

**MANAGEMENT ELEMENTS PROPOSAL FOR SUTLA NATURA 2000 SITE***Doru BĂNĂDUC* \* and *Angela CURTEAN-BĂNĂDUC* \*

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**KEYWORDS:** Sutla Natura 2000 site, fish, management elements, Croatia.**ABSTRACT**

Following the accession of Croatia to the EU, a study was carried out on a Croatian Natura 2000 site which includes habitats used by the following fish species of conservation interest: *Eudontomyzon vladykovi*, *Rhodeus sericeus amarus*, *Gobio uranoscopus*, *Romanogobio kesslerii*, *Barbus meridionalis*, *Zingel streber* and *Cottus gobio*. Harmful effects on fish fauna were found due to: poorly-integrated water management, over-extraction of water for irrigation, fragmentation of riparian vegetation, low cooperation between environment institutions in Croatia and Slovenia, abuse of pesticides, uncontrolled waste water, sources of chemicals and heavy metals, leakage of nitrogen, habitats fragmentation due to dams and canals, non-native fish species, invasive species and gravel extraction. Specific management actions are proposed that take account of the different fish species of conservation interest and their specific biological and ecological requirements.

**RESUMEN:** Propuesta de elementos de manejo para el área de Sutla dentro de la red Natura 2000.

En conformidad con el acuerdo de Croacia y la unión Europea, se realizó un estudio en un área natural croata dentro de la red Natura 2000, que incluyó hábitats utilizados por peces de interés para la conservación: *Eudontomyzon vladykovi*, *Rhodeus sericeus amarus*, *Gobio uranoscopus*, *Romanogobio kesslerii*, *Barbus meridionalis*, *Zingel streber* y *Cottus gobio*. Se detectaron efectos negativos en la ictiofauna, los cuales fueron relacionados con: manejo poco estructurado del agua, sobre extracción de agua para riego, fragmentación de vegetación riparia, poca cooperación entre instituciones ambientales de Croacia y Eslovenia, falta de control de aguas residuales, diversas fuentes de químicos contaminantes y metales pesados, fragmentación de hábitats por construcción de presas y canales, introducción de especies foráneas, especies invasivas y extracción de grava. Se proponen acciones específicas de manejo que toman en cuenta tanto a las diferentes especies de interés para la conservación y a sus requerimientos biológicos y ecológicos específicos.

**REZUMAT:** Propuneri de elemente de management pentru Situl Natura 2000 Sutla.

După aderarea Croației la UE s-a efectuat un studiu asupra sitului croat Natura 2000 desemnat pentru protecția speciilor de pești: *Eudontomyzon vladykovi*, *Rhodeus sericeus amarus*, *Gobio uranoscopus*, *Romanogobio kesslerii*, *Barbus meridionalis*, *Zingel streber* și *Cottus gobio*. S-a demonstrat că ihtiofauna este afectată în mod negativ de următoarele: managementul incorect al apelor, prelevarea unui volum prea mare de apă pentru irigații, fragmentarea vegetației ripariene, lipsa de cooperare între instituțiile de mediu din Croația și Slovenia, abuzul de pesticide, deversarea necontrolată de ape uzate, poluarea cu substanțe chimice și metale grele, poluare difuză cu azot, fragmentarea habitatelor datorită digurilor și canalelor, prezența unor specii alohtone de pești, a unor specii invazive și prezența balastierelor. Sunt propuse măsuri de management specifice care țin cont de structura comunităților de pești, de caracteristicile biologice și ecologice ale speciilor de pești de interes conservativ precum și de starea habitatelor caracteristice din zona de referință.

## INTRODUCTION

### *EU conservation legislation and Croatia's accession to the EU*

The Republic of Croatia (Republika Hrvatska) has been a member of the Convention on Biological Diversity since 1992, together with other 193 states. The Convention aspires to guarantee the worldwide conservation and sustainable use of species, habitats and ecosystems diversity. A new opportunity to study the effect of such legislation on conservation occurred on the first of July 2013, when Croatia became the 28th member of the European Union after a decade of trying to fulfil the needed reforms to align to the EU concept, laws and standards, including those related with the environment protection and conservation. Croatia will share not only the benefits of EU membership, but also the responsibilities that make the EU a successful union today.

The basic aspirations of the EU leadership with regard to the environment are the protection and conservation of environment structures and functions, with a specific focus on the protection of ecosystem services and ecological resources, including those from aquatic and semi-aquatic ecosystems. Over the last few decades, biodiversity issues have been considered very important in this context.

The European Community's action on biodiversity conservation is stated within the Birds Directive (79/409/EEC) and the Habitats Directive (92/43/EEC). These two European Directives have as the central ambition an intention to preserve the biodiversity in European Union territory, through a protected areas network (called Natura 2000) which preserves key habitats and species specific for all the biogeographic regions of Europe: Arctic, Boreal, Atlantic, Continental, Alpine, Pannonian, Mediterranean, Macaronesian, Steppic, Black Sea and Anatolian (Fig. 1).

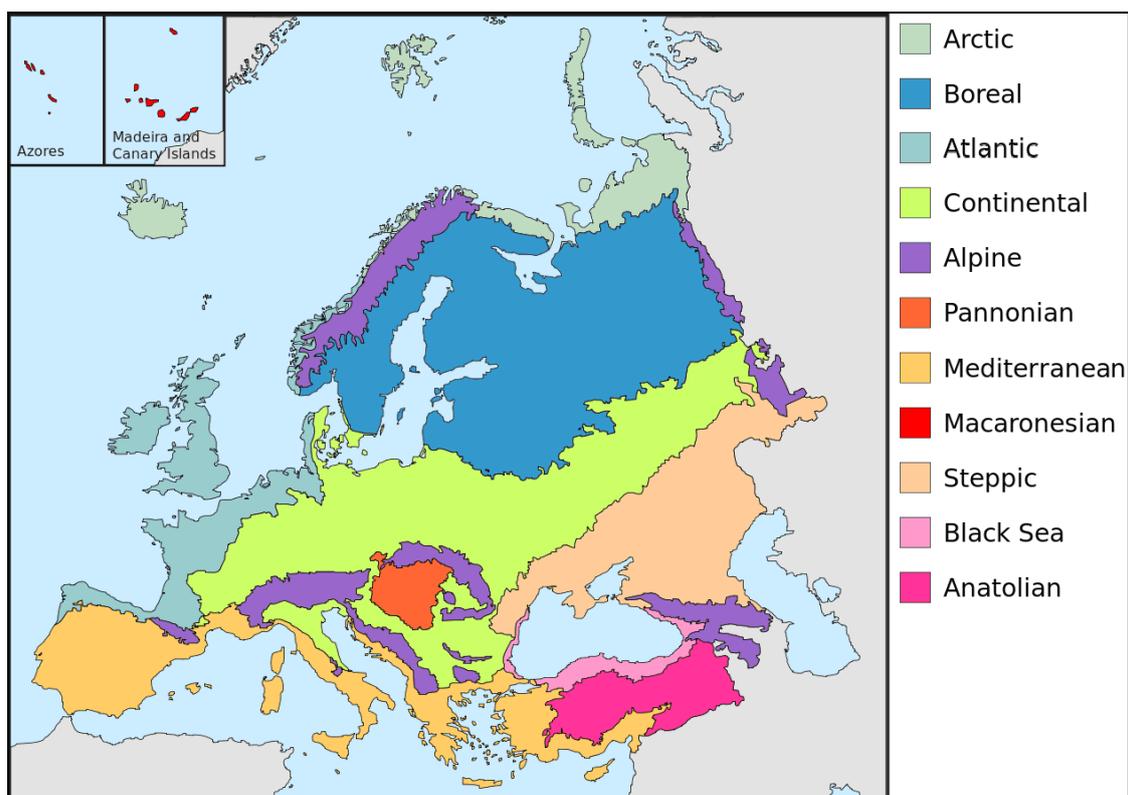


Figure 1: European biogeographic regions; European Environment Agency – [www.eea.eu.in](http://www.eea.eu.in)

Croatia has a relatively diverse biogeographic richness compared to some EU states, covering four biogeographic regions: Continental, Alpine, Pannonian and Mediterranean (Fig. 1). As part of its EU accession process, Croatia needs to take conservation measures to preserve and re-establish the favourable status of Natura 2000 habitats and species, in relation to the cultural, social and economic needs in both local and regional contexts.

One central element to fulfil the goals of these European Directives is the establishment of an optimum Natura 2000 network of sites within Croatia, a network which should include specific biodiversity monitoring plans for each habitat and species, including fish of conservation interest, and also including proper management plans on local, regional and national levels. In order to achieve this to a standard matching the EU environmental policies, the most up to date scientific and technical information should be considered.

Last, but not least, protection measures must include management plans configured for distinct areas and linked to other plans for neighbouring areas, and these must include proper statutory and administrative measures which correlate with the specific needs of the Natura 2000 species and habitats, to avoid their degradation. Across Europe's Natura 2000 network, management plans are necessary tools to provide the specific management that is required to safeguard a favourable status and to deal with situations where conflicts can appear.

#### *Study site: Sutla*

The Croatian Natura 2000 Site Sutla (HR2001070) covers around 192 ha in area and is situated in the Continental biogeographical region and encompasses diverse riparian and freshwater habitats along the Sutla River. It is inhabited by seven fish species of conservation interest: *Eudontomyzon vladykovi*, *Rhodeus sericeus amarus*, *Gobio uranoscopus*, *G. kesslerii*, *Barbus meridionalis*, *Zingel streber* and *Cottus gobio*, and by other, non-fish species of conservation interest including *Unio crassus* and *Lutra lutra*.

The Sutla River is a tributary of the Sava, and part of the Danube Basin. For some of its length, it marks the border between Croatia and Slovenia. It is 92 km long, rising in the Macelj Mountains in Croatia/Slovenia, at 625 m altitude. Its confluence with the Sava River is at Ključ Brdovečki. The majority of the Sutla River affluents are flowing from the Republic of Slovenia. The river basin is of 582 km<sup>2</sup>, of which 22% are located on the Croatian territory where Sutla River is passing mostly hilly sectors cutting sometimes narrow valley sectors.

This article provides an outline management plan for the above-mentioned fish species, with reference to identified challenges and issues in managing water quality and freshwater resources in the study area and the region more broadly.

## **RESULTS AND DISCUSSION**

### **Pollution and alternation of the river Sutla**

#### *Historic management of the Sutla River*

The Sutla River has a history of management problems. A dam was built in 1980 to block flooding in lower reaches, and to provide water for irrigation and tourism through the creation of a reservoir, Sutlanska Lake. Subsequent to its creation, and due to pollution issues, the reservoir was emptied, but the dam infrastructure still stands, and remains an obstacle to the upstream-downstream movement of fish. Additionally to this dam, there are other, smaller anthropogenic structures along the river, especially in the lower sectors, constructed to provide flood protection to agricultural riverine lands. These include alteration of the riverbed from wide and frequent meanders to more straightening course. These alterations to both river structure and the nature of water and other flow patterns have negatively impacted the fish fauna.

#### *Water quality issues in the Sutla River*

The Sutla River in both Croatia and in Slovenia has serious water quality issues, due to pollution with heavy metals in the upper part of the river and with nitrates in its lower part. The main sources of pollution in the Sutla River are considered to be communal and industrial waste water, agricultural pesticides and fertilizers, waste disposal and waste transportation. In some sectors of the river, sewage and water treatment plants are in action, whilst in many other settlements these are still missing.

#### *Agricultural pollution sources*

The landscape around the Sutla River is diverse with a combination of woodlands, grasslands and agricultural fields. The agriculture in the area relies extensively on fertilizers and pesticides, and also includes significant livestock production, both key sources of nitrate and chemical pollution.

The Sutla River basin has a high risk of pollution of surface waters from diffuse sources (including nutrients, organic substances, heavy metals and organic micropollutants). The diffuse pollution sources mostly stem from agriculture and include inadequate storage or inappropriate use of livestock manure, nitrate leaching from agricultural lands and illegal use of pesticides. In particular, nutrient loading into water sources causes eutrophication, especially in slow-moving or stagnant waters, which can induce changes in fish fauna structure, typically with a decrease in species diversity.

Dangerous substances can induce toxicity, can be persistent and may bioaccumulate in the aquatic environment. Organic substances produce a significant impact on the aquatic ecosystems through changes in species composition, decreasing species biodiversity, decreasing fish abundance and fish mass mortality. In 2009 for example Croatia produced 3,879 tons of pesticides, imported 5,760 tons, and exported 1,000 tons, leaving high quantities of pesticide for local use. Before accession to the EU, pesticides in Croatia could be bought without any competence certificate for pesticide use or storage, or any documentation regarding its use in farming and related business. Near Ključ Brdovečki and Drenje Brdovečko localities in the study area, studies of agricultural lands reveal temporary increases in the concentration of some metals as a result of sporadic emissions or leaks of farm manure into the river water; this can be correlated with the fact that the  $K_2O$ , CO, copper sulphate and Ti, are chemical elements used in fertilizers. In the same area the number of enterococci (typically indicative of faecal contamination) in the river water was significantly increased, as the concentrations of total N and total P. The agriculture is a major source of P, N and enterococci for aquatic ecosystems. As a consequence of the increased use of fertilizers in agriculture, additional humic substances entering river water can occur as a result of their use as additives for fertilizers.

#### *Urban/settlement pollution sources*

The main point sources of nitrate loading solution in the Sutla River are represented by human settlements in the area that lack a sewer system and a wastewater treatment plant. In addition, the efficiency of industrial units is a key potential source of urban pollution. In the Sava River basin, Croatia, over 90 cities discharge sewage into the river without any treatment.

However some of the most important potential sources of water pollution are waste landfills. These have been generally well-managed, reducing their potential to contributed pollution to the river.

Woodlands have a good effect for water sources, decreasing the negative impact of agricultural water pollution and contributing to the protection of water quality. The forests along River Sutla are mainly owned by individuals, and consist of beech, hornbeam and oak.

Rural households in Croatia are generally characterized by poor access to infrastructure equipment for water and sanitation compared to urban areas. Even in rural situations where households are connected to sewage systems, domestic water is not always treated, this having a negative impact on the environment (e.g. in 2007 42% of the Croatian Danube Basin were connected to sewage systems, which water was only 0.4% treated in a tertiary step).

#### *Managing the fish species of River Sutla*

Article 17 of the EU Habitats Directive compels Croatia to submit reports on the implementation of the measures taken under the Directive every six years. An improving situation for the seven fish species of conservation interest can only achieve favourable conservation status in the six-yearly reports if proper management measures will be identified, adapted and implemented on the ground. A favourable conservation status of these species means that they are prospering and have optimum conditions to remain the same in the medium and long term future. Some of the specific management measures for the conservation of these seven species are highlighted in the rest of this paper.

In the river Sutla there are four sport fishing associations: SRD "Sutla" Klanjec, SRD "Maple" Hum, SRD "Pike" Brdovec and SRD "Carp" Zapresic, all Croatian, and on the Slovene side Ribiška Sotli, Fellowship Ribiška and Fellowship Brežice. All of these sport fishing associations manage some sectors of the river Sutla on permitted management plans which specifically focus on fish management. Accepted fishing volumes vary in average between seven to eight kg/ha per year. Restocking with fish is done once or twice a year, with indigenous and also alien species.

All the positive and negative influences on the fish species of conservation interest and the management proposals were initially selected based on meetings with: experts, local stakeholders, Croatian Ministry of Environment and Nature Protection, State Institute for Nature Protection, (SINP), Natura 2000 Management and Monitoring (MANMON) team, Consortium Ramboll Denmark, Nature Bureau, etc. (Fig. 2).



Figure 2: Workshop with project team and stakeholders in Bdoveck locality.

Relatively numerous negative influences on fish populations were identified at the workshops with stakeholders and in the field: non-integrated water management, over-irrigation, improper maintenance of coastal and riparian vegetation, fisheries rivalry, unprofessional management of ponds, poor cooperation between environmental institutions in Croatia and Slovenia, misuse of pesticides in agriculture, unresolved issues of waste water in the entire area, waste leaks, sources of chemicals and heavy metals, leakage of nitrogen from farms, dams and canals that interfere with the continuity of river habitats, fisheries management plans created and implemented without the approval of the nature protection institutions, introduction of inappropriate foreign fish species and other, potentially invasive species, and gravel extraction.

The workshops also identified positive influences, including: adoption of ecologically-friendly agricultural systems, increasing awareness of environmental issues, sustainable forest management, protection of a part of Sutla River, agri-environment incentives, good cooperation with the Croatian Waters Administration, many wastewater treatment plants already operating, and rational fishing planning.

#### ***Species related data***

***Eudontomyzon vladykovi*** Oliva and Zanandrea, 1959 (Natura 2000 code 2485). Cephalaspidomorphi, Petromyzontiformes, Petromyzontidae, Lampetrinae. This freshwater, demersal fish species needs well-oxygenated and clear aquatic habitats commonly found in piedmont and mountain areas. Ammocoetes live in sands rich in detritus or clay sediments and eat detritus and microorganisms. Its known distribution covers the upper and middle Danube River basin, including the Sava River basin, and it is known to be present in our study area of the Sutla Basin. This species is protected by the Bern Convention and European Directive 92/43. In general, in its all distribution area the Danubian brook lamprey is sensitive to alteration in habitat quality (including from mineral extraction, drainage, and water pollution).

***Rhodeus sericeus amarus*** (Bloch, 1782) (Natura 2000 code 1134). Actinopterygii, Cypriniformes, Cyprinidae. This benthopelagic and freshwater fish species needs still or slow-flowing water habitats with relatively compact aquatic vegetation and sandy-silty ground as canals, slow flowing lotic sectors, ponds, oxbows and backwaters, where mussels are present, especially mussels in the *Unio* and *Anodonta* families which are needed for reproduction. It feeds mainly on plants and debris, and secondarily on invertebrates. Its known distribution is the Danube Basin, including the Sava Basin, and it is also present in our research area of the Sutla Basin. It is protected by Annex 3 of the Bern Convention and Annex 2 of the Habitats Directive. The bitterling is in general sensitive to habitat deterioration.

***Gobio uranoscopus*** (Agassiz, 1828) (Natura 2000 code 1122). Actinopterygii, Cypriniformes, Cyprinidae, Gobioninae. This benthopelagic and freshwater fish species lives in the riffles of small fast-flowing rivers (70-115 cm/s) and on the bottom of big rivers with relatively high water velocities and stone substrata in submountain lotic sectors. The alevines stand in not so fast flowing water sectors with sandy substrata. Its food consists of bioderma and rheophilic invertebrates. Its distribution is in the Danube Basin, including the Sava Basin, and it is present in our study area of the Sutla Basin. It is protected by the Bern Convention and European Directive 92/43/EEC. Generally speaking Danubian longbarbel gudgeon is vulnerable to organic pollution and sedimentation that appear due to the hydrotechnical constructions. This species is affected also by other disturbance of their habitats by humans.

***Gobio kessleri*** (Dybowski, 1862) (Natura 2000 code 1124). Actinopterygii, Cypriniformes, Cyprinidae, Gobioninae. This benthopelagic and freshwater fish species is present in general in fast flowing piedmont zone rivers with large areas of sand substrate. This species eats diatoms and small psammophile organisms. Its range is in the Dniester/Nistru Basin, upper Vistula Basin and tributaries of lower and middle Danube Basin, including the Sava Basin, and is also present in the Sutla Basin. This fish species is under the care of the Bern Convention Annex 3, Habitats Directive Annex 2 and the IUCN Red List Kessler's gudgeon can be negatively affected by human induced changes in watercourses and drains and the extraction of sand and gravel, and to pollution including organic pollution.

***Barbus meridionalis*** (Riso, 1827) (Natura 2000 code 1138). Actinopterygii, Cypriniformes, Cyprinidae, Barbinae. It is a benthopelagic, freshwater fish species, which can be found in hilly and mountainous lotic systems, especially those with springs. It prefers the clear and fast flowing water of lotic zones with hard substrata. Its food consists primarily of benthic aquatic invertebrates (tendipedes, ephemeropterans, trichopterans, gamarids, oligochetes and, rarely, plants). Its distribution is widespread through the Danube Basin, including the Sava Basin, the Sutla Basin. This species is listed on the IUCN Red List and protected by the Habitats Directive. The Mediterranean barbel is vulnerable to water pollution and abstraction, and environmental changes from drainage and mineral exploitation.

***Zingel streber*** (Siebold, 1863) (Natura 2000 code 1160). Actinopterygii, Perciformes, Percidae, Luciopercinae. This demersal and freshwater fish species lives in the central course of small to large lotic systems and in sectors with relatively high water velocity, with riverbeds formed of pebbles, sand or clay, in the hilly and plain rivers, sometimes being present in sandy areas. Its food consists principally of aquatic insects, amphipods and worms, and occasionally of roes and fish alevines. Its distribution range is the Dniester/Nistru and Danube basins, including the Sava Basin, and it is present in our study area of the Sutla Basin. It is under protection by Bern Convention Annex III, Habitats Directive Annex 2 and listed as XX on the IUCN Red List. The Danube streber is negatively affected by human impact like pollution and habitat changes such as canalisations and dams.

***Cottus gobio*** (Linnaeus, 1758) (Natura 2000 code 1163). Actinopterygii, Scorpaeniformes, Cottidae. This demersal and freshwater fish species lives exclusively in warm, mountainous lotic freshwater, and is rare in lakes which lack deep and relatively slow water sectors. Its food consists of insect larvae, amphipods, roes and alevines. It is protected by the Bern Convention and the Habitats Directive. Its known distribution includes much of the Danube Basin, including the Sava Basin, and it is present in the Sutla Basin too. The bullhead is threatened in general by pollution, changes in aquatic and riverine habitats, such as river canalisations and microhydropower plants and the accumulation of fine sediments.

#### **Management elements of the Sutla River for the future**

There is a necessity for supportive collaboration among Croatia, Slovenia, other Danube Basin and European Union countries across all sectors and stakeholders involved in the river, including academic institutions, experts, civil society, public administration and research networks. In particular, there is a need for joint, applied extensive and intensive specific studies, and for concentrated capacity building capacities through exchanging ideas and specific expertise. This way is essential to promote and boost Croatia's awareness, by sharing specific expertise to identify lotic sectors where management improvements are required. As an important first step, a joint Croatian-Slovenian network needs to be built to communicate emergencies and decide management solutions.

The Sutla Basin management plans required by Natura 2000 should include opportunities for improving the physico-chemical state of aquatic and riverine habitats to ensure favourable conditions for all the fish species of conservation interest in the Natura 2000 area. Specific management tasks that would improve the water quality and address the issues around availability of habitat discussed above can be grouped into four key areas: firstly, improving water quality, through building wastewater treatment plants, regulating discharges to the sewage networks, building sewage networks in the Sutla Basin for settlements currently lacking them, managing riverine dumps, discouraging illegal riverine dumps, and regular waste clean-up activities along the lotic and lentic sectors of the river. Secondly, addressing agricultural sources of water pollution, for example through starting training programmes on organic and ecological farming techniques include the use of nature-friendly fertilization and pest management, pesticide monitoring. Thirdly, by addressing loss of habitat/access to habitat that were caused by historic engineering projects or through ongoing land uses, including maintenance and restoration of riparian and basin vegetation, preserving favourable hydrological regimes when present, supporting natural water flow and river morphology conservation, improving habitat conditions, constructing new fish migration paths, improving the hydrological conditions of the dead river branches. Finally, by managing the multiple stakeholders involved in the river, for example working with fishing and angling groups to prevent the introduction of alien fish species, removing invasive fish species, collaborating with fishing sports societies in matters of stocking exotic species and preventing poaching, yearly official justification for restocking, initiating cross-border cooperation regarding fish populations assessment, monitoring and management, monitoring and controlling the exploitation of minerals including sand and gravel, and carrying out monitoring of the implementation of water works.

To preserve vital populations of Natura 2000 fish species in the Sutla River basin, the populations of target and key species like the ones listed above, should be extensively and intensively investigated.

One obvious way to address the need for monitoring of the river is to use existing monitoring stations and enlarge them to include studies on the target species in the Natura 2000 list. Sutla River has several stations where water chemistry is regularly monitored for nitrate (ammonium, nitrate, nitrite, total nitrogen, total phosphorus), heavy metals (Cu, Zn, Pb, Hg, Cr and Ni), nitrates, specific pollutants, dissolved macro elements (Na, K, Ca, Mg), dissolved trace elements (Al, As, Ba, Cd, Co, Cr, Cs, Cu, Fe, Li, Mn, Mo, Ni, Pb, Rb, Sb, Sn, Sr, Ti, Tl, U, and V), chemical state, microbes indicator (*Escherichia coli*, total coliforms, enterococci, heterotrophic bacteria), aquatic invertebrates, phytobenthos and macrophytes, BOD5 (biological oxygen demand), the ecological status (Lupinjak, Rogatec, Prišlin, Zelenjak, Harmica, Harmica, Rigonce, and Rakovec). However, we would recommend that the monitoring should be done on a river and basin scale rather than being restricted to within national borders, requiring cross-border agreements and standards.

For the identification of poor land and water management, and good or bad influences on the ecological state of the Sutla River biocoenosis, a second category of monitoring stations is needed, these to be permanent monitoring stations. These should be placed at the borders of the following municipalities on the Sutla River as follows: Đurmanec/Hum na Sutli, Hum na Sutli/Zargoska Sela, Zargoska Sela/Kumrovec, Kumrovec/Klanjec, Klanjec/Kraljevec na Sutli, Kraljevec na Sutli/Dubravica, Dubravica/Marija Gorica, Marija Gorica/Brdovec.

A third category of sampling sites represents stations in which the presence of anthropogenic structures causes permanent modifications in the lotic habitats physical and/or chemical characteristics. A good example in this respect is the Zelenjak Dam area.

In the fourth category should enter those sections which did not fit in the previous three categories of sections, but which are necessary for range of the species monitoring.

This combination of various criteria for monitoring sections facilitates the detection of potentially problematic sectors for the target species and allows a proper managerial response at the local and/or basin level, which is especially important in periods of low/base-flow when the river typically experiences a build up of pollutants, which generally lasts approximately two thirds of the year.

### CONCLUSIONS

There are seven fish species of conservation interest in the Natura 2000 site Sutla River in Croatia, each with different biological and ecological requirements, all affected by identified human impact pressures and threats. There are a range of possible different management aspects to consider, which this paper has outlined.

For *Eudontomyzon vladkovi*, *Barbus meridionalis* and *Zingel streber*, the position and impact of hydrotechnical works (dams, canals, etc.) that induce lotic fragmentation should be determined; hydrotechnical works negatively effects mitigation or removal in a way to allow upstream-downstream and downstream-upstream connection.

For *Rhodeus sericeus amarus*, the possibility of restoration of the river in the lower part of the flow should be considered: a move away from river embankment, towards re-establishment of a natural flooding regime, linking to stagnation in the period of flooding oxbows and dead branches restoration and maintenance.

For the species *Cottus gobio*, *Eudontomyzon vladkovi*, *Gobio uranoscopus*, *Gobio kesslerii*, *Rhodeus sericeus amarus*, *Barbus meridionalis*, *Zingel streber*, the following actions can have a positive impact: implementation of the Water Framework Directive, implementation of the Nitrates Directive, restoration and preservation of riparian zone woody vegetation (minimum 10 m) especially in areas of intensive agriculture, identification of the causes of the increased presence of mercury and mitigation options.

Important for the species *Cottus gobio*, *Eudontomyzon danfordi*, *Gobio uranoscopus*, *Gobio kesslerii*, *Rhodeus sericeus amarus*, *Barbus meridionalis*, *Zingel streber* are: planting and preservation of riparian zone vegetation (woody vegetation) with a minimum width of 10 meters along the watercourse, removal of existing artificial hydrological objects where possible, and a prohibition on removal sand and gravel from riverbeds.

Finally, all these fish species need updated research about the habitats quality and populations' structure and functions in order for good management to be designed and implemented.

Special attention should be focused on: water integrated management, too high water volume used for irrigations, riparian vegetation fragmentation, lack of collaboration among Croatian and Slovenian environmental institutions, pesticides use abuse, uncontrolled waste water discharging, pollution with different chemical substances and heavy metals, habitat fragmentation due to the banks embankments and channels, the presence of some invasive species and riverbed mineral exploitations, etc.

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