant pressure and foresees the systematic identification of arable areas and potential pollution sources. In combination with the present document on NbS objectives, it is providing an important basis for future NbS planning and prioritisation.

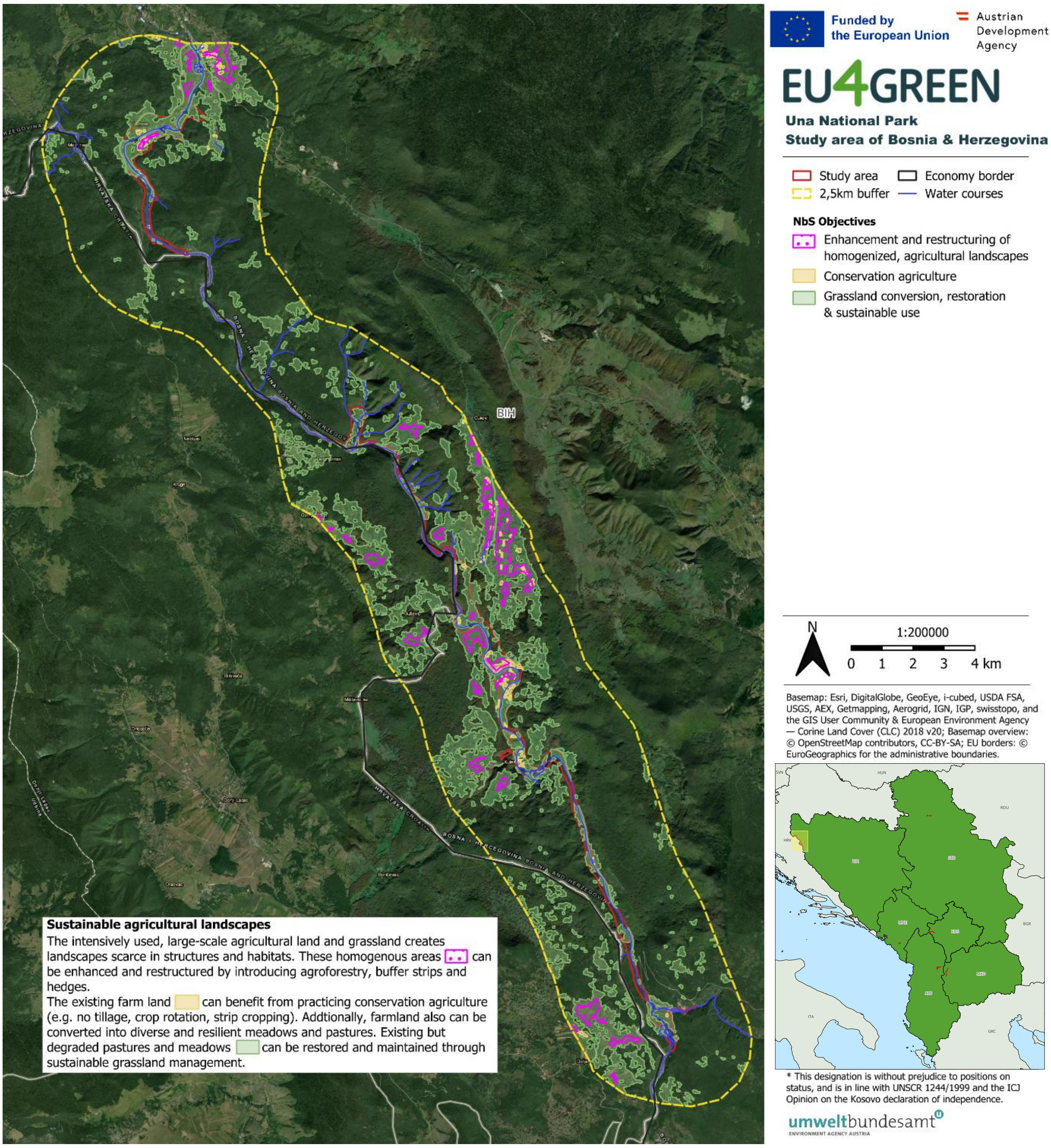

Figure 18: The NbS objectives for the field of action “Sustainable agricultural landscapes” in the Una River National Park study area, Bosnia and Herzegovina.

Forests and wooded ecosystems

Steep slopes along the upper reaches of the Una River and its tributaries represent priority areas for afforestation as a NbS (Figure 19). Both natural succession and targeted afforestation contribute to slope stabilisation, increased water infiltration and reduced surface runoff, thereby mitigating erosion and flood risks, particularly in the upstream regions of the study area, such as the surroundings of Martin Brod. These benefits are especially relevant during extreme rainfall events and in areas adjacent to agricultural land.

Forest ecosystems cover approximately 67% of Una River National Park, with succession processes occurring in riparian zones and on abandoned pastures and meadows, particularly in the southern parts of the national park and on surrounding plateaus. While these processes support natural regeneration, management capacity is limited due to the large area and restricted resources. Ecological forest management, based on close-to-nature forestry principles, is therefore essential to maintain resilient and multifunctional forests that provide flood mitigation, water retention and biodiversity benefits across the catchment. Illegal logging and flood-induced erosion remain key challenges, which the park administration is addressing through improved monitoring, including the recent acquisition of a drone.

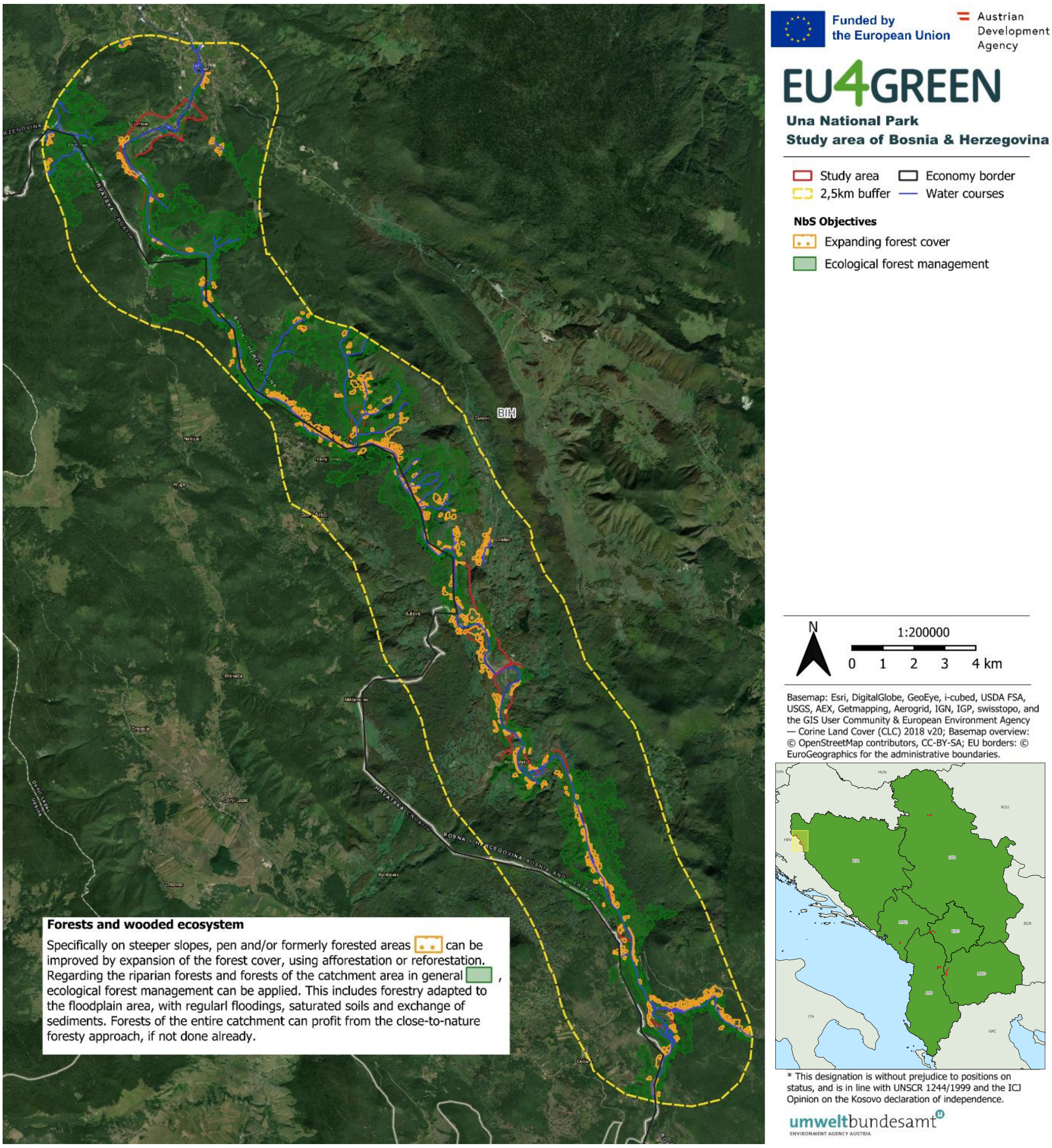

Figure 19: The NbS objectives for the field of action "Forests and wooded ecosystems" in the Una River National Park study area, Bosnia and Herzegovina

Riparian ecosystems restoration

The analysis identified high potential for riparian buffer zone restoration and floodplain revitalisation particularly in upstream sections of the Una River around Martin Brod, as well as along several tributaries and lower river reaches. Downstream, additional priority areas were identified between Lohovo and Ripač, where narrow riparian buffers and steep slopes increase vulnerability to flooding and extreme weather events (Figure 20).

Also, widespread illegal construction and riverbank modifications remain a major pressure on the riparian zone. To address this, the national park's Expert Service initiated a comprehensive mapping of riverbank interventions in 2025 using drone surveys, boat inspections and field assessments, with the resulting data currently being analysed to support future restoration and management planning.

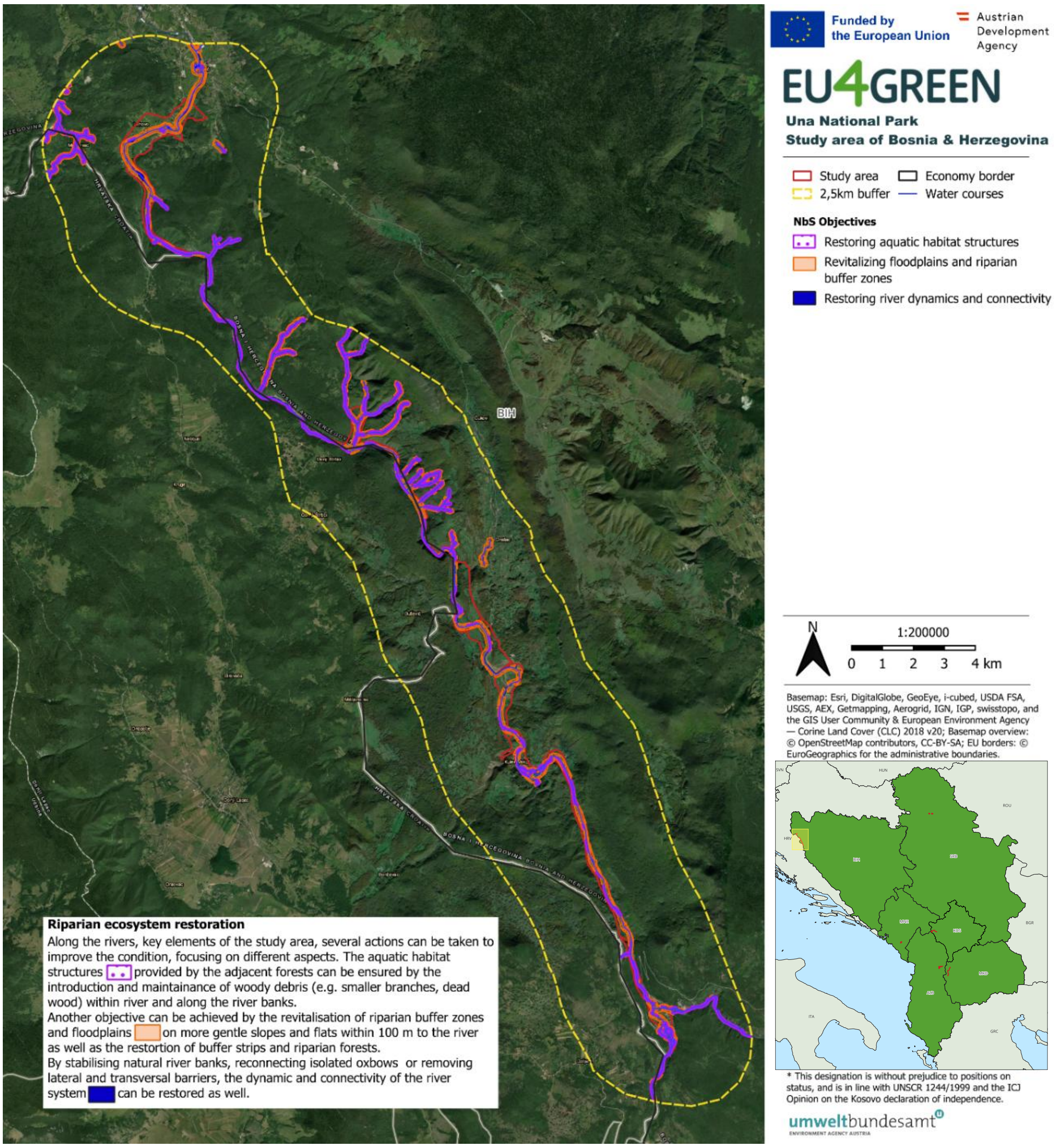

Figure 20: The NbS objectives for the field of action "Riparian ecosystems restoration" in the Una River National Park study area, Bosnia and Herzegovina

Protection of high-value ecosystems

The study area hosts numerous high-value Natura 2000 habitats (Figure 21), including riverbank vegetation such as ‘3220 Alpine rivers with herbaceous vegetation’, ‘3240 Alpine rivers with ligneous vegetation with *Salix elaeagnos*’, and ‘32A0 Tufa cascades of karstic rivers of the Dinaric Alps’. Riparian and gallery forests, notably ‘9180 Tilio-Acerion forests of slopes, screes and ravines’ and ‘91E0 Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*’, are also widespread along the river and its tributaries. These sensitive habitats require targeted protection measures, particularly for the tufa cascades, where site-specific actions such as visitor guidance, signage or protective fencing are recommended to prevent trampling and overuse. These needs are consistent with the site-specific conservation objectives developed for Una River National Park, reinforcing their priority for future management.

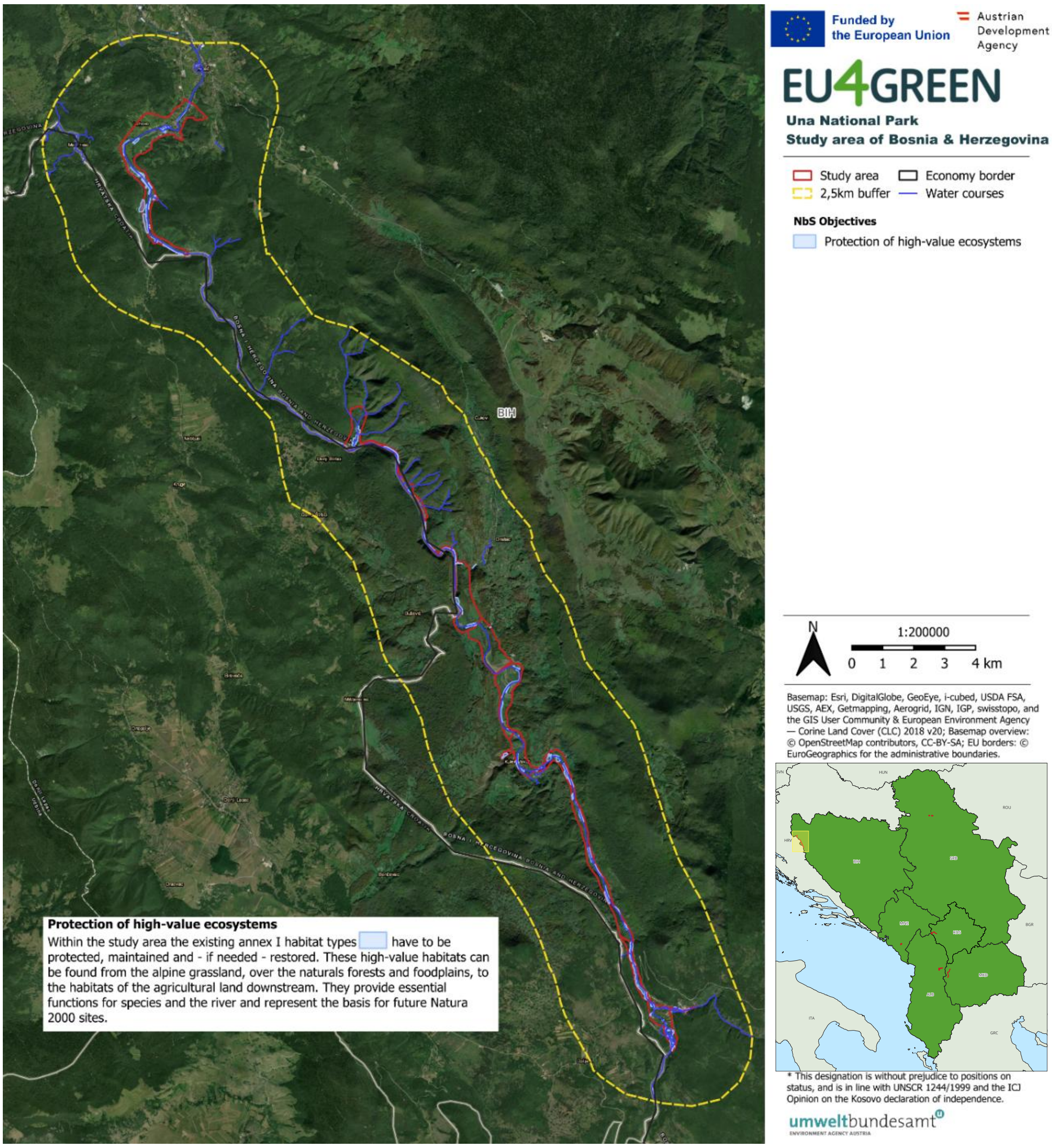

Figure 21: The NbS objectives for the field of action “Protection of high-value ecosystems” in the Una River National Park study area, Bosnia and Herzegovina

Soil desealing

Areas with potential for implementing permeable surface measures are mainly concentrated within settlements in the northern and southern parts of the study area (Figure 22). Even in this predominantly rural context, landscape elements such as roads, farmyards or other sealed surfaces can be targeted, delivering small-scale but effective improvements in runoff reduction and water retention.

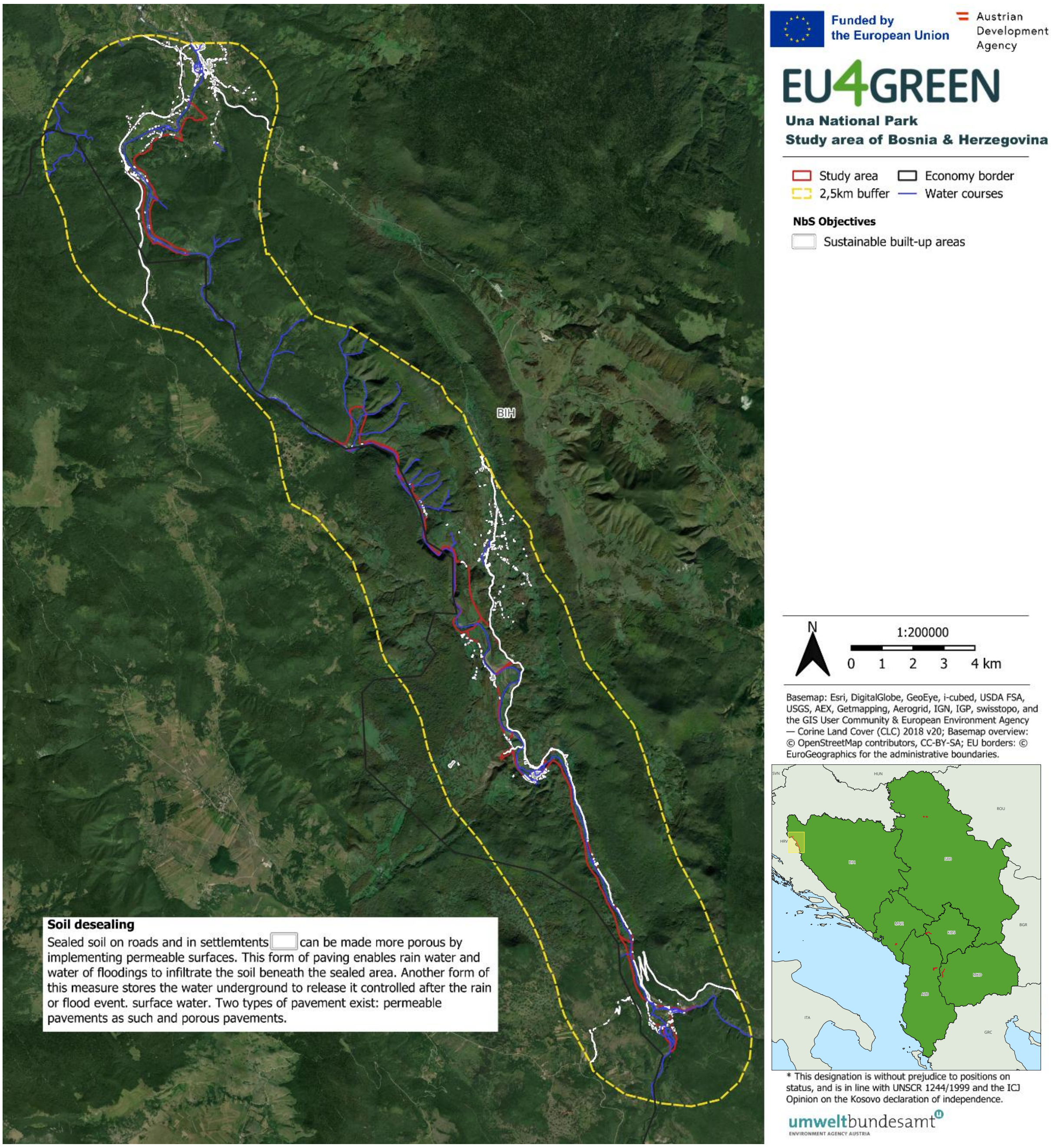

Figure 22: The NbS objectives for the field of action "Soil desealing" in the Una River National Park study area, Bosnia and Herzegovina

4.5. Conclusions

The development of NbS objectives 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 Bosnia and Herzegovina. 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 priorities and measures.

The main challenges for NbS implementation relate to competing land uses, especially intensive agriculture, existing riverbank constructions and infrastructure, and the complexity of administrative and property arrangements. Accordingly, future efforts should prioritise grassland management and restoration, the mitigation of agricultural pressures through riparian buffer zones, the gradual replacement of hard bank reinforcements with nature-based approaches for riverbank restoration, and ecologically adapted forestry in floodplain and riparian forests. These measures offer high potential to enhance biodiversity, water quality and flood resilience while delivering additional ecosystem services.

Effective implementation will depend on strong partnerships and participatory governance. Una River National Park 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 developed objectives 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 Una River valley.