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Mediterranean Corridor, Bosnia and Herzegovina - Croatia CVc Road Interconnection, Subsection: Konjic (Ovcari) - Prenj Tunnel - Mostar North

Gap Analysis & ESIA Disclosure Pack

WB20-BiH-TRA-02 Component 1

Volume 2: Technical Annexes to the ESIA

Annex C-1: Ichtyofauna (Fish)

October 2023

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Western Balkans Investment Framework (WBIF)

Infrastructure Project Facility Technical Assistance 8 (IPF 8)

Infrastructures: Energy, Environment, Social, Transport and Digital Economy

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The Infrastructure Project Facility (IPF) is a technical assistance instrument of the Western Balkans Investment Framework (WBIF) which is a joint initiative of the European Union, International Financial Institutions, bilateral donors and the governments of the Western Balkans which supports socio-economic development and EU accession across the Western Balkans through the provision of finance and technical assistance for strategic infrastructure investments. This technical assistance operation is financed with EUfunds.

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1 Introduction

1.1 Project Background

In August 2020, ENOVA was commissioned to conduct an environmental and social impact assessment referring to the Corridor Vc section Konjic (Ovcari) - Prenj Tunnel - Mostar North. The results of the previous biodiversity gap analysis indicated that additional information on biodiversity would be needed for an informed assessment of sensitive habitats and ecological characteristics. Additional information was obtained through field research and analysis of available literature and project documentation. The following field research has been done and is to be included in Annexes to the final Environmental and Social Impact Assessment Report:

- Annex A: Habitats, vegetation and invasive species
- Annex B: Invertebrates
- Annex C: Vertebrates
  - Annex C-1: Ichthyofauna
  - Annex C-2: Herpetofauna (amphibians and reptiles)
  - Annex C-3: Ornithofauna
  - Annex C-4: Mammals (Bats)
  - Annex C-5: Mammals (Large mammals).

This report provides the results of the ichthyofauna (fish) field survey.

1.2 Site Locations

This subproject includes three subsections between Konjic (Ovcari) and Mostar North along motorway Vc. According to the ToR, the subproject starts with the Konjic Intersection in Ovcari and ends with the Mostar North Interchange and the total length is 35.26 km, has six bridges and nine viaducts.

The motorway subsection Konjic (Ovcari) - Prenj Tunnel - Mostar North (Vrapcici) starts in settlement Ovcari with an interchange which will enable connection of the motorway and the existing main road M17. At the northern entrance to the City of Konjic, after the interchange, the motorway crosses the Sipad industrial zone. Further ahead, the subsection passes through the slopes where steep cuts are envisaged and where the Viaduct 3 over river Tresanica was designed to cross to the opposite side of the M17. Immediately after the end of Viaduct 3, the route enters the slope which passes through tunnels - Tunnel T1 and Tunnel T2.

After exiting the Tunnel T2, the route crosses over the Neretva River and the local road with Viaduct 4. Crossing to the opposite side, the motorway continues along the slopes at the rear of the settlement Bijela up to the settlement Mladeskovici, where the Konjic South interchange is positioned. Further on, the

motorway route is laid at the foot of the slope above the settlements of Bijela and Gornja Bijela all the way to the end of the section. The route further runs along the slopes parallel to the Rakov Laz shooting range, continues through the uninhabited green landscape to the slopes of Prenj Mountain, where the tunnel under Prenj (Tunnel T3) begins and terminates in the territory of the City of Mostar.

After exiting the tunnel through the Prenj mountain, the motorway route traverses mountain curves towards the south and the City of Mostar, through a system of cuts and bridges through uninhabited mountain areas. At the exit from the Prenj mountain range, the road crosses the valley on 300 m long embankment and enter the Klenova Draga Tunnel (Tunnel T3A) on the western cliffs of the gorge.

After the Klenova Draga Tunnel the next viaduct of approx. 800 m begins and turns into approx. 640 m long Tunnel T4. The viaduct over Badnjena Draga near Seliste, which stretches parallel to the settlement begins here.

The route continues northeast of the settlement and extends along the edges of the hill north of Podgorani, where the bridge over Seocka Draga begins and leads the route to Dolac, north of Humlisani. Further, the route continues in a slight semicircle around the settlement of Humilisani along the slopes of Porim. Below Humilisani, the route runs south and under Sljemen, it enters the 2,200-meter-long Tunnel T5, and exits into the Kuti area, the point where the Mostar (north) exit ramp has been envisaged.

The south connection to main road M17 (hereinafter: Konjic Bypass) is also a subject of this ESIA. Konjic bypass will connect the motorway at Ovcari Interchange with the M17 to Jablanica. This bypass will allow for M17 traffic to access the motorway directly without entering the urban area of Konjic. Konjic Bypass begins by turning off the motorway via the Ovcari Interchange. After that, motorway passes the next 100 m in an embankment and reach the first 80-meter-long viaduct. After the viaduct, it enters an 800-meter-long tunnel. After exiting the tunnel, the route goes for approx. 500 m through embankments and another 500 m through a cut with the highest point of approx. 30 m. The next 200 m of the route passes through embankments and cuts and reaches a 350-meter-long bridge that crosses the existing Sarajevo-Capljina railway, the Neretva River, and the main road M17. After 200 m, Konjic Bypass connects to M17.

1.3 Reporting Aim and Goals

The main purpose of this task is to prepare a written report to serve as basis for Environmental and Social Impact Assessment (ESIA) Disclosure Package and the Biodiversity Management Plan (BMP). For this purpose to be met, this report has been written in accordance with the following objectives:

- Provide field research methodology and results;

- Assess the respective project and impact areas for the potential presence of sensitive species and species of conservation importance;
- Recommend mitigation measures and/or monitoring if necessary.

2 Methodology

2.1 Survey Background

Field research on ichthyofauna, on the Konjic (Ovcari) – Prenj tunnel– Mostar North section of motorway on Corridor Vc, was carried out in 2020 for the scoping stage of the project, as well as on two separate occasions in 2021: from 13th to 16th May and from 27th to 30th May of 2021.

Field research was planned based on experience and extensive knowledge on ichthyofauna of river Neretva and its tributaries. Surveys were carried out during the breeding season of fish, considering the expected species, it was assumed that the breeding season will be in the spring-summer period when the water temperature is between 18-25°C. Intensive surveying was timed for the breeding season of salmonid fish. During spawning season these species migrate to the spawning grounds, and therefore they could be endangered during construction period of bridges, and after - in later stages of the motorway operation.

Field research also aimed to establish the status (presence or absence) of invasive fish species.

2.2 Survey Methodology

Desk research was undertaken to analyze the relevant literature (e.g. previous and ongoing assessments, papers and reports) and has been reviewed with regard to the presence of ichthyofauna species of conservation concern in the project area, as well as the ecological conditions of the project area and area of influence. The analysis of previous condition has been carried out on the basis of the following studies and literature sources[1]:

- Bioloski institut Univerziteta u Sarajevu (1965) - Ribarsko bioloska istrazivanja jablanicke vodene akumulacije
- Bioloski institut Univerziteta u Sarajevu (1972) - Ribarska osnova "Rama" Prozor
- Bioloski Institut Univerziteta u Sarajevu (1982) - Istrazivanja ekosistema na podrucju srednjeg sliva Neretve (od Jablanice do Mostara)
- Bioloski Institut Univerziteta u Sarajevu (1983) - Ekoloski aspekti kvaliteta vode ekosistema rijeke Neretve
- Vukovic, T., & Sofradzija, A. (1987). *Endemicna ihtiofauna Bosne i Hercegovine i problem njene zastite.* Akademija nauka i umjetnosti Bosne i

[1] All literature is in local languages.

Hercegovine, Posebna izdanja knjiga LXXXIII – Odjeljenje prirodnih i matematickih nauka, Knjiga 14, Sarajevo

- Kosoric, D. (1989): Endemske vrste riba i njihova zastita u slivu Neretve. U: Savjetovanje o ribarstvu na hidroakumulacijama: zbornik radova, Mostar.
- Škrijelj, R. (2002). *Populacije riba neretvanskih jezera: Ihtioloska monografija*. Prirodno-matematicki fakultet Univerziteta u Sarajevu, Sarajevo .
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2002) - Stanje ribljeg fonda i efekti poribljavanja u akumulaciji HE „Grabovica"
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2003) - Program za procjenu efekata dosadasnjih poribljavanja sliva rijeke Neretve i revizija programa poribljavanja sa planom i programom buducih poribljavanja
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2003) - Ribarstveno-gospodarska osnova: OSR „Konjic" Konjic. UGSR „Glavatica" Jablanica i UGSR „Neretva" Mostar.
- Mrakovcic, M., Brigic, A., Misetic, S., Marcic, Z., Caleta, M. (2007) Endemska ihtiofauna sliva rijeke Neretve i njenih pritoka i stanje ugrozenosti prema IUCN – u. Ugrozene i endemske vrste riba u slivovima rijeka Neretve, Trebisnjice i Morace: zbornik radova znanstveno-strucnog skupa. Skaramuca, B., Dulcic J. (ur.). Dubrovnik: Sveuciliste u Dubrovniku; EastWest Institute. 43-46.
- Muhamedahic, S., Gjoen, H. H., Vegara, M. (2008). *Salmonids of the Neretva river basin*. EIFAC FAO Fisheries and Aquaculture Report No. 871. European Inland Fisheries Advisory Commission (EIFAC): 224–233.
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2011) - Ribarska osnova USR „Glavatica" Jablanica – ribolovna zona – Jablanica
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo i Poljoprivredno-prehrambeni fakultet Sarajevo (2011) - Ribarska osnova za dio ribolovnog podrucja – ribolovna zona Konjic
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2016) - Revizija ribarske osnova USR „Glavatica" Jablanica – ribolovna zona – Jablanica
- Centar za ihtiologiju i ribarstvo Prirodno-matematickog fakulteta Sarajevo (2016) - Program revitalizacije ribljih zajednica za potrebe podruznice „Hidroelektrane na Neretvi" Jablanica

Fish sampling was done on multiple locations shown in Figure 1. Special attention was paid to the natural spawning grounds, which are situated on the river Neretva from the mouth of the river Krupac to the Old bridge in Konjic and from the Old Bridge to the mouth of the river Tresanica. These are salmonids spawning grounds for marble trout and softmouth trout in the length of 400 m. Standard surveying methods that cause no long-term negative effects to the fish population were implemented and fish were released back into the water immediately after identification. The following methods based on European Standards have been used during sampling, identification and quantification of fish fauna:

- EN 14962:2006 (Water quality - Guidance on the scope and selection of fish sampling methods),
- EN 14011:2003 (Water quality – Sampling of fish with electricity),
- EN 14757:2005 (Water quality - Sampling of fish with multi-mesh gillnets).

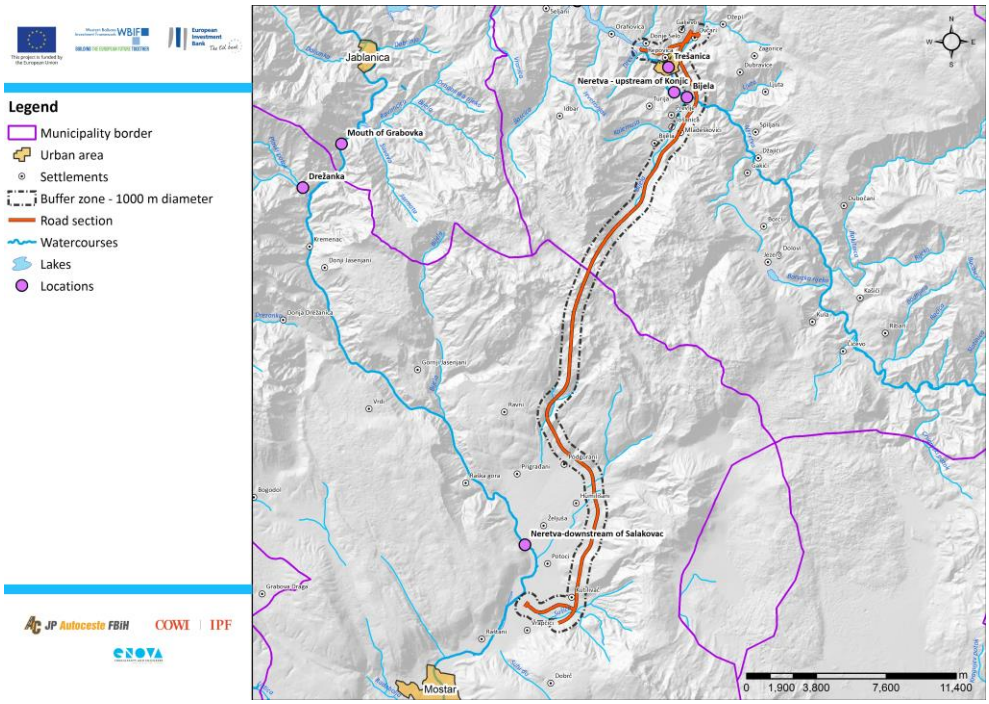

Figure 1: Fish sampling sites

Gathered fish samples were determined at site using the following determination keys:

- Vukovic, T. (1977). *Ribe Bosne i Hercegovine - kljuc za odredjivanje*. IGKRO "Svjetlost" OOUR Zavod za udzbenike, Sarajevo.
- Sofradzija, A. (2009). *Slatkovodne ribe Bosne i Hercegovine*. Vijece Kongresa bosnjackih intelektualaca Sarajevo. pp 353.

The degree of endangerment of species recorded during project research as well as species from literature sources in the study area was compared with the categorisation of fish endangerment under the Red List of Fauna of the Federation of Bosnia and Herzegovina and under the European Habitats Directive[2], as well as with the endangerment status according to the The International Union for Conservation of Nature Red List of Endangered Species[3].

The following standard abbreviations were used:

- IUCN RL – International Union for Conservation of Nature Red List
- FBiH RL – Federation of Bosnia and Herzegovina Red List

[2] Directive 2009/147 / EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds

[3] IUCN, 2021. The IUCN Red List of Threatened Species. Version 2021-1. http://www.iucnredlist.org

- IUCN and FBiH RL conservation status abbreviations:
  - CR – Critically Endangered
  - EN – Endangered
  - VU – Vulnerable
  - NT – Near Threatened
  - LC – Least Concern
  - DD – Data Deficient
  - NE – Not Evaluated
- HD – European Habitats Directive:
  - II – Annex II
  - IV – Annex IV
  - (*) - priority species.
- BC – Berne Convention

Ecologically appropriate areas of analysis (EAAA) were designed to include all sampling sites which have been defined on the basis of the previous investigations. EAAA also includes, among others, Natura 2000 site and spawning grounds.

Natura 2000 site Zlatar (BA8200095) encompasses river Ljuta, a river inhabited by the following fish species: *Cottus gobio* (bullhead), *Salmo marmoratus* (Marble trout), *Salmothymus obtusirostris oxyrhinchus* (Softmouth trout), and *Squalius svallize* (Adriatic dace). Ljuta flows into river Neretva approx. 2.1 km north of Konjic.

2.3 Assumptions and Limitations

During undertaking the desk research, available literature has been used, however no recent research has been undertaken in the envisaged area.

Due to the specific terrain, it was not possible to access the coast (canyon parts of the riverbed) in certain localities. The seasonal disappearance of rivers in the warmest part of the year was also one of the limiting factors for conducting field research. Other field trip in the second half of May was adapted to these specific conditions.

2.4 Project Area of Influence

Initiallz established area of influence was generally enough for field surveys, although biodiversity aspects must take biology of species and integrity of ecosystems into consideration. This is done so that "wider distribution of potentially affected biodiversity features and the ecological patterns, processes and functions that are necessary for maintaining them throughout this distribution" (EIB Guidance Note for Standard 3 on Biodiversity and Ecosystems, 2018) are included. Project's AOI (1 km-wide buffer zone) was enlarged in a way that reflects ecological characteristics of the area and biology of found

species. Output of said enlargement is ecologically appropriate area of analysis (EAAA). The methodology for ecologically EAAA was applied on the basis of field research, confirmed and expected species, characteristics of surrounding habitats and ecosystems, literature data, expert opinion and, later, IUCN estimated extent of occurrence (EOO) and the area of occupation (AOO) for each individual species. Initial AOI was expanded to include distribution of registered fish species and their habitats in the wider area so that the most adequate baseline for subsequent mitigation measures is ensured. Further evaluation of EAAA was done with regard to EOO based on IUCN data (if available) and expert inputs to facilitate critical habitat assessment (CHA). Critical habitat assessment for this Project is done separately and it is presented in the Annex D of the ESIA Study.

3 Results

3.1 Survey Findings

The investigations of fish fauna (Osteichthyes) in planned section Konjic (Ovcari) - Prenj Tunnel - Mostar North have been carried out in two phases: (1) literature data analysis, and (2) field investigations. The literature data analysis was carried out using results of previous investigations and studies of composition and structure of fish communities from this area. Main resources represent results of numerous studies carried out by Ichthyology and Fishing Center of the Faculty of Science Sarajevo (Center for Ichthyology and Fisheries, Faculty of Science, Sarajevo) which in various periods and with various objectives carried out investigation of ichthyofauna in this area.

The results of comprehensive literature review of all reliable sources from the year 1953 to date and field investigations have shown that 26 fish species from eight families inhabit the investigated area: Cyprinidae (12), Salmonidae (8), Cobitidae (1), Balitoridae (1), Percidae (1), Cottidae (1), Anguillidae (1), and Centrarchidae (1) (Table 1).

Several alien species live in surveyed area as well: Rainbow trout - *Oncorhynchus mykiss* (Walbaum, 1792), Prussian carp - *Carassius gibelio* (Bloch, 1782), Pike-perch - *Sander lucioperca* (Linnaeus, 1758), and Pumpkinseed - *Lepomis gibbosus* (Linnaeus, 1758) (Table 2).

Table 1: Literature records and field findings of fish species

English Name	Scientific Name	Conservation Status	Suitable Habitat in Area?	Survey finding – was species Found?	Location (where?)
Marble trout	*Salmo marmoratus* Cuvier, 1829	IUCN LC, FBiH CR, HD II	Yes	No	--
Brown trout	*Salmo trutta* Linnaeus, 1758	IUCN LC, FBiH LC	Yes	Yes	Bijela; Neretva, upstream from Konjic; Tresanica; Mouth of Grabovka; Drezanka; Neretva-dowstream of Salakovac
Softmouth trout, Adriatic trout	*Salmothymus obtusirostris oxyrhinchus (Heckel, 1851)*	IUCN EN, FBiH CR, HD II	Yes	No	--
Rainbow trout	*Oncorhynchus mykiss (Walbaum, 1792)*	Alien species	Yes	Yes	Drezanka
Grayling	*Thymallus thymallus* (Linnaeus 1758)	IUCN LC, FBiH LC	Yes	Yes	Neretva-dowstream of Salakovac
Arctic charr	*Salvelinus alpinus* (Linnaeus, 1758)	IUCN LC, FBiH LC	Yes	No	--
Brook trout	*Salvelinus fontinalis* (Mitchill, 1814)	IUCN LC, FBiH LC	Yes	No	--
Balkan brook trout	*Salmo farioides* Karaman, 1938	IUCN NE, FBiH NE	Yes	No	--
Bullhead	*Cottus gobio* Linnaeus, 1758	IUCN LC, FBiH LC, HD II, BC III	Yes	Yes	Bijela; upstream from Konjic; Tresanica; Drezanka
Carp	*Cyprinus carpio* Linnaeus, 1758	FBiH LC	Yes	No	--
Eurasian minnow	*Phoxinus phoxinus (Linnaeus, 1758)*	IUCN LC, FBiH LC	Yes	Yes	Drezanka
Spirlin	*Alburnoides bipunctatus* (Bloch, 1782)	IUCN VU, BC III	Yes	No	--
Common Gudgeon	*Gobio obtusirostris* Valenciennes, 1864	FBiH LC	Yes	No	--

English Name	Scientific Name	Conservation Status	Suitable Habitat in Area?	Survey finding – was species Found?	Location (where?)
Dalmatian Nase	*Chondrostoma knerii* Heckel, 1843	IUCN VU, FBiH EN, BC III	Yes	No	--
European chub	*Squalius cephalus (Linnaeus, 1758)*	IUCN LC, FBiH LC	Yes	Yes	Bascica; Mouth of Grabovka
Adriatic dace	*Squalius svallize* Heckel & Kner, 1858	IUCN VU, FBiH VU, BC III	Yes	Yes	Mouth of Grabovka; Drezanka; Neretva-dowstream of Salakovac
Italian chub	*Squalius squalius* (Bonaparte, 1837)	IUCN LC	Yes	No	--
Prussian carp	*Carassius gibelio* (Bloch, 1782)	Alien species	Yes	Yes	Bascica
Adriatic Minnow	*Phoxinellus alepidotus* Heckel, 1843	IUCN EN	Yes	No	--
Tench	*Tinca tinca* (Linnaeus, 1758)	IUCN LC	Yes	Yes	Bascica
Sunbleak	*Leucaspius delineatus* (Heckel, 1843)	FBiH LC	Yes	No	--
Pike-perch	*Sander lucioperca* (Linnaeus, 1758)	Alien species	Yes	Yes	Mouth of Grabovka
Pumpkinseed	*Lepomis gibbosus* (Linnaeus, 1758)	Alien species	Yes	Yes	Tresanica; Bascica
Neretvan Spined Loach	*Cobitis narentana* Karaman, 1928	IUCN VU	Yes	Yes	Tresanica; Bascica
Stone loach	*Barbatula barbatula* (Linnaeus, 1758)	IUCN LC	Yes	Yes	upstream from Konjic
European eel	*Anguilla anguilla* (Linnaeus, 1758)	IUCN CR, FBiH CR, HD II	Yes	No	--

4 Discussions and Recommendations

4.1 Summary of Main Findings

4.1.1 Sensitive Species

Assessment of the level of tolerance of species to human pressure related to the physical-chemical water degradation is very often used in ecological assessments. Intolerant species will be present in suitable conditions, but absent in the case of disturbances, when tolerant species will dominate/survive. The International Union for the Conservation of Nature – IUCN developed a group of five quantitative criteria used for the evaluation of the protection status of given species. In the evaluation of the protection status the following criteria are considered: 1. Population size, 2. Rate of decrease of abundance, 3. Size of the distribution area, 4. Degree of distribution, and 5. Degree of segmentation of population.

Considering very rich fish fauna, the Neretva River basin, together with four other areas in the Mediterranean Sea basin, represents one of the centres of endemism in the Mediterranean and Europe, and also it is distinguished by the largest number of endangered freshwater fish. Numerous fish species which live in this area have a very narrow and limited area of distribution. For this reason, many have not been evaluated by the IUCN or they have a conservation status of concern. Based on the Article 108 Paragraph 2 of the *Law on Nature Protection*[4], The Federal Ministry of the Environment and Tourism has defined as a special document The Red List of the wild species and subspecies of plants, animals and fungi in the Federation of BiH. This act has been passed in January 2014. According to the FBiH Red List, there are three species among the found and possibly present species in the surveyed area that fall in the Critically Endangered (CR) category. Endangered (EN) are two fish species while in the category Vulnerable (VU) are three fish species. The largest number of fish species (12) is in the category Least Concern (LC).

The results of the analysis indicate the confirmed or possible presence of species enlisted in the Red List of FBiH and they are as following:

- **Critically Endangered (CR) species:** Marble trout - *Salmo marmoratus* Cuvier, 1829; Softmouth trout - *Salmothymus obtusirostris oxyrhinchus* (Heckel, 1851); and European eel - *Anguilla anguilla* (Linnaeus, 1758)
- **Endangered (EN) fish species**: Dalmatian nase - *Chondrostoma knerii* Heckel, 1843; Adriatic minnow - *Phoxinellus alepidotus* Heckel, 1843;
- **Vulnerable (VU) fish species:** Spirlin - *Alburnoides bipunctatus* (Bloch, 1782); Adriatic dace - *Squalius svallize* Heckel & Kner, 1858; Neretvan spined loach - *Cobitis narentana* Karaman, 1928;

[4] Official Gazzette of FBiH, No. 66/13

There is a high number of species not classified as sensitive, and they fall under the **category Least Concern (LC):** Brown trout - *Salmo trutta* Linnaeus, 1758; Grayling - *Thymallus thymallus* (Linnaeus 1758); Arctic charr - *Salvelinus alpinus* (Linnaeus, 1758); Brook trout - *Salvelinus fontinalis* (Mitchill, 1814); Bullhead - *Cottus gobio* Linnaeus, 1758; Carp - *Cyprinus carpio* Linnaeus, 1758; Eurasian minnow - *Phoxinus phoxin*us (Linnaeus, 1758); Common gudgeon - *Gobio obtusirostris* Valenciennes, 1864; European chub - Squalius cephalus (Linnaeus, 1758); Italian chub - *Squalius squalius* (Bonaparte, 1837); Sunbleak - *Leucaspius delineatus* (Heckel, 1843); Stone loach - *Barbatula barbatula* (Linnaeus, 1758).

Cottus gobio – Bullhead (Bern Convention Annex III and EC Habitats Directive Annex II) is a species with LC status in FBiH and IUCN Red Lists; however, it is a species intolerant to pollution.

4.1.2 Invasive Species

During field research 4 invasive species were recorded (Table 2). The invasive species recorded are related to artificial hydro-accumulations and are the result of the introduction of alien species by fishermen either as attractive species for hunting such as pike-perch or as species used for baits.

Table 2: List of recorded invasive fish species.

Taxon	Species English Name	Origin[5]
Oncorhynchus mykiss	Rainbow trout	Am-N
Carassius gibelio	Prussian carp	Am-N / As
Sander lucioperca	Pike-perch	Am-N
Lepomis gibbosus	Pumpkinseed	Am-N

4.2 Mitigation Measures

4.2.1 Preconstruction Phase

The impact zone of the project is the area over which significant ecological effects extend outward from a road and typically is many times wider than the road surface when impacts on fish are evaluated. In the project area, aquatic ecosystems may be altered for considerable distances both upstream and downstream. This could be particularly case for the spawning grounds of endangered fish species in the river Neretva just upstream from the town of Konjic. Main preconstruction measure is adequate planning of construction

[5] Geographical origin: Am-C – Central America; Am-N – North America; Am-S – South America; Am-C&N – Central & North America; As – Asia; As-E –East Asia; As-W – West Asia

works and timely evaluation and implementation of proposed mitigation measures.

In order to protect fish species and their habitats, including species at risk, from development activities it would be necessary to reduce or eliminate constriction of flow through structure design. Design bridge or culvert to not affect existing or natural flow regimes. Design and install culverts to prevent creation of barriers to fish movement.

4.2.2 Construction Phase

Prohibit or limit access to banks or areas adjacent to waterbodies, to the extent required to protect the structural integrity of river banks. Dispose or temporarily store all materials used or generated (e.g. organic materials, soil, woody debris, temporary stockpiles, construction debris) during site preparation, construction and clean-up in a manner that mitigates their entry to waterbody.

Restrict riparian vegetation removals only to the area necessary for performing construction works and machinery access.

4.2.3 Operation Phase

Sediment and erosion controls to mitigate erosion of exposed soils to adjacent waterbody. Stabilize/reinforce stream banks using tree and shrub plantings. Rehabilitation of stream morphology and substrate to pre-disturbance condition or better is necessary.

4.3 Monitoring Measures

4.3.1 Preconstruction Phase

Monitoring of fish fauna should be timeply planned to be undertaken during construction and in operation phase.

4.3.2 Construction Phase

Special attention must be paid to the state and condition of critically endangered species: marble trout - *Salmo marmoratus* Cuvier, 1829; and softmouth trout - *Salmothymus obtusirostris oxyrhinchus* (Heckel, 1851) despite the fact that they weren’t confirmed during field surveys.

Together with biomonitoring of fish fauna it would be necessary to monitor physical and chemical water quality.

During the construction phase it would be necessary to monitor potential changes in water quality, changes in flow (both quantity and variability), and habitat loss.

4.3.3 Operation Phase

After completion of construction, it would be necessary to carry out monitoring of aquatic habitats and fish species. This should include monitoring of changes in water quality (temperature, sediments, chemicals due to pollution events), and changes to the flow regime.

Roads accelerate water flows and sediment transport, which raise flood levels and degrade aquatic ecosystems. Thus, local hydrologic and erosion effects along roads are dispersed across the land, whereas major impacts are concentrated in the stream network and distant valleys. Although gradual sediment transport and episodic landslides are natural processes affecting streams, elevated levels caused by roads tend to disrupt aquatic ecosystems. Buffer strips between roads and streams tend to reduce sediments reaching aquatic ecosystems.