TRANSYLVANIAN REVIEW OF SYSTEMATICAL AND ECOLOGICAL RESEARCH

16.2

The Wetlands Diversity

Editors

Angela Curtean-Bănăduc & Doru Bănăduc

Sibiu – Romania
2014

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Preface

In a global environment in which the climate changes are observed from few decades no more only through scientific studies but also through day by day life experiences of average people which feel and understand allready the presence of the medium and long-term significant change in the "average weather" all over the world, the most comon key words which reflect the general concern are: heating, desertification, rationalisation and surviwing.

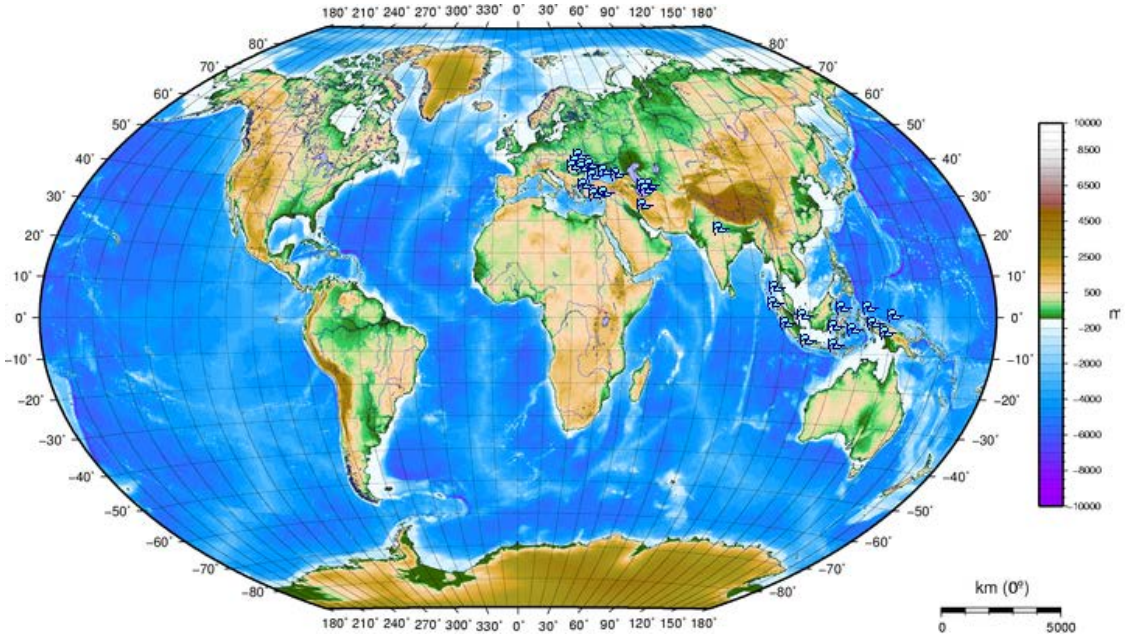
The causes, effects, trends and possibilities of human society to positively intervene to slow down this process or to adapt to it involve a huge variety of aproacess and efforts.

With the fact in mind that these aproaces and efforts should be based on genuine scientific understanding, the editors of the *Transylvanian Review of Systematical and Ecological Research* series launch a sub-series of volumes dedicated to the wetlands, volumes resulted mainly as a results of the *Aquatic Biodiversity International Conference*, Sibiu/Romania, 2007-2013.

The therm wetland is used here in the acceptance of the Convention on Wetlands, signed in Ramsar, in 1971, for the conservation and wise use of wetlands and their resources. **Marine/Coastal Wetlands** – Permanent shallow marine waters in most cases less than six metres deep at low tide, includes sea bays and straits; Marine subtidal aquatic beds, includes kelp beds, sea-grass beds, tropical marine meadows; Coral reefs; Rocky marine shores, includes rocky offshore islands, sea cliffs; Sand, shingle or pebble shores, includes sand bars, spits and sandy islets, includes dune systems and humid dune slacks; Estuarine waters, permanent water of estuaries and estuarine systems of deltas; Intertidal mud, sand or salt flats; Intertidal marshes, includes salt marshes, salt meadows, saltings, raised salt marshes, includes tidal brackish and freshwater marshes; Intertidal forested wetlands, includes mangrove swamps, nipah swamps and tidal freshwater swamp forests; Coastal brackish/saline lagoons, brackish to saline lagoons with at least one relatively narrow connection to the sea; Coastal freshwater lagoons, includes freshwater delta lagoons; Karst and other subterranean hydrological systems, marine/coastal. **Inland Wetlands** – Permanent inland deltas; Permanent rivers/streams/creeks, includes waterfalls; Seasonal/intermittent/irregular rivers/streams/creeks; Permanent freshwater lakes (over eight ha), includes large oxbow lakes; Seasonal/intermittent freshwater lakes (over eight ha), includes floodplain lakes; Permanent saline/brackish/alkaline lakes; Seasonal/intermittent saline/brackish/alkaline lakes and flats; Permanent saline/brackish/alkaline marshes/pools; Seasonal/intermittent saline/brackish/alkaline marshes/pools; Permanent freshwater marshes/pools, ponds (below eight ha), marshes and swamps on inorganic soils, with emergent vegetation water-logged for at least most of the growing season; Seasonal/intermittent freshwater marshes/pools on inorganic soils, includes sloughs, potholes, seasonally flooded meadows, sedge marshes; Non-forested peatlands, includes shrub or open bogs, swamps, fens; Alpine wetlands, includes alpine meadows, temporary waters from snowmelt; Tundra wetlands, includes tundra pools, temporary waters from snowmelt; Shrub-dominated wetlands, shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils; Freshwater, tree-dominated wetlands; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils; Forested peatlands; peatswamp forests; Freshwater springs, oases; Geothermal wetlands; Karst and other subterranean hydrological systems, inland. **Human-made wetlands –** Aquaculture (e. g., fish/shrimp) ponds; Ponds; includes farm ponds, stock ponds, small tanks; (generally below eight ha); Irrigated land, includes irrigation channels and rice fields; Seasonally flooded agricultural land (including intensively managed or grazed wet meadow or pasture); Salt exploitation sites, salt pans, salines, etc.; Water storage areas, reservoirs/barrages/dams/impoundments (generally over eight ha); Excavations; gravel/brick/clay pits; borrow pits, mining pools; Wastewater treatment areas, sewage farms, settling ponds, oxidation basins, etc.; Canals and drainage channels, ditches; Karst and other subterranean hydrological systems, human-made.

The editors of the *Transylvanian Review of Systematical and Ecological Research* started and continue this new annual sub-series (*The Wetlands Diversity*) as an international scientific debate platform for the wetlands conservation, and not to take in the last moment, some last heavenly "images" of a perishing world …

This volume included variated research results from diverse wetlands around the world.



The subject areas (▱) for the published studies in this volume.

No doubt that this new data will develop knowledge and understanding of the ecological status of the wetlands and will continue to evolve.

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The editors would like to express their sincere gratitude to the authors and the scientific reviewers whose work made the appearance of this volume possible.

The Editors

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IN MEMORIAM

Roger Bacon
(1214-1294)

Roger Bacon was one of the first medieval philosophers to champion experimental science. The details of his life are uncertain and he has become something of a legend, but his lifelong search for truth should be an example and inspiration to scientists today.

He was born, probably in 1214, into a wealthy family in the ancient town of Ilchester in the county of Somerset in S.W. England. His time was an unstable and often violent age – Bacon himself wrote of how "justice perishes, all peace is broken" – and his family lost property and royal influence in the civil war between Henry III and Simon de Montfort, Earl of Leicester, now regarded as a father of parliamentary democracy.

This was also a time of greatly expanding knowledge. The 12th-13th centuries, the age of Dante, Giotto, Staint Francis and Saint Thomas Aquinas, saw the flowering of the High Middle Ages, with the growth of universities in Italy, Spain, France and England, the increased use of practical agricultural innovations such as improved crop rotation and the windmill, and much building of great cathedrals in western Europe.

Bacon studied at the University of Oxford, by then well established, remaining there to lecture to students on Aristotle. By the 1240s he was lecturing at the University of Paris, the very hub of European intellectual life. Bacon was one of several philosophers, including the great Aristotelian scholar Albertus Magnus (*c.*1193-1280), with whom he worked in Paris, who would gradually explore what today we would recognize as science.

In *c.*1256, when he was apparently no longer holding an academic post, Bacon joined the Franciscan Order of friars, which greatly curtailed his studies, as friars, although living among the ordinary people and not enclosed in monasteries as were the orders of monks, were prohibited from publishing books without approval from the Order.

However, Bacon enjoyed the patronage of Cardinal Guy le Gros de Foulques, who became Pope Clement IV. In 1266 this Pope requested that Bacon write an account of the place of philosophy within theology, and he gathered together a body of his work as *Opus Maius*, effectively an encyclopedia of known science. The section on Optics, a particular interest of Bacon, is a wide-ranging scientific account of the subject, influenced by Arab texts. Bacon wanted science, and languages (he was concerned that too few scholars read Greek), to be an integral part of the philosophy and theology curriculum that dominated university studies. Above all, he strove to promote the work of Aristotle in medieval scholarship.

Bacon has been credited with being a modern scientist and visionary in an age of superstition and the Church's intolerance of learning. The truth is much more complex, for he was loyal to the Franciscans and there is no reason to suppose he intended other than to improve the intellectual standing of medieval philosophy and lessen the hold of superstition. He was scrupulous in going back to the original Greek texts of Aristotle, who himself had an impressive knowledge of biology and other subjects. He greatly admired Aristotle's *Secretum Secretorum*, which had been translated by Arab scholars, and even produced an edition with his own introduction and notes, after his return to Oxford during the late 1270s or early 1280s.

Bacon also wrote on mathematics, astronomy (including the need to reform the Calendar), medicine and alchemy, famously describing and experimenting with samples of gunpowder, which he may have received via a Franciscan embassy to the Mongol khan. A true scientist, he always championed experimental verification over an uncritical appeal to published authority.

He died in Oxford, probably in 1294. Later generations called him *Doctor Mirabilis*.

The Editors

CONSIDERATIONS REGARDING ALPINE RIVERS AND THEIR LIGNEOUS VEGETATION WITH *MYRICARIA GERMANICA* IN THE MARAMUREȘ MOUNTAINS NATURE PARK (ROMANIA)

Oana DANCI *

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KEYWORDS: German tamarisk, habitat management, riverbanks.

ABSTRACT

The habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica* was not listed in the standard form based on which the Natura 2000 site ROSCI0124 Maramureș Mountains was declared. The aim of this study is to offer some new information regarding the structure, distribution and ecology of the Natura 2000 habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica* in Maramureș Mountains Nature Park. The ecological importance of habitat 3230 results from the capacity of *Myricaria germanica* to colonize new deposits of gravels and set up new biocoenoses, this ability being possible only in the case of natural morphodynamics of the mountain streams, not influenced by human activities.

ZUSAMMENFASSUNG: Betrachtungen über die Gebirgsfließgewässer und ihre Gehölzvegetation mit *Myricaria germanica* im Naturpark Maramurescher Gebirge/Munţii Maramureșului (Rumänien).

Der Habitattyp von gemeinschaftlichem Interesse 3230 Montane Flüsse und ihre Gehölzvegetation mit *Myricaria germanica* ist unter den Habitaten des Standarddatenbogens, der zur Ausweisung des Natura 2000 Gebietes Maramurescher Gebirge/Munţii Maramureșului geführt hat nicht aufgelistet. Daher bestand die Notwendigkeit eine umfassende Untersuchung über die im Gebiet des Naturparks Maramurescher Gebirge vorkommenden naürlichen Lebensräume durchzuführen. Ziel der Untersuchung ist es, neue Informationen über Struktur, Verbreitung und Ökologie des Natura 2000 Habitatyps 3230 Montane Flüsse und ihre Gehölzvegetation mit *Myricaria germanica* auf dem Gebiet des Naturparks der Maramurescher Gebirge zu liefern. Die Bedeutung dieses Habitattyps besteht in seiner Fähigkeit Schotterpionierflächen zu besiedeln und neue Biozönosen aufzubauen. Seine Ansiedlung ist allein an natürlichen Gebirgsflüssen mit einer natürlichen Hydro-Morphodynamik gegeben.

REZUMAT: Considerații privind râurile alpine și vegetația lor lemnoasă cu *Myricaria germanica* în Parcul Natural Munții Maramureșului (România).

Habitatul de interes comunitar 3230 Râuri montane și vegetația lor lemnoasă cu *Myricaria germanica* nu face parte dintre habitatele listate în formularul standard pe baza căruia s-a declarat situl Natura 2000 Munții Maramureșului. Scopul acestui studiu este de a oferi noi informații referitoare la structura, distribuția și ecologia habitatului Natura 2000 3230 Râuri montane și vegetația lor lemnoasă cu *Myricaria germanica* în Parcul Natural Munții Maramureșului. Importanța ecologică deosebită a tipului de habitat 3230 se datorează capacității speciei *Myricaria germanica* de a coloniza noi depozite de aluviuni și de a pune bazele unor noi biocenoze, acest lucru fiind posibil doar în cazul morfodinamicii naturale a râurilor de munte, neinfluenţată de activitatea antropică.

INTRODUCTION

European nature conservation policy is based especially on the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora, known as Habitats Directive and on the Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds, known as Birds Directive (***, 1992, 1995, 2007; ***, 2009).

The Habitats Directive and Birds Directive consist of the two pillars around which the European ecological network Natura 2000 was designed. The establishment of this network of Natura 2000 sites also fulfils a Community obligation under the UN Convention on Biological Diversity (***, 1992).

The purpose of the Natura 2000 network is to assure the long-term survival in situ of Europe's most valuable species and habitats. It is comprised of Sites of Community Importance (SCI) adopted as Special Areas of Conservation (SAC) designated by Member States under the Habitats Directive, and also incorporates Special Protection Areas (SPAs) (***, 2014).

Natura 2000 network includes sites selected for conservation of species and natural habitat representative for the Europe's biogeographically regions: Atlantic, Continental, Alpine, Mediterranean, Boreal, Macaronesian, Pannonian, Steppic and the Black Sea region (***, 2014).

Starting from 2007, as part of the European Union, Romania assumed obligations in order to assure the conservation of natural habitats and species, by the process of declaring Natura 2000 Sites. By Governmental Decision 1284/2007 a total of 106 Special Protection Areas were declared in Romania. This Governmental Decision was updated by the Governmental Decision 971/2011 and the number of Special Protection Areas in Romania increased at 149 sites. Also in 2007, by the Order of Ministry of Environment and Sustainable Development a number of 273 Sites of Community Importance were declared. This order was updated in 2011 by the Order of Ministry of Environment and sustainable Development no. 2387 at 408 Sites of Community Importance.

Of the nine biogeographical regions in Europe, five occur in Romania: Alpine, Continental, Pannonian, Steppic (existing only in Romania at UE Level) and Black Sea, (***, 2014).

In Romania, the Habitats and Birds Directive are enforced by the Governmental Emergency Ordinance no. 57/2007 regarding the protected areas regime, conservation of natural habitats and wild flora and fauna, completed and modified by Law 49/2011 and by Governmental Emergency Ordinance no. 31/2014. According to these regulations, 98 habitats of community interest are protected in Romania by SCIs, as part of the Natura 2000 network.

The aim of our study is to offer some new information regarding the structure, distribution and ecology of the Natura 2000 habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica* in Romania, and especially in the Maramureș Mountains Nature Park protected area (Curtean-Bănăduc et al., 2008). The Maramureș Mountains have been declared as a protected area since 2004, by the Governmental Decision 2151/2004 regarding the establishment of new protected areas in Romania. After Romania's attendance to the European Union, about 70% of the territory of the Maramureș Mountains Nature Park is part of the European ecological Network Natura 2000 as the Maramureș Mountains site ROSCI0124. The entire territory of the Natura 2000 site is inside the limits of the nature park and it is administrated by the National Forest Administration (ROMSILVA), the Maramureș Mountains Nature Park Administration, which is why we will consider the study area the territory of the nature park.

The habitat 3230 is one of the 19 Natura 2000 nature habitats that were identified in the area of the Maramureș Mountains Nature Park (Danci, 2011) and this habitat is not included in the standard form of the Natura 2000 site Maramureș Mountains. The diagnostic plant association for the habitat 3230 was cited by Beres M. in 2000 and Schneider E. made reference to this habitat for the territory of the Maramureș Mountains in 2005.

This habitat is a pioneer one and its presence and dynamics are related to the streams and rivers dynamics.

The habitat of mountain rivers and their ligneous vegetation with *Myricaria germanica* is under protection of the Natura 2000 Network and also of the Emerald Network.

In Europe, this habitat includes rivers in the Alps and other high mountains where the banks are dominated by herbaceous plants rather than trees or scrubs. Although typical for the Alpine biogeographical region it is also reported from the Boreal, Continental, Macaronesian and Mediterranean regions (***, 2012).

In Romania, the habitat of mountain rivers and their ligneous vegetation with *Myricaria germanica* is specific for alpine region, as it is defined in the biogeographical regions of Europe. It is important to mention that this habitat is not specific to the alpine storey of vegetation, as they are presented in Vegetation of Romania, but it is an intrazonal type of vegetation in mountain storey of vegetation.

This habitat establishes as a pioneer one, on gravels and sediments in the minor riverbed of the streams in mountain areas where floods are frequent. *Myricaria germanica,* the diagnostic species for the habitat 3230 is a pioneer shrub that requires natural river dynamics and, due to river corrections leading to the destruction of its habitat, the species is extinct in many rivers of Romania. The presence of this habitat may be an indicator of natural dynamics of water courses. Once established, this habitat sets up the proper conditions for the installation of some tree species that fix river banks, and so it creates the conditions for biocoenoses to establish and survive close to the rivers and also create ecological corridors.

German tamarisk or false tamarisk, *Myricaria germanica* L. (Desv.), a representative species of family Tamaricaceae in the Romanian flora (Sârbu, 2013), is known in vernacular Romanian as “cătină mică”, “prundar”, “râureancă”, “zdrohiș” (Drăgulescu, 2013). It is distributed in Europe and South-West Asia.

Myricaria germanica is a deciduous shrub 0.6-2.5 m in height, sparsely distributed from the hills to the spruce forest zone, on river gravels and sandy alluvia. It presents twigs erect, brown reddish. The leaves are small, three to five mm, linear-lanceolate, grayish-green, obtuse, sessile and imbricate. The bracts are longer than flowers. The flowers are pink to white, grouped in terminal spikes; calyx and corolla five-lobed, anthers 10, the ovary with sessile stigmas (Clinovschi, 2005). The inflorescence is presented in figure 1. The fruit is a pyramidal capsule, as can be seen in figure 2. The seeds are small, with a pappus of hairs, as seen in figure 3. It flowers from June to August and disperses by the air-borne seeds.

Myricaria germanica (Fig. 4), is demanding of good conditions of both light and soil moisture (Sârbu, 2013). It is a native species and is cultivated in gardens too for ornament and also for medicinal purposes (Mahmoud, 2013). The dense root system of the shrubs firmly anchors them in the substrate and thus reduces soil erosion. Flexible branches exhibit only minimal resistance to floodwaters and thus prevent the plants from being dislodged. Since natural river dynamics continuously alter the sites the plants rarely reach more than 15-20 years of age. Damaged and buried plants show a high ability to regenerate, an important adaptation to repeatedly shifting gravel banks (Kudrnovsky, 2013).

Figure 1: Inflorescence of *Myricaria germanica* (photo Manci C.).

Figure 2: Fruits of *Myricaria germanica* (photo Manci C.).

Figure 3: *Myricaria germanica* seed dissemination (photo Manci C.).

Figure 4: Aspect of the leaves of *Myricaria germanica* (photo Manci C.).

MATERIAL AND METHODS

Due to the fact that the habitat 3230 Mountain rivers and its vegetation with *Myricaria germanica* was found on the study area and it is not found on the Natura 2000 standard data form of the Maramureș Mountains ROSCI0124, an analysis of the available data on this habitat within the study area and also at national level was required. Also a comparison between data at the Romanian national level from different sources was a necessity.

After the study area was defined at the limits of Maramureș Mountains Nature Park, all the permanent water courses in the area were covered in order to identify the presence of the habitat 3230 in the field. The main diagnostic species of the habitat is *Myricaria germanica*, so the identification of the habitat in the field was easy. All the fragments of the habitat were analyzed regarding structure and geographical position; coordinates were registered for all the sites. Collection of the data from the field was made in 2011. For the data collection we used data collection sheets and GPS receptor Garmin Dakota 10. Data interpretation was made in the office using Quantum GIS.

An assessment of the pressures and anthropic impact was made using the data collected on the field. Also a set of minimum management measures and recommendations was made.

The previous presented materials and methods facilitated us to reach the aim of this study, to offer new data regarding the chorology of habitat 3230 in Romania and especially in Maramureș Mountains Nature Park.

Maramureş Mountains represent the highest mountainous massif located on the Romanian national border, the convergence point of several ethnographic regions (Romanian Maramureş, Zacarpatia, Southern and Northern Bucovina, Galiţia). Maramureş Mountains are located in the Northern part of the Oriental Carpathians, and they border upon Ţibău Mountains in the East, upon Rodnei Mountains and Maramureş Depression in the South, and upon Rahiv and Cernahora Mountains (Ukraine) in the North (***, 2008).

The entire surface of the massif (including the depression and marginal hills areas) is 1,500 km^2. The area subjected to this study is represented by the territory of the Maramureş Mountains Nature Park (MMNP; Fig. 5), with the limits stipulated by GD 2151/2004. These limits comprise a 133,354 ha surface.

The morphological fragmentation of the massif is a peculiarity of Maramureş Mountains, as the hydrographical network determines the separation and fragmentation of massif's high areas. There are two classes of fragmentation depth that prevail within Maramureş Mountains: 300-450 m and 150-300 m. The highest values are found in metamorphic rocks and in the Toroiaga Massif on volcanic rocks (Curtean-Bănăduc et al., 2008). Over 60% of the surface of Maramureş Mountains has fragmentation depth ranging between one and three km/km^2 (Mureşan, 2008).

The hydrographical network is highly developed, providing abundant, permanent water runoff during the entire year. The Maramureş Mountains include three drainage basins: Vişeu (Tisa), Bistriţa (Siret) and Ceremuş (Prut). The surface of the region belonging to the Vişeu drainage basin is 1,023 km^2, that of the region drained by Bistriţa tributaries is 168 km^2 and that of the Ceremuş drainage basin is 25 km^2. The average runoff value specific to Maramureş Mountains is 8.41 $l/s/km^2$, lower than in Oaş, Gutâi and Ţibleş mountains, located to the West first in front of the oceanic air masses. (Mureşan, 2008)

The river dynamics have been influenced by the historical floods in the study area. According to the Administration of the Basin of the Someș-Tisa rivers, historical floods, with a probability of one to five percent, took place in 1970, 2001 and most recently in 2008. The floods affected mostly the basins of the Vișeu, Vaser, Ruscova and Repedea rivers (***, 2013). Certainly the floods mentioned by the Administration of water basin Someș-Tisa had a great negative impact on the distribution and structure of the habitat 3230 Mountain rivers and their vegetation with *Myricaria germanica* in Maramureș Mountains Nature Park, especially the floods along the Vaser River that destroyed the riverbanks and the narrow-guage railway line along the river, except the places where the riverbanks were fixed by forest vegetation from the habitat type 91E0* Alluvial forest with *Alnus glutinosa* and *Fraxinus excelsior*. Once again it is proved that the best solution for riverbank stabilization is by using the vegetation instead of concrete.

The Maramureş Mountains are located in the continental moderate climate area, permanently subjected to the influence of Western oceanic air masses advection, whose characteristics reflect into the evolution of all climatic elements (Moldovan, 2000). The month with the lowest average temperatures is January, with values between -6°C and -10°C. July has average values between 8°C and 12°C. The presented values result in annual average amplitude of 22-24°C, the moderate value highlighting the continental moderate temperate climate nature with significant thermal extreme values between summer and winter (***, 2008).

Summer is the rainiest season, when 61% of total rainfall is registered. The poorest rainfall season is winter, with only 17% of the total rainfall. The annual number of rainfall days is 150-170. The snow layer occurs in September and the last snow may be recorded as the average data in the last decade of March. The snow layer is maintained between 120 and 200 days, and the layer thickness ranges from 75 to 150 cm (***, 2008).

From the large soil groups, significant surfaces are covered by districambosoil, prepodzolic soils, litosoils, humisoils and alluvial soils. (Curtean-Bănăduc et al., 2008)

Two towns (Borşa and Vişeu de Sus) and eight communes (Moisei, Vişeu de Jos, Ruscova, Repedea, Poienile de Sub Munte, Leordina, Petrova and Bistra with their villages Valea Vişeului and Crasna Vişeului) are included within the MMNP. These have developed along the courses of the Vişeu, Repedea, Ruscova and Tisa rivers. (Curtean-Bănăduc et al., 2008)

The population of the 10 localities in the MMNP is approximately 90,000 inhabitants, of which 62,000 are Romanian, 25,000 Ukrainian and 1,774 German, as this is the location of the largest Ukrainian community in Romania and the largest settlement with a majority Ukrainian population, Poienile de Sub Munte (10,170 inhabitants) (***, 2008).

The evolution of the landscape is closely connected to the traditional occupations. Therefore, logging, cattle farming and mining have affected the landscape and implicitly the natural framework over time. The pre-Christian customs related to nature worship, old and new religious holy days, agricultural customs and traditions related to the human life cycle harmoniously combine in the communities of the MMNP (Danci, 2011).

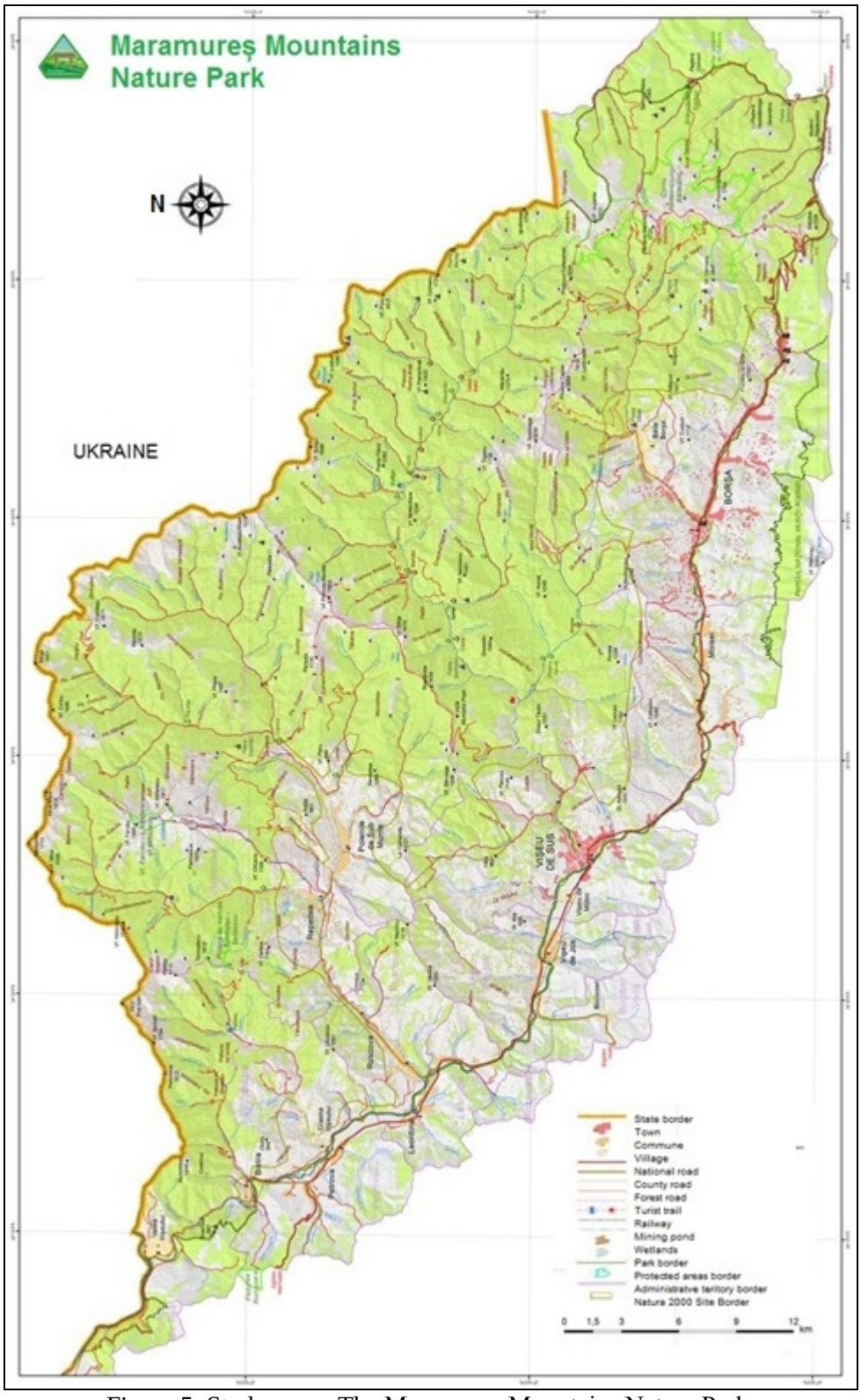

Figure 5: Study area - The Maramureș Mountains Nature Park.

RESULTS AND DISCUSSION

Doniță et al. (2005) present the habitat 3230 Mountain rivers and their specific ligneous vegetation with *Myricaria germanica* without offering details: Eastern and Western Carpathians, Moldavian Subcarpathians, in the distribution area of durmast oak and beech. We can observe that the study area is included in the very generally distributions details provided.

Gafta and Mountford (2008), give the information that the habitat 3230 exists in 18 Natura 2000 sites, without providing a list of them.

Starting from 2011, the number of Natura 2000 sites in Romania increased at 408 sites. We analyzed the standard forms of these sites in order to identify the presence of the habitat 3230, the surface and the conservation status. The results of the analysis we made are presented in table 1 and are based on the Order of Ministry of Environment and Sustainable Development no. 2387/2011.

Table 1: List of SCIs in Romanian territory that include in the standard form the specific habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica*.

No. crt.	Name of Natura 2000 Site	Code	Surface (ha)	% of the habitat	Surface of the habitat	Conservation status
1.	Apuseni	ROSCI0002	75943	0.01	7.5943	B
2.	Bucegi	ROSCI0013	38787	0.1	38.787	D
3.	Cheile Bicazului - Hășmaș	ROSCI0027	7642	0.5	38.21	B
4.	Ciucaș	ROSCI0038	21864	1	218.64	A
5.	Cozia	ROSCI0046	16760	1	167.6	B
6.	Creasta Nemirei	ROSCI0047	3509	1	35.09	B
7.	Defileul Jiului	ROSCI0063	10946	1	109.46	A
8.	Munții Făgăraș	ROSCI0122	198618	1	1986.18	B
9.	Munții Rodnei	ROSCI0125	48062	1	480.62	C
10.	Nordul Gorjului de Est	ROSCI0128	49160	1	491.6	B
11.	Nordul Gorjului de Vest	ROSCI0129	86958	0.5	434.79	B
12.	Parâng	ROSCI0188	30434	1	304.34	B
13.	Penteleu	ROSCI0190	11268	0.003	0.33804	D
14.	Piatra Craiului	ROSCI0194	15867	1	158.67	B
15.	Putna - Vrancea	ROSCI0208	38213	3	1146.39	B
16.	Retezat	ROSCI0217	43561	1	435.61	B
17.	Siriu	ROSCI0229	6230	0.01	0.623	D
18.	Slănic	ROSCI0230	1408	1	14.08	B
19.	Valea Iadei	ROSCI0262	2946	0.1	2.946	B
20.	Vânători Neamț	ROSCI0270	30206	0.01	3.0206	D
21.	Munții Ciucului	ROSCI0323	59641	0.1	59.641	B
22.	Râul Suceava	ROSCI0379	881	1	8.81	C

According to this analysis, the number of sites of community importance containing the habitat 3230 in Romania increased from 18 in 2007 to 22 in 2008, but Marmamureș Mountains ROSCI0124 is still not included in the reviewed standard forms. Table 1 also presents the surface of the identified sites and the percentage assumed to be covered by the habitat 3230 inside them. The total surface, resulted by this method, covered by the habitat of mountain rivers and their vegetation whit *Myricaria germanica* in Romania is 6,143 ha. All the sites identified are situated in the alpine or in both alpine and continental biogeographical regions of Europe. Their distribution at national level is especially in the Carpathian Mountains arch and it is presented in figure 6.

Assessments on the conservation status of the habitat types and species of Community interest have been carried out in EU 25 for the period 2001-2006 and in EU 27 for the period 2007-2012, compiled as part of the Habitats Directive - Article 17 reporting process. The data summary sheet for species conservation status provides an overview on biogeographical region. This information presented in the data sheet of the habitats is provided for each country by the authority responsible for nature conservation and environment. For Romania, the reports were made by the Ministry of Environment. The surface reported for the habitat 3,230 is 5,600 ha (2007-2012) and the surface range to 13,900 ha, for the period 2001-2012 and the method used for providing this surfaces is based on partial data with some extrapolation and/or modeling. According to this report the global conservation status is favorable. This conservation status and also the surface range are not the same presented in the standard form based on which the Natura 2000 sites were designated in Romania. The trend regarding the evolution of the surface in the short term is assessed to be stable.

All these differences regarding surface range, different global conservation status, lack of some habitats from the Natura 2000 standard forms are problems that should be solved as soon as possible as far as the standard forms represent the only legal documents regarding the Natura 2000 sites, until the approval of their management plans.

The report also identifies the following pressures and threats: E03.01 - disposal of household/recreational facility waste, K01.01 - Erosion, C01.01.01 - sand and gravel quarries.

For the Maramureș Mountains, the situation is presented in the standard form different from the reality. The list of identified habitats in the field (Danci, 2011) is presented (Tab. 2).

There are major differences between the standard form and the data in the field. The most important habitats, considering conservative value and surface, are listed below. Priority habitats: 91D0* Wooded peateries, 91E0* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae) and 9180* Slope, detritus or ravines forests composed of Tilio-Acerion are missing from the standard form.

The habitat 9410 Forests with *Picea* from the alpine - mountain regions is also missing from the data form. This habitat is one of the most representative habitats in Maramureș Mountains Nature Park and it covers 30,442 ha, 30% of the surface of the Natura 2000 site Maramureș Mountains. The life of the communities in the park area is directly related to this habitat and to the culture of wood which defines the land of Maramureș and the traditional landscape. Due to the problems mentioned, the necessity of appropriate field studies becomes more obvious. The aim of this study is to clarify for the surface of the Maramureș Mountains Nature Park the distribution and structure of this very sensitive habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica.* This need became important because of the ecological role of the habitat as a pioneer in sands and gravel colonization, in order to assure proper conditions for settlement of new biocenoses.

Table 2: List of identified habitats (Danci, 2011).

No.	Natura 2000 code	Type of Natura 2000 habitat
1.	3230	Mountain rivers and their wood vegetation with *Myricaria germanica*
2.	4060	Alpine and boreal pastures
3.	4070*	Shrubs with *Pinus mugo* and *Rhododendron hirsutum* (Mugo-Rhododendretum hirsuti) in the Carpathians *Rhodendron hirsutum* being replaced by *Rhododendron myrtifolium*
4.	6230*	*Nardus* rich grasslands in terms of species, on the siliceous substrata of mountainous areas
5.	6430	Woodside associations with tall hygrophyle grass from the level of plains to the mountainous and alpine level
6.	6520	Mountain grasslands
7.	7140	Transition peat swamps and moving peatlands (not fixed in the substrata)
8.	7220*	Petrifying springs with travertine formation (Cratoneurion)
9.	8210	Rocky slopes with chasmophytic vegetation
10.	9110	Luzulo-Fagetum type forests
11.	9130	Asperulo-Fagetum type forests
12.	9150	Cephalanthero-Fagion type medio-European forests
13.	9170	Oak forest with Galio-Carpinetum
14.	9180*	Slope, detritus or ravines forests composed of Tilio-Acerion
15.	91D0*	Wooded peatlands
16.	91E0*	Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae and Salicion albae)
17.	91V0	Dacic beech (Symphyto-Fagion) forests
18.	91Y0	Dacic oak and hornbeam forests
19.	9410	Forests with *Picea* from the alpine - mountainous region

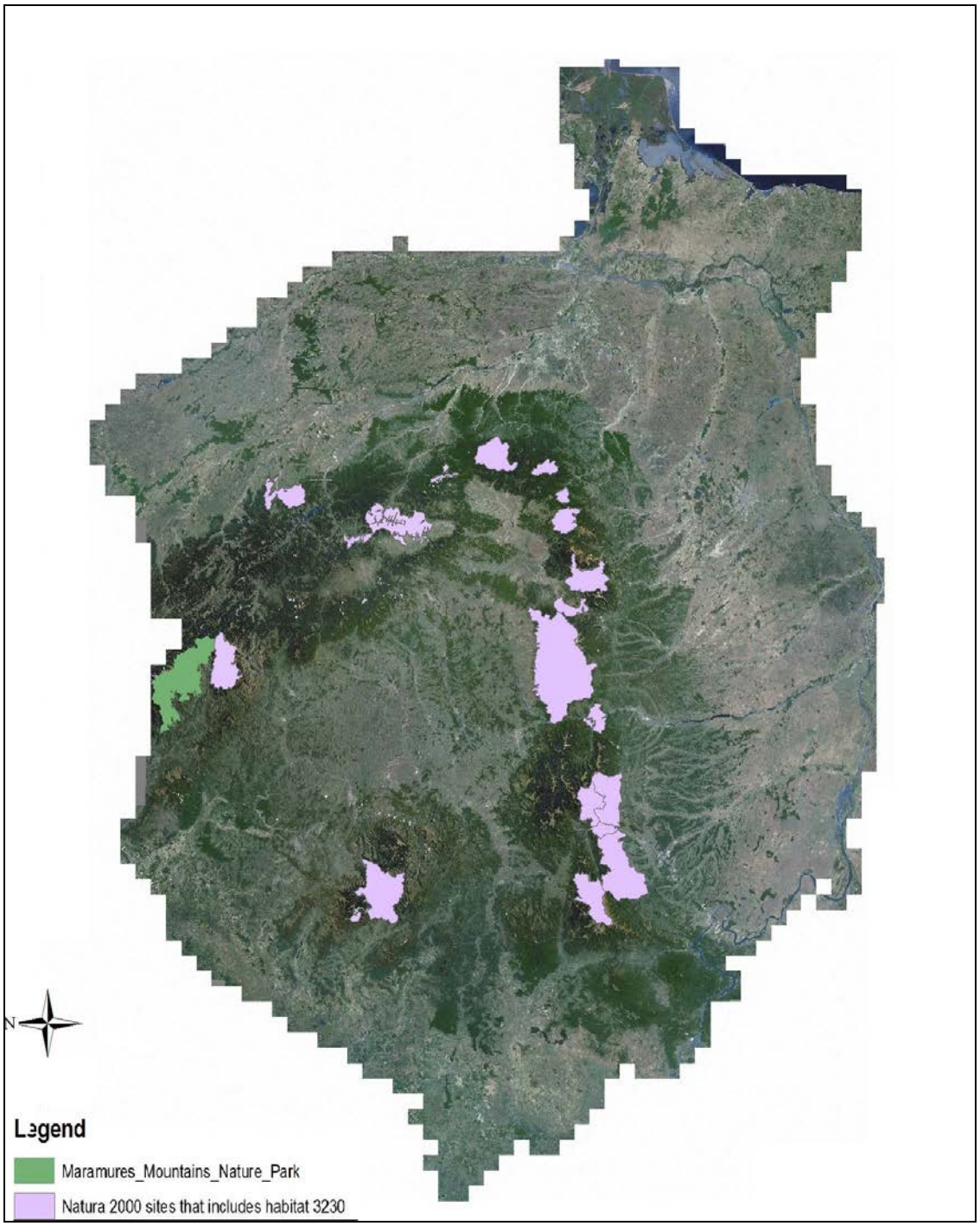

Figure 6: Distribution map of Natura 2000 sites that includes Habitat 3230 in Romania.

In order to realize the chorology of the habitat 3230 in Maramureș Mountains Nature Park and Natura 2000 site, all the permanent water courses were covered. The habitat of mountain rivers with *Myricaria germanica* was identified in the study area in the major streambed of the confluents of the Ruscova River, Rica River, Socolău River and Repedea River. The habitat is more often found on the Socolău and Repedea rivers than on the Rica River. Along the alluviums in the riverbed of Rica River more frequent is the habitat 91E0* Alluvial forests with *Alnus glutionsa* and *Fraxinus excelsior*, type R4401 *Alnus glutinosa* and *Telekia speciosa.* The essential difference between the two tributaries of Ruscova, Rica and Socolău rivers, is the different anthropic impact generated by the constructions aimed to reduce the frequency and the impact of floods. These constructions modified the water regime and also the succession of the phytocenoses in the streambed. While the Rica River is more natural, the Socolău River has been affected by concrete riverbanks consolidations.

The distribution area of the habitat 3230 Mountain rivers and their vegetation with *Myricaria germanica* was also disturbed by the floods in 2001 and in 2008.

The distribution map of the habitat is presented in figure number 8. The surface identified in the field in 2011 is about 10 ha. In order to make it visible on the map, figure 8 presents only the North East part of the study area. The aspects of the habitat in the study are presented in figures number 7, 9 and 10.

Figure 7: *Myricaria germanica* in the Maramureș Mountains Natura 2000 site.

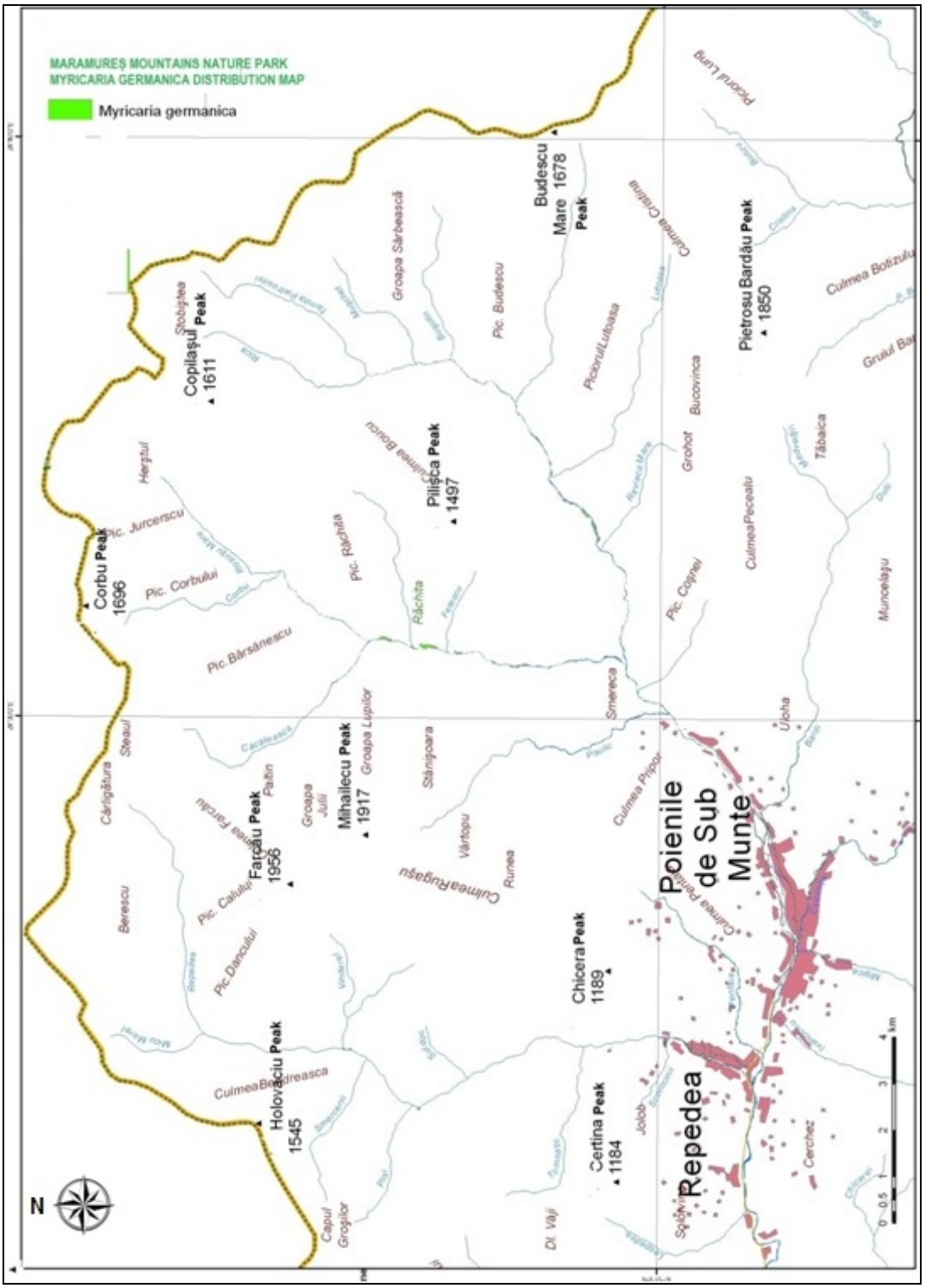

Figure 8: Distribution map of *Myricaria germanica* in North East of the Maramureș Mountains.

Figure 9: *Myricaria germanica* mature habitat on the Socolău River.

Figure 10: *Myricaria germanica* after floods in 2008.

Description of the habitat

NATURA 2000: 3230 Alpine rivers and their ligneous vegetation with *Myricaria germanica* Romanian habitats: R4415 Dacic shrubs of tamarisk (*Myricaria germanica*).
EMERALD: !44. Riparian willow formations.
CORINE: 44.111 Willow-tamarisk bush.
PAL.HAB 1999: 44.111 Pre-Alpine willow tamarisk scrub.
EUNIS: F9.111 Pre-Alpine willow-tamarisk scrub.

Chorology in MMNP: Socolău, Rica and Repedea rivers.

Surface: 10 hectares.

Plant associations: Salici purpureae-Myricarietum Moor 1958 (Syn.: Myricario-Epilobietum Ardelean 1981 non Aichinger).

Structure: A pioneer plant association, identified by mezotherm, mezo-hygrophyllic and hydrophilic species. The herbs may also have eutrophic preferences after the floods. The shrub layer is dominated by *Myricaria germanica*, in different proportions together with *Salix purpurea, Alnus incana, Fagus sylvatica.* The coverage of this layer is 40-70%, the height is between 0.5 m and 2.5 m. The herb layer has very active dynamics, and is frequently damaged by floods. The coverage is 20-50%, depending on the time since the last water flows. *Agrostis stolonifera, Festuca pratensis* and *Dactylis glomerata* are the most frequent gramineous species. The height of the gramineous layer is about 0.5 m. Other frequent species are *Trifolium pratense, Lysimachia nummularia, Lycopus europaeus, Tussilago farfara, Aegopodium podagraria, Glechoma hederacea* and *Ranunculus repens* (Doniță et al., 2005, 2006).

Conservative value: high, habitat protected by Emerald network.

Plant composition

Edifying species: *Myricaria germanica.*

Characteristic species: *Salix purpurea, Myricaria germanica, Salix fragilis, Cirsium oleraceum.*

Other important species: *Lysimachia nummularia, Mentha longifolia, Calamagrostis pseudophragmites, Humulus lupulus, Saponaria officinalis, Salix elaeagnos, Calystegia sepium, Alnus incana, Fagus sylvatica, Agrostis stolonifera, Festuca pratensis, Dactylis glomerata, Trifolium pratense, Lycopus europaeus, Tussilago farfara, Aegopodium podagraria, Glechoma hederacea,* and *Ranunculus repens*.

Fauna: The structure of the gravel banks and the colonizing pioneer species *Myricaria germanica, Salix purpurea* and *Epilobium dodonaei* constitutes the typical habitat for two bird species *Actitis hypoleucos*/Common Sandpiper and *Charadrius dubius*/Little Ringed Plover. Also *Myricaria germanica* is the food plant for the phytophagous and oligophagous insects *Coniatus splendidus* (Curculionidae) and *Tuponia prasina* (Myridae/Heteroptera). In the distribution area of *Myricaria germanica* these are monophagous, living only on this species. If *Myricaria germanica* disappears in the Carpathian area, the above-mentioned insect species will disappear as well (***, 2013).

Human impact:

C01.01. sand and gravel extraction;
D01.01. paths, tracks, cycling tracks, includes non-paved forest roads;
I01 invasive non-native species;
J02.05.02 modifying structures of inland water courses;
J02.06.06 surface water abstractions by hydro-energy;
K01.01 erosion;
L08 inundation (natural processes);
River bank consolidation and loss of hydro-morphodynamics.

Management measures

The habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica* is not listed in the standard form of the site ROSCI0124 Maramureș Mountains and the first measure necessary for the appropriate management of the habitat is to review the standard form of the site.

Due to the high sensitivity of this habitat to the dynamics of the water course, it is important to keep the river dynamics close to the natural state. Activities such as construction of hydro power plants, sand and gravel extraction, construction of concrete dams and gabion wall, and modernization of forest roads are recommended to be avoided.

Another important measure is related to the forest management. All the bare surfaces that in the past were covered by forest should be re-afforestated in order to limit and prevent the inundation process that is frequent in the area and it has a big impact on the habitat 3230 structure and surface.

Invasive non-native species are present in the Maramureș Mountains Nature Park in aquatic or riparian ecosystems (Dumitrașcu et al., 2014). *Impatiens glandulifera* and *Fallopia japonica* (*Polygonum cuspidatum*) are also species that may occupy the same habitat as *Myricaria germanica*, sandy soils and alluvium. For this reason it is very important to limit the spread of those species upstream on the Rica, Socolău and Repedea rivers, from the riverbanks of the Ruscova and Vișeu riverbanks. Mostly these invasive species are on finer-sized sediments and only accidentally present in a habitat such as that of *Myricaria germanica*.

Long term information and education of local communities related to the importance of the habitat 3230 in riverbanks stabilization, regarding the ecological role in some insect life and regarding natural succession of vegetation related to dynamics of the rivers is needed.

This habitat has a rapid evolution related to the water course dynamics, so periodic monitoring of the evolution of this habitat should be one of the priorities for the Maramureș Mountains Nature Park Administration.

CONCLUSIONS

This paper analyzes the European and national context of nature conservation of habitats listed in the Habitats Directive for which Natura 2000 sites of community interest were declared, focused on the habitat 3230.

The habitat 3230 Mountain rivers and their ligneous vegetation with *Myricaria germanica* was found to be present in Romania in 22 sites of community importance situated in the alpine and both alpine and continental biogeographical regions of Europe, according to analyze of Natura 2000 standard data forms.

Supplementary from the 22 sites, the habitat was identified in the site of community importance ROSCI0124 Maramureș Mountains. The distribution map of the habitat 3230, the description of its structure and the human impact for this habitat were presented.

In order to assure the appropriate management of the habitat, a set of management measures was elaborated. These measures refer to economical activities, invasive non-native species limitation, monitoring of the habitat and public awareness.

The evolution of the habitat is rapid and dependent on the water dynamics, and the researches in the field should keep in line with it.

Collaboration between all stakeholders in area is the key of successful management of valuable biocenoses for the protection of which the Maramureș Mountains Nature Park, ROSCI0124 Maramureș Mountains and ROSPA0131 Maramureș Mountains were stated.

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THE AQUATIC AND MARSHY FLORA OF THE LOTRU RIVER BASIN (SOUTHERN CARPATHIANS, ROMANIA)

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ABSTRACT

The present paper continues the series of floristic inventories of the main Romanian rivers in the Carpathian Mountains (from which have been published those of Mureş, Sadu, Olt, Someş, Criş, Târnave, Tisa). In this work the author lists 204 plant taxa (hydrophilic, meso-hygrophilic and hygrophilic) identified by the author or by other botanists in the Lotru Valley basin. Noted for each species were life form, floral element, ecological preferences for humidity (U), temperature (T), soil reaction (R), corology and coenology. Bibliographical sources are coded with numbers (see the references at the end of the paper). The sign "!" indicates that the author has seen the plant in that locality.

ZUSAMMENFASSUNG: Die Flora der Gewässer und Sumpfgebiete im Einzugsgebiet des Lotru-Flusses (Südkarpaten, Rumänien).

Mit vorliegender Arbeit wird die floristische Erfassung an den wichtigsten Flüssen im Inneren des Karpatenbogens fortgesetzt, nachdem davor bereits die floristische Erfassung der Flussgebiete des Mureş/Mieresch, Sadu/Zoodt, Olt/Alt, Someș/Somesch, der drei Criș/Kreisch-Flüsse, der beiden Târnava/Kokel-Flüsse und der Tisa/Theiß veröffentlicht wurde. Der Verfasser zählt 204 Taxa hydrophiler, hygrophiler und meso-hygrophiler Pflanzen auf, die von ihm oder anderen Botanikern im Einzugsgebiet des Lotru-Flusses festgestellt wurden. Für jede Art wird Lebensform, floristisches Element, ökologische Ansprüche gegenüber Feuchtigkeit (U), Temperatur (T) und Bodenreaktion sowie Zönologie und Chorologie angegeben. Die Literaturquellen sind mit Hilfe eines Zifferncodes (siehe Literaturverzeichnis am Schluss der Arbeit) vermerkt. Das Ausrufezeichen „!" weist darauf hin, dass der Verfasser die Art an dem betreffenden Ort selbst festgestellt hat.

REZUMAT: Flora acvatică şi palustră din bazinul Lotrului (Carpații Meridionali, România).

Lucrarea continuă seria inventarelor floristice ale principalelor râuri din interiorul arcului carpatic românesc (din care au fost publicate cele ale Mureşului, Sadului, Oltului, Someşelor, Crişurilor, Târnavelor, Tisei). În prezenta lucrare autorul enumeră 204 taxoni vegetali hidrofili, higrofili şi mezo-higrofili identificaţi de el sau de alţi botanişti în bazinul văii Lotrului. La fiecare specie au fost notate bioforma, elementul floristic, preferinţele ecologice faţă de umiditate (U), temperatură (T) şi reacţia solului (R), cenologia şi corologia. Sursele bibliografice sunt codificate cu cifre (a se vedea bibliografia de la sfârşitul lucrării). Semnul „!" indică faptul că autorul a văzut planta în locul respectiv.

INTRODUCTION

This paper continues a series of floristic inventories of the main Romanian rivers in the Carpathian Mountains, like the followings: Mureş (Drăgulescu, 1995a), Sadu (Drăgulescu, 1995b), Criş (Drăgulescu and Macalik, 1997), Olt (Drăgulescu, 1999), Someş (Drăgulescu and Macalik, 1999), Tisa (Drăgulescu et al., 1999), Târnave (Drăgulescu, 2005).

The right side Lotru River tributary of the Olt River has a length of 76.6 km and a basin of 1,024 km^2, and is situated in the core of Meridional Carpathians. Its direction of flow is East-West, separating the crystalline schists of the Lotrului Mountains (to the North) from the Parângului and Căpăţânii mountains (to the South). The climate is mountainous with an average air temperature of 5°C and 900 mm precipitation per year (Ploaie, 1983).

The first data on the Lotru flora were recorded during the second half of the 19th century, provided by the botanists Fuss (1853, 1866), Schur (1866), Brândză (1879-1883) and Grecescu (1898). During the 20th century (particularly the second half of this century) the Lotru flora was intensively studied by Ştefureac and colleagues (1955, 1959, 1962, 1969), Pócs (1957, 1961, 1962, 1963, 1967), Buia and colleagues (1943, 1962, 1963), Ciurchea (1962, 1963), Ploaie and colleagues (1983, 1987, 1999, 2004), Drăgulescu (1995) and more recently by Boruz (2004, 2006, 2007, 2008).

The Lotru Basin wetlands comprise the springs, streams, Lotru River, swamps, natural lakes (glacial lakes), dam lakes and ponds. The main areas where these can be found are in the Latoriţa Valley, Voineşiţa Valley, Jidoaia Valley, Mânăileasa Valley, Păscoaia Valley, Repedea Valley, Stan's Valley, Măceşului Valley, Obârşia Lotrului, Latoriţei Lake, Câlcescu Lake, Vidra Lake, Mălaia Lake, Brădişor Lake, Galbenu Lake, Petrimanu Lake, Balindru Lake and Jidoaia Lake.

MATERIALS AND METHODS

The paper is based on the references (Grecescu, 1909; Fekete and Blattny, 1913; Nyárády, 1955; Oprea, 2005), on herbarium material (Annex 1) and on personal research in the field over the period 1969-2012. The taxonomic data (taxon names, family order) are taken from Săvulescu (1952-1996) with the updates made by Ciocârlan (2000), and the biological (plant bio-forms), phytogeographical (floristic elements), ecological (U, T and R values) and phytocoenological (coenotaxa) data from Sanda et al. (2003). The species chorology is presented in accordance with personal field observations and notes (where the sign "!" is used in the text) or based on the information of other authors (where a figure appears this is the code of the paper listed in the paper references).

RESULTS AND DISCUSSION

In total, in the Lotru catchment area 204 vegetal taxa were identified that are either hydrophilous, hygrophilous or meso-hygrophylous. These taxa belong to 170 species, eight subspecies, nine varieties, ten forms and seven hybrids. For each species were recorded the bio-form, the floristic element, the ecological preferences concerning humidity (U), temperature (T) and soil pH (R), coenology and chorology. The bibliographical sources are encoded in figures (see the references). Most of the species are micro-mesothermal and microthermal, euro-ionic and feebly acido-neutrophyle, of Eurasian and circumpolar origin.

Among rare and endangered species are: *Thelypteris palustris, Trollius europaeus, Angelica archangelica, Myricaria germanica, Salix aurita, Salix bicolor, Salix daphnoides, Oxycoccus palustris, Empetrum nigrum, Menyanthes trifoliata, Carex brunescens, Carex lepidocarpa, Carex magellanica* ssp. *irrigua, Carex pauciflora,* etc. The species *Tozzia alpina* ssp. *carpatica* is included in the Habitats Directive 92/43/CEE concerning conservation of natural habitats and of wild flora and fauna.

Flora

Lycopodiaceae

Lycopodium inundatum L. (Lycopodiella inundata L.) Holub.: Ch, Cp; U5T2, 5R1, Vaccinio-Piceetea, Oxyccoco-Sphagnetea, Scheuchzerio-Caricetea nigrae: Clăbucet Peak (69), Sterpu Peak (69);

Equisetaceae

Equisetum fluviatile L.: (E. limosum L.): Hh, Cp; U5T3R0, Magnocaricion elatae, Phragmitetea: Obârşia Lotrului (57, !), Mânăileasa Valley (!);

Equisetum hyemale L.: G, Cp; U3.5T2.5R4, Alno-Padion: Latoriţei Gorge (!), Păscoaia Valley (!);

Equisetum palustre L.: G, Cp; U5T2R0, Molinietalia: Groapa Seacă (19), Vidra Lake (!), Obârşia Lotrului 1,430 m (4), Lotru Valley 1,300-1,350 m (4, !), Mânăileasa Valley (!), Voineasa (!); f. *fallax* Milde: Mânăileasa Valley (!); var. *simplicissimum* A. Br.: Obârşia Lotrului-Vidra Lake (!), Mânăileasa Valley (!);

Equisetum sylvaticum L.: G, Cp; U3.5T2R0, Alno-Padion, Alnion glutinosae-incanae: Vidra Lake (!), Obârşia Lotrului 1,430 m (4, 57, !), Lotru Valley 1,250-1,350 m (4), Malaia Valley 1,100 m (4);

Equisetum telmateia Ehrh. (E. maximum Lam.): G, Cp; U3.5T2R0, Alno-Padion, Eriophorion latifolii, Filipendulo-Petasition: Brezoi (!), Curmătura Vidruţei (!), Mânăileasa Valley (!);

Athyriaceae

Matteuccia struthiopteris (L.) Todaro (Struthiopteris filicastrum All.): H, Cp; U4T2R0, Alno-Padion: Brezoi (!), Latoriţei Gorge (!), Ciungetu (!), Coasta lui Rusu 1,850 m (4), Malaia (47, HBZ, !), Săliştea (!), Stan's Valley (!), Măceşului Valley (!), Mânăileasa Valley (!), Păscoiaia Valley (!), Repedea Valley (!), Voineasa (!);

Aspidiaceae

Dryopteris cristata (L.) A. Gray: H, Cp; U4T2R3, Scheuchzerio-Caricetalia nigrae: Bucureasa Mare Valley (7), Voineasa (42);

Thelypteridaceae

Thelypteris palustris Schott (Dryopteris thelypteris (L.) A. Gray): Hh-G, Cp; U4T0R3, Alnion glutinosae, Alno-Padion, Magnocaricion elatae: Vidra, 1,300 m (4, 37);

Ranunculaceae

Caltha palustris L.: H, Cp; U4.5T0R0, Calthion palustris, Cardamini-Montion, Molinietalia: Câlcescu (2), Coasta lui Rusu 1,700 m (4), Groapa Dengherului (12), Iezeru (2), Mohoru (2), Muntinu Mare (2), Obârşia Lotrului, 1,430 m (4, 57, !), Ştefanu (2), Lotru Valley, 1,220-1,350 m (4), Malaia Valley, 1,000-1,100 m (4, !), Vidra (!), Ştefleşti Peak (!), Voineasa (!), Zănoguţa (2); var. *alpina* (Schur) Graebn.: Câlcescu Lake (4, 10, 14, 59), Urdele (10);

Ranunculus flammula L.: H, Eua; U4.5T3R0, Agrostion stoloniferae, Caricion canescenti-nigrae, Magnocaricion elatae: Groapa Seacă to Obârşia Lotrului (19), Lotru Valley, 1,300-1,350 m (4);

Ranunculus repens L.: H, Eua; U4T0R0, Agropyro-Rumicion, Alno-Padion, Bidentetalia tripartiti, Calystegion, Molinio-Arrhenatheretea, Phragmitetea, Plantaginetea majoris, Salicetea purpureae: Brezoi (!), Căldarea Coasta lui Rusu 1,850 m (4), Ciobanu, 1,550-1,600 m (4), Ciungetu (!), Corbu (!), Golotreni (!), Groapa Seacă (19), Vidra Lake (!), Lotru (!),

Malaia (!), Obârşia Lotrului (57, !), Păscoaia (!), Rudaru (Zăvoiul lui Badac) (56), Sălişţea (!), Latoriţa Valley (!), Stan's Valley (!), Măceşului Valley (!), Lotru Valley, 1,250-1,500 m (4, !), Mânăileasa Valley (!), Pravăţu Valley (!), Vasilatu (!), Vidra, 1,250 m (4, 27, !), Voineasa (27, !), Voineşiţa Valley (!), Voineasa-Obârşia Lotrului (57);

Ranunculus sardous Cr.: Th-TH, Eua; U3,5T3R4, Agropyro-Rumicion, Agrostion stoloniferae, Nanocyperion flavescentis: Lotrului Valley, 510 m (7), Muşătoiu (11);

Thalictrum aquilegifolium L.: H, E; U3.5T2.5R4, Adenostylion alliariae, Alno-Padion, Filipendulo-Petasition: Brezoi (!), Gura Lotrului (!), Jidoaia Valley (!), Voineşiţa Valley (!), Vidra (4, 27), Voineasa (27);

Thalictrum lucidum L.: H, Ec; U4.5T3R5, Alnetea glutinosae, Alno-Padion, Filipendulo-Petasition, Molinietalia, Salicetea purpureae: Brezoi (44, !); var. *heterophyllum* (Wimm. and Grab.) Hay.: Brezoi (!); f. *peucedanifolium* (Gris. and Sch.) A. Nyar.: Golotreni (!);

Trollius europaeus L. ssp. ***europaeus***: H, E; U4T2R4, Calthion palustris, Molinietalia: Balţuri (6), Dobrunu (6), Găurile (10), Mohorul (10), Voineasa (!), Zănoguţa (10);

Betulaceae

Alnus glutinosa (L.) Gaerter: Mph-mPh, Eua; U5T3R3, Alnion glutinosae, Alno-Padion: Brezoi (!), Ciungetu (!), Corbu (!), Gura Lotrului (!), Lotrului Valley, 510 m (7), Malaia (!), Păscoaia (!), Sălişţea (!), Stan's Valley (!), Măceşului Valley (!), Bucureasa Valley (7), Malaia Valley (7, !), Malaia Valley 667 m (4);

Alnus incana (L.) Moench: Mph-mPh, E; U4T2R4, Alno-Padion, Salicion albae: Latoriţei Gorge (!), Ciungetu (!), Malaia (!), Sălişţea (!), Voineasa (6, !), Voineasa-Obârşia Lotrului (57, !), Bucureasa Valley (7), Lotrului Valley, 510-1,350 m (4, 7), Malaia Valley, 764 m (4), Voineşiţa Valley, 1,100 m (!);

Caryophyllaceae

Lychnis flos-cuculi L.: H, Eua; U4T2.5R0, Magnocaricion elatae, Molinietalia, Molinio-Arrhenatheretea: Brezoi (!), Golotreni on Narăţu Mountain (30), Gura Lotrului (!), Obârşia Lotrului (!), Lotrului Valley, 1,350 m (4), Malaia Valley, 1,100 m (4, !), Voineasa (!);

Myosoton aquaticum (L.) Moench (Stellaria aquatica (L.) Scop.): H, Eua; U4T3R0, Alno-Padion, Bidention tripartiti, Salicion albae, Senecion fluviatilis: Ciungetu (!), Malaia (!), Robu Mountain (55), Rudaru (Zăvoiul lui Badac) (56), Măceşului Valley (!), Deluşelu Valley (!), Jidoaia Valley (!), Malaia Valley (7, !), Mănăileasa Valley (!), Rânjeu Mare Valley (!), Rânjeu Mic Valley (!), Voineşiţa Valley (!), Balindru Peak (!), Buceciu Peak (!), Clăbucet Peak (!), Conţu Mare Peak (!), Cristeşti Peak (!), Negovanu Mare Peak (!), Ştefleşti Peak (!), Voineagu Cătănesii Peak (!), Voineşiţa Peak (!), Voineasa (!);

Spergularia rubra (L.) J. and C. Presl.: Th-H, Cp; U4T3R4, Bidentetea tripartiti, Nanocyperion flavescentis, Plantaginetea majoris: Brezoi (!), Obârşia Lotrului (57), Văleanu (12);

Stellaria uliginosa Murray (S. alsine Grimm.): H, Cp; U4.5T2.5R2.5, Cardamini-Montion: tail of Vidra Lake (!), Lotrului Valley, 1,230-1,350 m alt. (4, 37), Rânjeu Mare Valley (!), Voineşiţa Valley (!), Voineasa (!);

Polygonaceae

Polygonum bistorta L.: G, Eua; U4T2.5R3, Calthion palustris, Molinietalia, Triseto-Polygonion: Urdele-Cărbunele (10), Vidra (4, 27), Negovanu Mare Peak (68, !), Sterpu Peak (73, 74, HF), Ştefleşti Peak (68, HDRG, !), Voineasa (27, !); f *puberulum* Beck: Negovanu Mare Peak (68, !)

Polygonum hydropiper L.: Th, Cp; U4.5T3R4, Alnetea glutinosae, Bidention tripartiti, Salicion albae: Brezoi (!), Ciungetu (!), Mălaia (!), Păscoaia (!), Sălişţea (!), Stan's Valley

(!), Măceşului Valley (!), Latoriţa Valley (!), Lotrului Valley, 510 m (7), Mânăileasa Valley (!), Voineasa (!), Voineşiţa (!);

Polygonum lapathifolium L. ssp. ***lapathifolium***: Th, Cosm; U4T0R3, Bidention tripartiti, Polygono-Chenopodion polyspermi, Sisymbrion officinalis; Brezoi (!), Malaia (!), Măceşului Valley (!);

Polygonum mite Schrank: Th, E; U5T3R4, Bidentetalia tripartiti; Brezoi (!);

Polygonum persicaria L.: Th, Eua; U4.5T3R0, Phragmitetea, Polygono-Chenopodietalia, Salicetalia purpureae: Brezoi (!), Mălaia (!);

Rumex conglomeratus Murray: H, Cp; U4T3R4, Agropyro-Rumicion, Bidention tripartiti; Brezoi (!), Ciungetu (!), Corbu (!), Malaia (!), Săliştea (!), Stan's Valley (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!);

Rumex crispus L.: H, Eua; U4T3R0, Agropyro-Rumicion, Arrhenatherion elatioris: Brezoi (!), Corbu (!), Golotreni (!), Gura Lotrului (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!), Voineşiţa (!);

Rumex maritimus L.: Th, Cosm; U5T3.5R4.5, Bidentetea tripartiti, Plantaginetea majoris, Brezoi (!);

Rumex sanguineus L.: H, E; U4T3R4, Alno-Padion, Fagetalia silvaticae: Brezoi (!), Golotreni (!), Mânăileasa Valley (!), Voineasa (!); f. ***atropurpureus*** Aschers. Mânăileasa Valley (!), Voineasa (!);

Saxifragaceae

Chrysosplenium alpinum Schur (C. oppositifolium L. ssp. alpinum (Schur) Jav.: H, Carp; U4T3R3.5, Androsacion alpinae, Montio-Cardaminetalia: Circul Câlcescu (14);

Chrysosplenium alternifolium L.: H, Cp; U4T2R4, Alno-Padion, Fagetalia silvaticae: Brezoi (!), Coasta Bengăi (10), Mohorul (10), Obârşia Lotrului 1,350 m (4, !), Găuri Valley (4), Vidra 1,200 m (4, !), Voineasa (!), Ştefleşti Peak (68, HDRG, HRDG, !);

Saxifraga stellaris L. ssp. ***robusta*** (Engler) Gremli: Ch, Eua (arct-alp); U5T1.5R3, Cardamini-Montion; Circul Câlcescu (14), Coasta Bengăi (10), Dobrun (HBZ), Groapa Seacă-Obârşia Lotrului (19), Obârşia Lotrului 1,350 m (4, !), Păpuşa, 1,800-2,000 m (4), Piatra Tăiată, 2,250 m (4), Puru (10), Setea Mare 2,340 m (4), Găuri Valley (4), Vidra, 1,220-1,300 m (4, 27, !), Rânjeu Mare Valley (!), Buceciu Peak (!), Clăbucet Peak (68, !), Conţu Mare Peak (68, HDRG, HBZ, HF, !), Negovanu Mare Peak (68, !), Ştefleşti Peak (68, HRDG, !), Voineagu Cătănesii (68, !);

Parnassiaceae

Parnassia palustris L.: H, Cp; U4.5T2R4.5, Caricetalia davallianae, Molinion coeruleae, Tofieldietalia: Boarneşu (10), Latoriţei Gorge (!), Câlcescu (2), Coasta lui Rusu, 2,150 m (4), Coasta Petresii, 1,800 m (2), Coasta Pietroasă (2), Iezeru (2), Mogoşu (2, 10, 86), Mohoru (2), Obârşia Lotrului (4, !), Pietrele (2), Poliţi, 2,240 m (4), Ştefanu (2), Urdele (10), Găuri Valley, 2,125 m (4), Lotrului Valley, 1,300 m (4), Zănoguţa (2);

Rosaceae

Filipendula ulmaria (L.) Maxim.: H, Eua; U4.5T2R0, Alno-Padion, Filipendulo-Petasition, Molinietalia: Malaia (!), Muşătoiul (10), Obârşia Lotrului (57, !), Lotrului Valley, 1,300-1,350 m (4), Piatra Albă-Tărtărău Peak (62); ssp. ***denudata*** (J. and C. Presl.) Hayek.: Mirăuţu Mountain (!), Vidra-Obârşia Lotrului (!), Miru Valley (!), Mânăileasa Valley (!), Puru Valley (!), Voineasa (!);

Geum rivale L.: H, Cp; U4.5T0R4.5, Adenostylion alliariae, Calthion palustris, Filipendulo-Petasition; Ciobanu, 1,790-1,850 m (4), Coasta lui Rusu, 1,700 m (4), Căldarea Coasta lui

Rusu 1,850 m (4), Târnovu Mountain (HBZ), Obârşia Lotrului (4, !), Păpuşa 1,800 m (4), Lotrului Valley, 1,300-1,500 m (4, !), Vidra, 1,250 m (4, 27, !), Negovanu Mare Peak (68, HDRG, !), Ştefleşti Peak (68, !), Voineagu Cătănesii (68, HDRG, !), Voineasa (27, 59);

Potentilla anserina L.: H, Cosm; U4T3R4, Bidentetalia tripartiti, Molinietalia, Nanocyperetalia, Plataginetalia majoris: Brezoi (!), Gura Lotrului (!), Stan's Valley (!), Lotrului Valley, 1,300 m (4), Voineasa (!), Voineşiţa (!);

Potentilla supina L.: TH-H, Eua-sM; U4T3R0, Bidention tripartiti, Nanocyperion flavescentis; Gara Lotru (13);

Fabaceae

Trifolium hybridum L. ssp. ***hybridum***: H, Atl-E; U3.5T3R4, Agropyro-Rumicion, Agrostion stoloniferae, Calthion palustris: Brădişor (!), Brezoi (!), Golotreni (59), Muşătoiu (10), Mânăileasa Valley (!), Voineşiţa Valley (!), Văleanu (12), Voineasa (!);

Lythraceae

Lythrum portula (L.) D. A. Webb. (Peplis portula L.): Th, Atl-M; U4T3R0, Nanocyperion flavescentis; Gura Lotrului (!);

Lythrum salicaria L.: H, Cp; U4T3R0, Alnetea glutinosae, Filipendulo-Petasition, Molinietalia, Phragmitetea, Salicetea purpureae: Brezoi (!), Ciungetu (!), Gura Lotrului (!), Malaia (!), Golotreni (!), Păscoaia (!), Sălişte a (!), Stan's Valley (!), Măceşului Valley (!), Lotrului Valley, 1,350 m (4), Voineasa (!), Voineşiţa (!); var. *tomentosum* D. C.: Golotreni (30);

Onagraceae

Epilobium alsinifolium Vill.: H, E (arct-alp); U5T1.5R0, Montio-Cardaminetea, Căldarea Coasta lui Rusu, 1,850 m (4), Ciobanu, 1,850 m (4), Obârşia Lotrului, 1,350 m (4), Găuri Valley (10, 27), Clăbucet Peak (68, HDRG, !);

Epilobium anagalidifolium Lam. (E. alpinum auct. non L.): H, Cp (arct-alp); U4T1.5R0, Androsacetalia alpinae, Cardamini-Montion: Obârşia Lotrului (!);

Epilobium ciliatum Rafin (E. adenocaulon Hausskn, E. hirsutum var. adenocaulon Hausskn.): H, Adv; U4T3R3, Filipendulo-Petasition, Molinietalia, Phragmitetea: Brezoi (!);

Epilobium hirsutum L.: H, Eua; U4T3R3, Filipendulo-Petasition, Phragmitetea: Ciungetu (!);

Epilobium nutans F. W. Schmidt: H, E (alp); U5T2R2, Cardamini-Montion, Sphagnion fusci; Groapa Seacă-Obârşia Lotrului (19), Obârşia Lotrului (!), Găuri Valley (4), Vidra (4), Ştefleşti Peak (68, !), Voineagu Cătănesii (68, !);

Epilobium obscurum Schreber: H, E; U5T0R2, Cardamini-Montion, Epilobietea angustifolii, Glycerio-Sparganion: Brezoi (!), Ciungetu (!), Malaia (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!), Voineşiţa (!);

Epilobium *palustre* L.: H, Cp; U5T0R2, Calthion palustris, Magnocaricion elatae, Scheuchzerio-Caricetalia nigrae: Lotrului Valley, 1,250-1,300 m (4), Malaia Valley, 1,000 m (4, !), Mânăileasa Valley (!);

Epilobium parviflorum Schreber: H, Eua; U5T3R4.5, Glycerio-Sparganion, Phragmitetea: Lotrului Valley, 1,300-1,350 m (4), Mănăilesa Valley (!);

Epilobium roseum Schreber: H, Eua; U4.5T3R4.5, Glycerio-Sparganion: Câlcescu Lake, 1,930 m (2), Iezeru, 1,935 m (2), Muntinu Mic, 1,910 m (2), Ştefanu, 1,910 m (2);

Geraniaceae

Geranium palustre Torn.: H, Eua-C; U4T3R4.5, Filipendulo-Petasition: Rânjeu Mare Valley, 1,300 m (!), Voineşiţa Valley (!);

Apiaceae

Angelica archangelica L.: TH-H, Eua (bor); U4.5T2.5R0, Adenostyletalia, Filipendulo-Petasition: Ciobanu, 1,400-1,500 m (4), Câlcescu (10), Latoriţei Gorge (!), Coasta lui Rusu, 1,700 m (4), Dobrun (!), Jidu (!), Obârşia Lotrului (!), Măceşului Valley (!), Jidoaia Valley (!), Voineşiţa Valley, Vidra, 1,250 m (4);

Angelica sylvestris L. ssp. ***sylvestris***: TH-H, Eua; U4T3R3, Alno-Padion, Molinietalia: Groapa Seacă-Obârşia Lotrului (19), Galbenu Stream (10), Stan's Valley (!), Măceşului Valley (!); ssp. ***montana*** (Brot.) Archang.: Coasta lui Rusu, 1,700 m (4), Vidra, 1,250 m (4);

Angelica x mixta Nyar. (archangelica x sylvestris): LakeVidra-Obârşia Lotrului (!);

Oenanthe peucedanifolia Pollich (O. stenoloba Schur): H, D-B; U4T0R4.5, Molinietalia: Lotrului Valley, 1,400 m alt. (4, 37);

Hypericaceae

Hypericum tetrapterum Fries. (H. quadrangulum L.): H, E; U4T3R4, Filipendulo-Petasition, Glycerio-Sparganion, Magnocaricion elatae: Brezoi (!), Ciobanu, 1,700-1,850 m (4), Narăţu Mountain (30);

Tamaricaceae

Myricaria germanica (L.) Desv.: nPh, Eua; U0T0R4.5, Salicion eleagni: Obârşia Lotrului (57, !), Latoriţei Valley (!) under Târnovu Mountain (HBZ), Lotrului Valley, 1,300 m (4, !), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);

Brassicaceae

Cardamine amara L. ssp. ***amara***: H, Eua; U5T0R0, Alno-Padion, Cardamini-Montion: Circul Câlcescu (86), Obârşia Lotrului, 1,350-1,430 m (4), Găuri Valley (4), Haneşu Valley (!), Lotrului Valley, 1,200-1,300 m (4, !), Vidra (!), Cristeşti Peak (!), Ştefleşti Peak (68, !); ssp. *opicii* (J. and C. Presl.) Celak.: H, Ec; Câlcescu, 1,930 m (2), Coasta lui Rusu 1,700 m (4), Iezeru, 1,935 m (2), Muntinu Mic, 1,910 m (2), Ştefanu, 1,910 m (2), Găuri Valley (4), Lotrului Valley, 1,300-1,350 m (4),

Cardamine pratensis L. ssp. ***pratensis***: H, Cp; U5T3R0, Molinio-Arrhenatheretea: Câlcescu, 1,930 m (2), Coasta Bengăi (10), Găuri (4, 10, 27), Muntinu Mare (10), Muntinu Mic (10), Ştefanu, 1,910 m (2); ssp. *matthioli* (Moretti) Nyman (ssp. hayneana (Welw.) D. E. Schultz): H, E; Clăbucet Peak (68, !), Negovanu Mare Peak (!); ssp. *rivularis* (Schur) Nyman: H, Carp-B: Circul Câlcescu (14), Dobrun (HBZ), Păpuşa, 1,800-1,850 m (4), Găuri Valley, 2,060 m alt. (4, 37), Lotrului Valley, 1,300-1,400 m (4, 37);

Rorippa austriaca (Crantz) Besser: H, P; U4T3.5R4, Agropyro-Rumicion, Bidentetea tripartiti, Plantaginetea majoris, Senecion fluviatilis; Brezoi (!);

Rorippa sylvestris (L.) Besser ssp. ***sylvestris***: H, Eua; U4T3R4, Agropyro-Rumicion: Brădişor (!), Brezoi (!), Ciungetu (!), Golotreni (!), Groapa Seacă-Obârşia Lotrului (19), Malaia (!), Obârşia Lotrului (57, !), Păscoaia (!), Săliştea (!), Măceşului Valley (!), Lotrului Valley 510-1,300 m (4, 7, !), Mânăileasa Valley (!), Rânjeu Mare Valley (!), Rânjeu Mic Valley (!), Voineşiţa Valley (!), Vasilatu (!), Voineasa (!), Voineşiţa (!); ssp. *kerneri* (Menyh.) Soo: H, Pn: Lotrului Valley, 510 m (7);

Salicaceae

Populus alba L.: Mph-mPh, Eua; U3.5T3R3, Salicetalia purpureae: Brădişor (!), Golotreni (!), Gura Lotrului (!), Voineşiţa Valley (!);

Salix alba L. ssp. ***alba***: Mph-mPh, Eua; U5T3R4, Alno-Padion, Salicion albae: Brezoi (!), Ciungetu (!), Corbu (!), Golotreni (!), Lotru (!), Malaia (!), Măceşului Valley (!),

Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);
Salix aurita L.: mPh, E; U4.5T0R2, Alnetea glutinosae: Lotrului Valley, 1,300 m alt. (4, 37);
Salix bicolor Willd. (S. phylicifolia auct.): mPh, Eua (bor); U4T1.5R2, Vaccinio-Piceetea: Câlcescu Lake (1, 4, 6, 8, 10, 14);
Salix cinerea L.: mPh, Eua; U5T3R3, Alnetea glutinosae, Alno-Padion; Pravăţu Mare (1), Sărăcinu Mic (1), Vidra (52, !); f. *aquatica* (Sm.) Koch: Lotrului Valley (1);
Salix daphnoides Vill.: mPh, Eua; U4.5T2.5R4.5, Salicion eleagni: Pasul Turnu-Roşu (90, 74);
Salix eleagnos Scop. (S. incana Schrank): mPh, Ec; U4T3R4.5, Salicion eleagni; Brădişor (!), Gura Lotrului (!), Malaia (!), Latoriţa Valley (!), Lotrului Valley (4, 59), Voineşiţa Valley (!);
Salix fragilis L.: mPh-MPh, Eua; U4.5T3R4, Alno-Padion, Salicion albae, Salicion triandrae: Brezoi (!), Golotreni (!), Malaia (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!), Voineşiţa (!); f. *discolor* Kern.: Măceşului Valley (!);
Salix purpurea L. ssp. ***purpurea***: mPh, Eua; U5T3R4.5, Salicetalia purpureae; Brădişor (!), Brezoi (!), Latoriţei Gorge (!), Ciungetu (!), Corbu (!), Golotreni (!), Gura Lotrului (!), Malaia (!), Obârşia Lotrului (!), Măceşului Valley (!), Latoriţa Valley (!), Lotrului Valley, 1,300 m (4), Mânăileasa Valley (!), Voineşiţa Valley (!), Vidra (1), Voineasa (!), Voineşiţa (!);
Salix silesiaca Willd.: mPh, Carp-B-Sud; U4T2R2, Adenostyletalia, Pinion mugi; Ciobanu, 1,500 m (4), Groapa Seacă-Obârşia Lotrului (19), Pravăţu Mare (1), Sărăcinu Mare (1), Sărăcinu Mic (1), Lotrului Valley, 1,300-1,450 m (4), Mânăileasa Valley (!),Vidra (1, 27), Sterpu Peak (!), Voineasa (27);
Salix starkeana Willd.: nPh (Ch), Eua (bor); U4T2.5R2, Oxycocco-Sphagnetea; Sărăcinu Mare (1), Sărăcinu Mic (1);
Salix triandra L. emend. Ser. ssp. *triandra*: mPh, Eua; U5T3R0, Salicion triandrae: Malaia (!), Păscoaia (!), Sălişţea (!), Stan's Valley (!), Lotrului Valley, 1,300 m (4), Vidra (1); ssp. *amygdalina* (L.) Schubl. and G. Martens (ssp. discolor (Koch) Arcangeli): Măceşului Valley (!);
Salix viminalis L.: mPh, Eua; U5T2.5R4.5, Salicion triandrae; Brezoi (!), Ciungetu (!), Gura Lotrului (!);
Salix x capreola Kern. (aurita x caprea): Vidra (1);
Salix x multinervis Doll. (aurita x cinerea): Vidra (1);
Salix x reichardtii Kern. (caprea x cinerea): Vidra (1);
Salix x rubens Schrank. (alba x fragilis): Mălaia (!), Voineşiţa (!);
Salix x subcaprea Anderss. (caprea x silesiaca): Lacul Vidra Lake (!), Obârşia Lotrului (!), Sărăcinu Mare (1), Sărăcinu Mic (1), Mânăileasa Valley (!), Vidra (1);
Salix x subcinerea Anderss. (cinerea x silesiaca): Vidra (1);

Ericaceae

Oxycoccus palustris Pers. (Vaccinium oxycoccos L. ssp. oxycoccos): Ch, Cp; U5T0R2, Oxycocco-Sphagnetea: Iezerul Latoriţei (8);

Empetraceae

Empetrum nigrum L.: Ch-nPh, Cp; U4T0R0, Junipero-Bruckenthalion; Circul Câlcescu (2, 8, 10, 14), Iezeru (10, 14), Mohoru (14), Obârşia Lotrului-Vidra (52), Petrimanu, 1,850 m (2), Puru, 1,850 m (2, 14);

Primulaceae

Lysimachia nummularia L.: Ch, Eua; U4T3R0, Alnetea glutinosae, Alno-Padion, Bidentetea tripartiti, Calthion palustris, Filipendulo-Petasition, Molinietalia, Phragmitetea, Plantaginetea majoris, Querco-Fagetea, Salicion albae: Brezoi (!), Latoriţei Gorge (!), Ciungetu (!), Golotreni (30, !), Gura Lotrului (!), Malaia (!), Păscoaia (!), Stan's Valley (!), Măceşului Valley (!), Lotrului Valley 510-1,350 m (4, 7, !);

Lysimachia vulgaris L.: H(-Hh), Eua; U5T0R0, Alnetea glutinosae, Molinietalia, Phragmitetea, Salicetea purpureae, Scheuchzerio-Caricetea nigrae; Brezoi (!), Golotreni (30, !), Stan's Valley (!), Măceşului Valley (!), Voineasa (!);

Gentianaceae

Centaurium pulchellum (Swartz) Druce: Th-TH, Eua; U4T3.5R4, Isoeto-Nanojuncetea; Ciungetu (!);

Solanaceae

Solanum dulcamara L.: Ch (nPh), Eua; U4.5T3R4, Alnetea glutinosae, Alno-Padion, Bidentetea tripartite, Calystegion, Epilobietalia angustifolii, Phragmition australis: Brezoi (!), Golotreni (!), Mălaia (!), Păscoaia (!), Sălişţea (!), Voineşiţa Valley (!);

Convolvulaceae

Calystegia sepium (L.) R.Br.: G(H), Eua; U4.5T3R4, Calystegion, Salicion albae, Arction lappae: Brezoi (!), Ciungetu (!), Golotreni (!), Gura Lotrului (!), Malaia (!);

Menyanthaceae

Menyanthes trifoliata L.: Hh, Cp; U5T0R0, Magnocaricion elatae, Scheuchzerio-Caricetalia nigrae: Violeta Lake in Latoriţa Valley (8, 25);

Boraginaceae

Myosotis caespitosa K. F. Schultz: Th-TH, Cp; U4.5T0R0, Magnocaricion, Phragmition; Sălişţea (!);

Myosotis nemorosa Besser (M. palustris var. *nemorosa* (Bess.) Schmalh.): TH-H, Eua; U5T3R0, Calthion; Negovanu Mare Peak (68, HDRG, !);

Myosotis scorpioides L. (M. palustris (L.) Hill): H(Hh), Eua; U5T3R0, Alnetea glutinosae, Calthion palustris, Molinietalia, Phragmitetea: Brezoi (!), Ciungetu (!), Golotreni (!), Groapa Seacă-Obârşia Lotrului (19), Gura Lotrului (!), Vidra Lake (!), Malaia (!), Obârşia Lotrului (4, !), Găuri Valley (4), Latoriţa Valley (!), Lotrului Valley, 1,250-1,350 m (4, !), Malaia Valley, 1,100 m (4, !), Mânăileasa Valley (!), Ştefleşti Peak (68, HDRG, !);

Symphytum officinale L. ssp. ***officinale***: H, Eua; U4T3R0, Molinietalia, Phragmitetea: Golotreni (!);

Lamiaceae

Lycopus europaeus L.: H (Hh), Eua; U5T3R0, Bidentetea tripartiti, Phragmitetea, Salicetea purpureae: Ciungetu (!), Golotreni (30, !), Malaia (!), Sălişţea (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!);

Mentha aquatica L.: H (Hh), E; U5T3R0, Alnetea glutinosae, Molinietalia, Phragmitetea, Salicion albae: Lotru (!), Golotreni (!); var. *riparia* Schreb.: Brezoi (!), Sălişţea (!);

Mentha arvensis L. ssp. ***arvensis*** (ssp. agrestis (Sole) Briq.): H(G), Cp; U4T3R0, Calthion palustris, Molinietalia, Phragmitetea, Secalietea: Golotreni (30, !), Malaia (!), Măceşului Valley (!), Voineasa (!);

Mentha longifolia (L.) Hudson ssp. ***longifolia***: H(G), Eua; U4.5T3R0, Agropyro-Rumicion, Bidentetea tripartiti, Chenopodietea, Filipendulo-Petasition, Glycerio-Sparganion, Molinietalia: Brezoi (!), Ciobanu, 1,600 m (4), Ciungetu (!), Gura Lotrului (!), Malaia (!), Păscoaia (!), Săliştea (!), Stan's Valley (!), Măceşului Valley (!), Latoriţa Valley (!), Lotrului Valley, 510-1,300 m (4, 7, !), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!); var. *horridula* Briq.: Măceşului Valley (!);
Mentha pulegium L.: H, Eua (sM); U4T3R5, Isoeto-Nanojuncetea, Nanocyperion flavescentis; Brezoi (!), Golotreni (!); var. *hirsutum* (Per.) Lab.: Golotreni (!);
Scutellaria galericulata L.: H, Cp; U4T3R4, Magnocaricion elatae, Molinietalia, Phragmitetea Brezoi (30, 59, !);

Callitrichaceae

Callitriche cophocarpa Sendtner (C. polymorpha Lonnr.): Th-H (Hh), Eua; U6T3R0, Nanocyperion flavescentis, Potamion: Malaia (!);
Callitriche palustris L. (C. verna L.): Th-H (Hh), Cp; U6T3R0, Nanocyperion flavescentis, Potamion: Câlcescu (2), Iezeru (2, 10);

Scrophulariaceae

Gratiola officinalis L.: H, Cp; U4.5T3R4, Magnocaricion elatae, Molinion coeruleae, Nanocyperetalia, Phragmitetea: Gura Lotrului (!);
Tozzia alpina L. ssp. ***carpatica*** (Woloszczak) Hayek: H, Carp-B; U4T2R4.5, Adenostyletalia, Cardamini-Montion; Vidra, 1,250 m (4), Voineagu Cătănesii (68, HDRG, !), Voineasa (!);
Veronica anagallis-aquatica L.: H (Hh), Cp; U5T0R4, Bidentetea tripartiti, Glycerio-Sparganion, Phragmitetea: Gura Lotrului (!), Săliştea (!), Mânăileasa Valley (!), Voineasa (!);
Veronica beccabunga L.: H (Hh), Eua; U5T3R4, Bidentetea tripartiti, Glycerio-Sparganion, Salicetalia purpureae: Brezoi (!), Ciungetu (!), Dengheru-Păpuşa, 1,910 m (2), Groapa Dengherului (12), Gura Lotrului (!), Săliştea (!), Măceşului Valley (!), Găuri Valley (4), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);

Lentibulariaceae

Pinguicula alpina L.: H, Eua (arct-alp); U4T0R4, Caricion davallianae, Cratoneurion commutati, Eriophorion latifolii, Seslerietalia coeruleae: Lotrului Valley, 1,300 m alt. (4, 37);
Pinguicula vulgaris L.: H, Cp; U3,5T0R4, Caricion canescenti-nigrae, Caricion davallianae, Cratoneurion commutati, Tofieldietalia; Groapa Dengherului (12);

Rubiaceae

Galium palustre L. ssp. *palustre*: H, Cp; U5T3R0, Magnocaricion elatae, Molinietalia: Brezoi (!), Gura Lotrului (!), Obârşia Lotrului (!), Gura Pravăţului (4, 27, !), Lotrului Valley, 1,250 m (4), Malaia Valley, 1,100 m (4, !), Mânăileasa Valley (!);
Galium uliginosum L.: H, Eua; U4.5T3R4, Calthion palustris, Magnocaricion elatae, Molinietalia, Scheuchzerio-Caricetalia nigrae: Găuri Valley (4), Lotrului Valley, 1,250-1,350 m (4, !), Malaia Valley, 1,100 m (4, !);

Valerianaceae

Valeriana officinalis L.: H, Eua (sM); U4T3R4, Alnetea glutinosae, Alno-Padion, Filipendulo-Petasition, Magnocaricion elatae, Molinietalia: Latoriţei Gorge (!), Coasta lui Rusu at Poliţi (36), Găuri Valley, 2,080-2,165 m (4, 37), Obârşia Lotrului (!), Păscoaia (!), Săliştea (!), Stan's Valley (!), Jidoaia Valley (!), Voineşiţa Valley (!); var. *latifolia* Vahl: f. *altissima* (Hornem.) Koch: Brezoi (30, 59);

Valeriana sambucifolia Mikan fil. (V. officinalis L. ssp. sambucifolia (Mikan fil.) Celak.): H, Ec; U4T2R3.5, Adenostyletalia, Fagion, Filipendulo-Petasition: Latoriţei Gorge (!), Căldarea Coasta lui Rusu, 1,850 m (4), Coasta lui Rusu, 1,700 m (4), Ciobanu, 1,850 m (4), Malaia (!), Măceşului Valley (!), Mânăileasa Valley (!), Vidra, 1,250 m (4), Voineasa (!), Jidoaia Valley (27, 59);

Asteraceae

Bidens tripartita L.: Th, Eua; U4.5T3R0, Bidentetea tripartiti, Chenopodio-Scleranthetea, Nanocyperion flavescentis: Brezoi (!), Ciungetu (!), Gura Lotrului (!), Malaia (!), Lotrului Valley, 510 m (7), Stan's Valley (!), Măceşului Valley (!), Voineasa (!), Voineşiţa (!); f. *pumila* (Roth) Nyar.: Mânăileasa Valley upstream of Voineasa (!);

Bidens vulgata E. L. Greene: Th, Adv; U5T0R0, Bidention; col: Gura Lotrului (!);

Carduus personatus (L.) Jacq. ssp. ***personatus***: H, Ec; U4.5T2.5R4.5, Adenostylion alliariae, Alno-Padion, Filipendulo-Petasition; Ciungetu (!), Curmătura Vidruţei (!), Vidra Lake (!), Malaia (!), Păscoaia (!), Sălişţea (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineasa (!);

Cirsium canum (L.) All.: G, Eua-C; U4.5T3R4.5, Alno-Padion, Magnocaricion elatae, Molinietalia: Brezoi (!), Sălişţea (!);

Cirsium erisithales (Jacq.) Scop.: H, Ec (mont); U3,5T3R4.5, Fagetalia silvaticae, Filipendulo-Petasition; Brezoi (!), Latoriţei Gorge (!), Ciungetu (HBZ, !), Golotreni (47, !), Malaia (!), Sălişţea (!), Deluşelu Valley (!), Măceşului Valley (!), Mânăileasa Valley (!), Rânjeu Mare Valley (!), Rânjeu Mic Valley (!), Voineşiţa Valley (!), Vidra (!), Voineasa (!), Jidoaia Valley (27, !);

Cirsium oleraceum (L.) Scop.: H, Eua; U4T3R4, Alno-Padion, Calthion palustris, Filipendulo-Petasition, Molinietalia: Brezoi (!), Voineasa (42);

Cirsium palustre (L.) Scop.: TH, Eua; U4.5T3R2.5, Alnetea glutinosae, Epilobietalia angustifolii, Molinietalia, Phragmitetea: Curmătura Vidruţei (!), Groapa Seacă-Obârşia Lotrului (19), Vidra Lake (!), Obârşia Lotrului-Vidra Lake (!), Galbenu Stream (10), Mânăileasa Valley (!), Pravăţu Valley (!), Rânjeu Mare Valley (!), Voineşiţa Valley (!), Voineasa (!);

Cirsium rivulare (Jacq.) Link.: H, Ec (mont); U4T3.5R0, Alnetea glutinosae, Calthion palustris, Magnocaricion elatae, Molinietalia: Sălişţea (!);

Cirsium waldsteinii Rouy: H, Alp-Carp; U4T2R2, Adenostylion alliariae, Caricion curvulae, Filipendulo-Petasition; Coasta Bengăi (2, 86), Cracul Butirii-Malaia (55), Gaura Mohorului (10), Micaia (2), Mohoru (2), Păpuşa (10), Părăginosu (2), Galbenu Stream (10), Voineşiţa Valley (!), Voineasa (59, !), Jidoaia Valley (27, 59, !);

Crepis paludosa (L.) Moench: H, E (mont); U4.5T0R4.5, Adenostyletalia, Alnetea glutinosae, Alno-Padion, Calthion palustris, Montio-Cardaminetea; Căldarea Mohorului (2), Mohoru (10), Păpuşa (10), Lotrului Valley, 1,300 m alt. (37);

Eupatorium cannabinum L.: H, Eua; U4T3R0, Alnion glutinosae, Epilobietea angustifolii, Filipendulo-Petasition, Phragmitetea, Salicetalia purpureae: Brădişor (!), Brezoi (31, !), Ciungetu (!), Lotru (!), Malaia (!), Păscoaia (!), Sălişţea (!), Stan's Valley (!), Măceşului Valley (!), Latoriţa Valley (!), Mânăileasa Valley (!), Voineasa (!);

Gnaphalium uliginosum L.: Th, Eua; U5T3R4, Nanocyperetalia: Bora (2), Brezoi (31), Coasta Pietroasă (2), Dengheru (2), Gaura Mohorului-Urdele, 2,120 m (2), Micaia (2), Mirăuţu (2), Mogoşu-Turcinu Mare, 1,920 m (2), Mohoru (2, 11), Muntinu Mic (2), Muşătoiu (2, 86), Nopteasa (11), Păpuşa (2, 86), Puru (2, 86), Zănoguţa (2);

Petasites albus (L.) Gaertner: G, Eua; U3.5T0R0, Alno-Padion, Fagion: Golotreni (47), Păscoaia (!), Jidoaia Valley (!), Latoriţei Valley (!), Repedea Valley (HBZ, !), Voineşiţa Valley (!), Zmeurătu (!);
Petasites hybridus (L.) P. Gaertner, B. Meyer and Scherb.: G, Eua; U5T3R3, Adenostyletalia, Alno-Padion, Filipendulo-Petasition: Brezoi (!), Ciungetu (!), Malaia (!), Măceşului Valley (!), Latoriţa Valley (!), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);
Pulicaria dysenterica (L.) Bernh.: H, Ec; U4T3.5R0, Agropyro-Rumicion, Molinietalia; Brezoi (!);
Pulicaria vulgaris Gaertner: Th, Eua; U4T3R3, Agropyro-Rumicion, Bidention tripartiti, Isoeto-Nanojuncetea; Golotreni (30);
Senecio rivularis (Waldst. and Kit.) DC.: H, Ec; U4T2R2.5, Adenostylion alliariae, Filipendulo-Petasition, K: Sterpu Peak/Negru Hill (74); var. *alatus* (Jacq.) Cuf.: Sterpu Peak/Negru Hill (59, 90);
Telekia speciosa (Schreber) Baumg.: H, Carp-B-Cauc-Anat; U4T2R0, Alnion glutinosae-incanae, Filipendulo-Petasition, Telekion: Brezoi (30, !), Latoriţei Gorge (!), Ciungetu (!), Vidra Lake (!), Malaia (!), Păscoaia (!), Săliştea (!), Măceşului Valley (!), Latoriţei Valley (10), Mânăileasa Valley (!), Voineasa (!), Voineşiţa (!);

Alismataceae
Alisma plantago-aquatica L.: Hh, Cp; U6T0R0, Phragmitetea: Brădişor (!), Brezoi (!), Gura Lotrului (!), Săliştea (!), Mânăileasa Valley (!), Voineasa (!);

Potamogetonaceae
Potamogeton nodosus Poiret (P. fluitans Roth): Hh, Cp; U6T3.5R4, Potametalia; Gura Lotrului (!);

Orchidaceae
Dactylorhiza cordigera (Fries) Soo (Orchis cordigera Fries) ssp. cordigera: G, Carp-B; U4.5T2R2, Montio-Cardaminetalia, Scheuchzerio-Caricetalia nigrae; Gaura Mohorului (10), Setea Mare (41, 45), Lotrului Valley (45);
Dactylorhiza saccifera (Brongn.) Soo (D. maculata ssp. macrostachys (Tineo) Hayek): G, E; U4T2R2, Molinietalia: Vidra (27), Voineasa (27);
Epipactis palustris (L.) Crantz: G, Eua; U4.5T3R4.5, Caricetalia davallianae, Eriophorion latifolii, Molinion coeruleae: Obârşia Lotrului-Vidra (!), Voineasa-Măceşului Valley (!);

Juncaceae
Juncus articulatus L. (J. lampocarpus Ehrh.): H, Cp; U5T2R0, Agropyro-Rumicion, Calthion palustris, Nanocyperion flavescentis: Brădişor (!), Brezoi (!), Ciungetu (!), Groapa Seacă-Obârşia Lotrului (19), Vidra Lake (!), Obârşia Lotrului (12, 57, !), Măceşului Valley (!), Jidoaia Valley (!), Lotrului Valley, 510 m (7), Rânjeu Mare Valley (!), Voineşiţa Valley (!);
Juncus bufonius L.: Th, Cosm; U4.5T0R3, Bidentetea tripartiti, Nanocyperetalia, Plantaginetalia majoris: Ciungetu (!), Vidra Lake (!), Obârşia Lotrului (!), Lotrului Valley, 510 m (7), Măceşului Valley (!), Mânăileasa Valley (!), Voineşiţa Valley (!), Vidra (!), Voineasa (!);
Juncus compressus Jacq.: G, Eua; U4T3R4, Agropyro-Rumicion, Agrostion stoloniferae, Nanocyperion flavescentis, Plantaginetea majoris, Puccinellio-Salicornietea: Brădişor (!), Brezoi (!), Gura Lotrului (!), Malaia (!), Păscoaia (!), Săliştea (!), Stan's Valley (!), Măceşului Valley (!), Mânăileasa Valley (!), Rânjeu Mare Valley, 1,400 m alt. (!), Voineşiţa Valley (!), Voineasa (!); var. *metzleri* (F. Schultz) Ascherson and Graebner: Obârşia Lotrului (!), Vidra (!);

Juncus conglomeratus L.: H, Cp; U4.5T3R3, Calthion palustris, Molinietalia, Molinion coeruleae, Scheuchzerio-Caricetalia nigrae: Brezoi (!), Curmătura Vidruţei (!), Groapa Seacă-Obârşia Lotrului (19), Vidra Lake (!), Obârşia Lotrului (12, 57, !), Mânăileasa Valley (!), Voineasa (!);
Juncus effusus L.: H, Cosm; U4.5T3R3, Alnetea glutinosae, Bidentetea tripartiti, Calthion palustris, Molinietalia, Plantaginetea majoris: Brădişor (!), Brezoi (!), Ciungetu (!), Gura Lotrului (!), Vidra Lake (!), Malaia (!), Obârşia Lotrului (57, !), Păscoaia (!), Săliştea (!), Lotrului Valley (1), Mânăileasa Valley (!), Rânjeu Mare Valley, 1,400 m alt. (!), Rânjeu Mic Valley (!), Voineşiţa Valley (!), Voineasa (!);
Juncus filiformis L.: H (G), Cp (arct-alp); U4.5T2.5R2.5, Caricion canescenti-nigrae; Câlcescu (2, 10), Iezeru, 1,935 m (2); var. *transsilvanicus* (Schur) A. and G.: Circul Câlcescu (14), Lotrului Valley (1);
Juncus inflexus L.: H, Eua; U4T3.5R4, Agropyro-Rumicion: Brezoi (!), Ciungetu (!), Gura Lotrului (!), Obârşia Lotrului (57), Măceşului Valley (!);

Cyperaceae

Blysmus compressus (L.) Panzer: G, Eua; U4.5T3R4.5, Agropyro-Rumicion, Caricion canescenti-nigrae, Lotrului Valley (1, 59), Mânăileasa Valley (!);
Carex acuta L. (C. gracilis Curtis) ssp. ***acuta***: G (Hh), Cp; U5T3R0, Alno-Padion, Calthion palustris, Caricion gracilis, Magnocaricion elatae; Obârşia Lotrului (!);
Carex brunescens (Pers.) Poiret: H, Cp (arct-alp); U4T1.5R2, Cardamini-Montion, Scheuchzerio-Caricetea nigrae: Circul Câlcescu (14), Negru Hill (59, 73, 90, HF), Lotrului Valley (1, 59);
Carex curta Good. (C. canescens auct. non L.): H, Cp (bor); U5T0R2, Caricion canescenti-nigrae: Circul Câlcescu (2, 10, 14, 86), Negru Hill (59, 74, 90, HU), Groapa Seacă-Obârşia Lotrului (19, !), Iezeru (2, 10), Lunca cu Funiile (1, !), Muntinu Mare (2), Muntinu Mic (10, 86), Muşătoiu (2), Pravăţu Mare (1), Puru (10), Sărăcinu Mare (1), Sărăcinu Mic (1), Ştefanu (1), Urdele (2, 10), Lotrului Valley, 1,300 m (1, 59), Vidra (1, !), Zăvoi-Vidra (1, 1962), Zănoguţa (2); f. *tenuis* O. F. Lang: Lotrului Valley (1, 59);
Carex distans L.: H, Eua (sAtl-sM); U4T3R4, Agrostion stoloniferae, Eriophorion latifolii, Molinion coeruleae: Brezoi (!), Obârşia Lotrului (!), Vidra (!);
Carex echinata Murray (C. stelllulata Good.): H, Cp; U5T2R1, Calthion palustris, Caricion canescenti-nigrae, Magnocaricion elatae: Circul Câlcescu (2, 10, 86), Groapa Seacă-Obârşia Lotrului (19, !), Iezeru (2, 10), Lunca cu Funiile (1, !), Mohoru (14), Muntinu Mic (86), Obârşia Lotrului (!), Pravăţu Mare (1), Sărăcinu Mare (1), Sărăcinu Mic (1), Ştefanu (2), Lotrului Valley, 130-1,400 m alt. (37, 59), Mânăileasa Valley (!), Ştefleşti Peak (68, !), Vidra (1, !), Voineasa (!), Zăvoi-Vidra (1); var. *grypos* Schk.: Lotrului Valley (1);
Carex elongata L.: H, Eua (bor); U5T2.5R4, Alnetea glutinosae: Lunca cu Funiile (1), Vidra (1), Lotrului Valley, 1,200-1,400 m alt. (1, 37, 59);
Carex flava L.: H, Cp; U4.5T3R0, Calthion palustris, Caricetalia davallianae, Eriophorion latifolii, Tofieldietalia: Câlcescu (2), Groapa Dengherului (12), Groapa Seacă-Obârşia Lotrului (19, !), Iezeru (2, 10), Muntinu Mic (2, 10), Muşătoiu (10), Obârşia Lotrului (!), Puru (10), Ştefanu (2), Lotrului Valley in Sphagnetum (1);
Carex lepidocarpa Tausch: H, Euram; U4.5T3R0, Eriophorion latifolii, Molinietalia, Montio-Cardaminetalia: Lotrului Valley (1);
Carex magellanica Lam. ssp. ***irrigua*** (Wahlenb.) Hiitonen (C. paupercula Michx.): G, Cp (arct-alp); U5T2R2, Scheuchzerio-Caricetea nigrae: Negru Hill (59, 74, 84, 90);

Carex nigra (L.) Reichard (C. fusca All.) ssp. ***nigra***: G, Cp; U4T3R2, Calthion palustris, Caricetalia davallianae, Caricion canescenti-nigrae: Groapa Dengherului (12), Obârşia Lotrului (!), Sărăcinu Mic (1), Negovanu Mare Peak (68, !); ssp. ***dacica*** (Heuffel.) Soo (C. dacica Heuffel, Carex bigelowii Torrey and Schwein.): G, Carp-B; U0T2R2,5; Caricion canescenti-nigrae: Circul Câlcescu (1, 2, 10, 14, 86), Negru Hill (90), Ierezu 1,935 m (2), Păpuşa (10); f. *longifolia* Circul Câlcescu (6, 14);
Carex ovalis Good. (C. leporina auct. non L.): H, Cp; U4T2.5R3, Caricion canescenti-nigrae, Molinietalia, Nardetalia: Brezoi (!), Cărbunele (10), Groapa Seacă-Obârşia Lotrului (19, !), Lunca cu Funiile (1, !), Vidra Lake (!), Malaia (!), Mohoru (2), Muntinu Mare (2), Muntinu Mic (10), Muşetoiu (2, 11), Obârşia Lotrului (57, !), Părăginosu (2, 86), Petrimanu (2), Pietrele (2), Pravăţu Mare (1), Sărăcinu Mare (1), Sărăcinu Mic (1), Ştefanu (2), Mânăileasa Valley (!), Urdele (2), Vidra (12), Zăvoi-Vidra (1), Zănoguţa (2);
Carex pallescens L.: H, Cp; U3.5T3R3, Molinio-Arrhenatheretea, Nardetalia: Groapa Seacă-Obârşia Lotrului (19), Muntinu Mic (10), Sărăcinu Mic (1), Urdele (10);
Carex panicea L.: G, Cp; U3.5T3R0, Magnocaricion elatae, Molinietalia, Molinio-Arrhenatheretea, Scheuchzerio-Caricetea nigrae, Tofieldietalia: Obârşia Lotrului (!), Voineşiţa Valley (27, 59);
Carex pauciflora Lightf.: G, Cp (bor); U5T2.5R1, Oxycocco-Sphagnetea, Sphagnion fusci: Câlcescu Lake (1, 8, 14), Lotrului Valley, 1,300 m alt. (37, 59);
Carex remota L.: H, Cp; U4.5T3R3, Alno-Padion, Fagetalia silvaticae: Brezoi (!), Golotreni (!), Sălişţea (!);
Carex rostrata Stokes ssp. ***rostrata***: H (Hh), Cp; U5T2R0, Caricion rostratae, Magnocaricion elatae: Câlcescu (10, 14), Obârşia Lotrului (!), Pravăţu Mare (Ştefureac et al., 1962), Ştefanu, 1,700-1,900 m (2, 10), Lotrului Valley (1, 59);
Carex vesicaria L.: Hh, Cp; U6T3R4, Caricion gracilis, Magnocaricion elatae: Câlcescu (14);
Carex vulpina L.: H, Eua; U4T3R4, Agropyro-Rumicion, Caricion gracilis, Magnocaricion elatae, Phragmition australis; Brezoi (!), Golotreni (!), Gura Lotrului (!), Sălişţea (!);
Cyperus flavescens Jacq. (Pycreus flavescens (L.) Reichenb.): Th, Cosm; U4.5T0R4, Nanocyperion flavescentis; Brezoi (27, 59, !);
Eleocharis palustris (L.) Roemer and Schultes: G (Hh), Cosm; U5T0R4, Molinietalia, Nanocyperetalia, Phragmitetea: Brădişor (!), Gura Lotrului (!), Sălişţea (!), Mânăileasa (!);
Eriophorum angustifolium Honck.: G (Hh), Cp; U4.5T3R3, Molinietalia, Scheuchzerio-Caricetalia nigrae; Lotrului Valley (37);
Eriophorum latifolium Hoppe: H, Cp; U5T0R4.5, Caricion davallianae, Eriophorion latifolii, Scheuchzerio-Caricetalia nigrae, Tofieldietalia; Circul Câlcescu (14), Groapa Dengherului (12), Obârşia Lotrului (!), Lotrului Valley (1);
Eriophorum scheuchzeri Hoppe: H, Cp (arct-alp); U5T1.5R2.5, Eriophorion scheuchzerii, Balindru Peak (HBZ), Negovanu Mare Peak (59, 74, 73, HF, HU);
Eriophorum vaginatum L.: H, Cp; U4.5T0R1.5, Sphagnion fusci: Circul Câlcescu (2, 10, 14, 86), Groapa Dengherului (12), Iezeru, 1,935 m (2, 10), Lunca cu Funiile (1, 6), Mohoru (14), Muntinu Mic, 1910 m (2), Obârşia Lotrului (!), Sărăcinu Mare (1), Sărăcinu Mic (1, !), Ştefanu, 1910 m (2), Negovanu Mare Peak (68, HBZ; HDRG, !), Ştefleşti Peak (68, !),
Schoenoplectus lacustris (L.) Palla (Scirpus lacustris L.): G (Hh), Cosm; U6T3R4, Phragmition australis; Gura Lotrului (!);
Scirpus sylvaticus L.: G, Cp; U4.5T3R0, Alno-Padion, Calthion palustris, Molinietalia, Phragmitetea: Brădişor (!), Brezoi (!), Ciungetu (!), Gura Lotrului (!), Malaia (!), Obârşia Lotrului (!), Sălişţea (!), Măceşului Valley (!), Rânjeu Mare Valley (!), Voineşiţa Valley (!), Vidra (!), Voineasa (!), Lotrului Valley (1);

Poaceae

Agrostis canina L. ssp. *canina*: H, Eua; U4T3R3, Caricion canescenti-nigrae, Molinio-Arrhenatheretea: Obârşia Lotrului (!), Lotrului Valley (1);

Agrostis stolonifera L. ssp. ***stolonifera***: H, Cp; U4T0R0, Agropyro-Rumicion, Agrostion stoloniferae, Alno-Padion, Magnocaricion elatae, Molinion coeruleae: Brezoi (!), Ciungetu (!), Golotreni (!), Gura Lotrului (!), Malaia (!), Obârşia Lotrului (57), Stan's Valley (!), Măceşului Valley (!), Lotrului Valley (1), Mânăileasa Valley (!), Voineasa (!);

Alopecurus aequalis Sobol.: Th-TH, Cp; U5T3R4, Agrostion stoloniferae, Bidentetalia tripartiti, Nanocyperion flavescentis: Gura Lotrului (!), Păscoaia (!), Sălişte a (!), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);

Alopecurus geniculatus L.: Th-TH, Cosm; U5T0R4, Agropyro-Rumicion, Agrostion stoloniferae, Plantaginetea majoris: Brezoi (!);

Alopecurus pratensis L. ssp. ***pratensis***: H, Eua; U4T3R0, Agrostion stoloniferae, Calthion palustris, Filipendulo-Petasition, Molinio-Arrhenatheretea: Malaia (!);

Calamagrostis pseudophragmites (Haller fil.) Koeler: H, Eua-C; U5T3R5, Salicion eleagni: Latoriţei Gorge (!), Ciungetu (!), Gura Lotrului (!), Malaia (!), Obârşia Lotrului (57, !), Vidra (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineşiţa Valley (!), Voineasa (!);

Calamagrostis stricta (Timm) Koeler (C. neglecta auct non Ehrh.): H, Cp; U4.5T2R3, Magnocaricion, Caricion rostratae; Obârşia Lotrului-Vidra (1, !), Mânăileasa Valley (!);

Calamagrostis villosa (Chaix) J. F. Gmelin: H, Eua; U4T2.5R1.5, Calamagrostidion villosae, Vaccinio-Piceion; Urdele (10);

Deschampsia caespitosa (L.) Beauv. ssp. ***caespitosa*** (incl. ssp. ***alpicola*** Chrtek and Jirasek): H, Cosm; U4T0R0, Betulo-Adenostyletea, Molinietalia, Phragmitetalia: Ciungetu (!), Câlcescu (1, 2, 14), Coasta Bengăi 1,800 m (2), Curmătura Vidruţei (!), Groapa Dengherului (12), Groapa Seacă to Obârşia Lotrului (19); Iezeru (1, 10), Vidra Lake (57, !), Miru Mare (1, 27), Mirăuţu Mountain (86, !), Mogoşu (86), Mohoru (2, 10, 11, 14), Muntinu Mare (2), Muntinu Mic (86), Muşătoiu (2, 10, 11), Nopteasa (2), Obârşia Lotrului (57, !), Păpuşa (71), Puru (2), Setea Mare (10, 11), Ştefanu (2), Urdele (2), Măceşului Valley (!), Haneşul Valley (!), Mânăileasa Valley (!), Pravăţu Valley (!), Voineşiţa Valley (!), Clăbucet Peak (68, !), Cristeşti Peak (!), Fratoşteanu Peak (!), Negovanu Mare Peak (68, !), Ştefleşti Peak (68, !), Voineagu Cătănesii (68, !), Voineasa (!), Zănoguţa (2);

Glyceria nemoralis (Uechtr.) Uechtr. and Koernicke: H, Ec; U5T3R3, Cardamini-Montion: Iezeru (10), Muşătoiu (10), Obârşia Lotrului (!), Mânăileasa (!), Voineasa (!), Voineşiţa (!);

Glyceria notata Chevall. (G. plicata (Fries) Fries): H (Hh), Cp; U6T3R4.5, Glycerio-Sparganion: Groapa Seacă-Obârşia Lotrului (19), Păscoaia (!), Sălişte a (!), Lotrului Valley (1), Măceşului Valley (!), Voineşiţa Valley (!), Voineasa (!);

Phragmites australis (Cav.) Steudel ssp. ***australis***: G (Hh), Cosm; U6T0R4, Phragmition australis: Corbu (!), Gura Lotrului (!);

Poa palustris L.: H, Cp; U5T3R4, Alnetalia glutinosae, Calthion palustris, Magnocaricion elatae, Phragmition australis: Lotrului Valley (1), Mânăileasa Valley (!), Voineasa (!);

Typhaceae

Typha angustifolia L.: G (Hh), Cp; U6T4R0, Phragmition australis: Gura Lotrului (!);

Typha latifolia L.: G (Hh), Cosm; U6T3.5R0, Phragmition australis: Brădişor (!), Gura Lotrului (!), Stan's Valley (!), Măceşului Valley (!), Mânăileasa Valley (!), Voineşiţa Valley, 700 m alt. (!).

CONCLUSIONS

The aquatic and marshy flora of the Lotru River basin can be considered rich for a mountainous Carpathian area with its inventory of 204 taxa, and with the occurences of some rare species and species typical of the area. They are distributed particularly in smaller standing waters, bogs and springs and less represented in the water body of Lotru River. Due to the human impact caused by hydrotechnical constructions on the Lotru River and its tributaries, many of the natural habitats of the hydro- and hygrophilous flora have been entirely destroyed and have disappeared, others are still present in small area and frequently modified by human impact, but also some man-made new habitats have developed.

The present paper constitutes a documentary basis for the flora of the Lotru River basin, a useful species list for phytodiversity and comparative studies with other hydrographic basins.

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Annex 1: Herbariums

BUCA Romanain Academy Biology Institute, Bucharest.

HBZ Herbarium J. Bielz, E. Krauss, G. Hergotta, V. Klotz - Brukenthal Museum Sibiu, Natural Sciences, no. inv. 79.911-81.464, 81.568-81.687.

HDRG Herbarium C. Drăgulescu Botanical Garden Cluj-Napoca.

HDRG Herbarium C. Drăgulescu Natural History Museum of Sibiu.

HF Herbarium M. Fuss (incl. Herb. Cryptogam. şi Herb. Norm. Transs.) - Brukenthal Museum of Sibiu, Şt. nat. no. inv. 1-28.983.

HFA Anmex Herbarium M. Fuss - Muzeul Brukenthal Sibiu, Şt. nat. no. inv. 82.435-84.427.

HK Herbarium E. Kisch - Muzeul Brukenthal Sibiu, Şt. nat. no. inv. 78.26-79.910.

HU Herbarium K. Ungar - Muzeul Brukenthal Sibiu, Şt. nat. no. inv. 35.520-43.288.

COMPARATIVE STUDY OF ALLUVIAL CNIDION-TYPE MEADOWS IN THE LOWER DANUBE RIVER BASIN

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KEYWORDS: biodiversity loss, endangered species and habitats, flood tolerance.

ABSTRACT

Alluvial Cnidion-type meadows (Habitat type 6440 of the Habitats Directive), mostly characteristic for the lower courses of large rivers in continental climate conditions of Europe are presented from the Lower Danube upstream the municipality of Giurgiu (river-km 510-524). The ecological requirements of the characteristic species, as well as their sensitivity to human-induced changes that derive from regular flooding, drainage, intensification of use and/or abandonment, are highlighted; these changes frequently lead to a decrease of biodiversity of the Cnidion-type meadows or to their total loss The studied meadows are compared with similar alluvial meadows from other sites of the lower Danube River basin. Finally, the strong interlocking of Cnidion type meadows with those of the Agropyro-Rumicion, Molinion and Deschampsion caespitosae alliances are discussed.

ZUSAMMENFASSUNG: Vergleichende Untersuchungen der Brenndoldenwiesen (Cnidion) im Einzugsgebiet der Unteren Donau.

Überschwemmungswiesen des Verbandes Cnidion (Habitattyp 6440 der Habittat-Richtlinie), die für die Unterläufe meist größerer Flüsse im kontinentalen Klimabereich Europas kennzeichnend sind, werden von der unteren Donau oberstrom der Stadt Giurgiu (Fluss-km 510-524) beschrieben. Dabei geht die Verfasserin auf die ökologischen Ansprüche der charakteristischen Arten sowie ihre Empfindlichkeit gegenüber menschlichen Eingriffen (Abtrennung vom Überflutungsregime, Entwässerungsmaßnahmen, Nutzungsintensivierung oder Nutzungsaufgabe) ein, die zu einer Veränderung der Artenvielfalt der Cnidion-Wiesen oder gar zu ihrem Verschwinden führen. Die untersuchten Wiesen werden mit ähnlichen von anderen Flüssen aus dem Einzugsgebiet der unteren Donau verglichen und schließlich die engen Beziehungen zu den Agropyro-Rumicion, Molinion und Deschampsion caespitosae - Verbänden aufgezeigt.

REZUMAT: Studiul comparativ al pajiștilor de tip Cnidion în bazinul Dunării de Jos.

Pajiştile aluviale de tip Cnidion (tipul de habitat 6440 după Directiva Habitate), caracteristice mai ales pentru cursul inferior al râurilor mai mari din regiunile cu climat continental ale Europei, sunt descrise din lunca Dunării de Jos, în amonte de municipiul Giurgiu (km-fluvial 510-524). Autoarea analizează cerinţele ecologice ale speciilor caracteristice, scoţând în evidenţă sensibilitatea lor faţă de impactul uman, cum ar fi despărţirea prin diguri de regimul liber de inundaţie, prin drenaje şi desecări în luncă, prin schimbări ale modului de folosinţă, intensificarea sau din contră abandonarea pajiştilor, toate acestea ducând la scăderea biodiversităţii sau chiar pierderea completă a pajiştilor de tip Cnidion. Acestea sunt comparate cu pajişti aluviale similare din alte localităţi ale bazinului Dunării inferioare. În încheiere, sunt discutate relaţiile ecologice strânse între alianţa Cnidion cu pajiştile de luncă de tip Agropyro-Rumicion, Molinion şi Deschampsion caespitosae.

INTRODUCTION

In the last decades, i.e. in the second half of the 20th century, the area of wet, temporary flooded meadows decreased and suffered many changes in Europe due to manifold human impacts. Duration and intensity of man interventions influenced the species composition and structure of meadow communities. Presently, only a small part of the remained floodplain meadows are supposed to regularly flood, the most of them being separated by dykes from the natural river dynamics and influenced in the old floodplain only by changing groundwater level.

In the Danube River basin, flooded meadows have been described in detail by Balátová-Tulácková (1965, 1966, 1969, 1979) from Southern Moravia on the Dyje River, (a tributary of the Morava River) also from the Morava River - a left tributary of the Danube - in Southern Slovakia, on the border between Slovakia and Austria and as well from the Danube River in Austria. She was the first author describing a new alliance of flooded meadows characteristic for the floodplains of large rivers in continental to subcontinental climate conditions with low precipitation named Cnidion venosi (Balátová-Tulácková, 1965). The Cnidion venosi alliance which stays on the base of the habitat type 6440 of the Habittat-Directive (***, 2013) is represented according to its author by species with small ecological amplitude, which attaints in this alliance of the highest constancy (Balátová-Tulácková, 1966).

The distribution area of the alliance is the continental part of Europe; this fact being in strong relation with the distribution area of the most of its characteristic species. Cnidion meadows are regularly flooded throughout spring and dry up during the summer due to the continental climate conditions (Balátová-Tulácková, 1966, 1969). Determinant, from the ecological point of view is the period of flooding as well the duration, height and periodicity of floods with input of suspended solids. The phytocoenoses of the associations included in the alliance Cnidion generally occurs on the lower courses of the rivers, on heavy, clay-like soils with a low buffering capacity and light salinity (Balátová-Tulácková, 1966, 1969, 1988).

Cnidion type meadows are known not only from the Morava and Dyje rivers and the lowest stretch of the Upper Danube in Austria, but also from the Elbe River and some of its tributaries in Germany (Hundt, 1958; Passarge, 1964) and as well from the Odra River (Rast et al., 2000; Burkart et al., 2004). Also, they have been described from the Upper Rhine as the most western limit of such type of continental-subcontinental communities (Dister, 1980; Oberdorfer, 1983). Although these communities constitute on the Upper Rhine, an outpost area, the characteristic species of the alliance Cnidion are almost well represented.

The characteristic species for the Cnidion venosi alliance = Cnidion dubii are according to Balátová-Tulácková (1966) *Viola elatior*, *Viola persicifolia* (*stagnina*), *Viola pumila*, *Cnidium venosum* (*dubium*), *Allium angulosum*, *Gratiola officinalis*, *Lathyrus paluster*, *Scutellaria hastifolia*, *Leucojum aestivum*, *Lythrum virgatum*, *Juncus atratus*, *Oenanthe silaeifolia*, and *Clematis integrifolia* (Eastern and South-Eastern Europe). In contact with the phytocoenoses of the alliance Cnidion there are, on the one part species of more wet areas of the alliances Agropyro-Rumicion and Caricion gracilis; and on the other side, species of the Molinion as well as Arrhenatherion and Arrhenatheretalia. Between the lastly mentioned, *Alopecurus pratensis*, is represented frequently with high abundance-dominance values. This is why phytocoenoses are frequently edified by *Alopecurus pratensis*, and species of the Cnidion alliance are included in this phytocoenological unit. The high abundance-dominance values of this depends on the more or less eutrophic conditions as a consequence of flooding and as well in some cases by an additional anthropogenic fertilization (Burkart et al., 2004).

The Cnidion alliance is characteristic for continental floodplain meadows, and have been considered as a vicariance of the Deschampsion caespitosae Horvatic alliance (1930) 1935, this last being described for the first time by Horavtic from Northern Croatia (Balátová-Tulácková 1966 and 1988). According to Schubert et al. (1995), the alliance Cnidion dubii Bal.-Tul. 1966 is synonymous with the alliance Deschampsion caespitosae Horvatic 1935, including meadows with changing wetness. But the boundaries of this alliance are larger and its clear content is still missing for South-Eastern Europe (Burkart et al., 2004).

In strong relation with the flooding, i.e. the period in the year, duration, height and frequency, displacements occur in the species composition of Cnidion-type meadows in the direction of the more wet side to Agropyro-Rumicion, Caricion gracilis and Agrostion albae; or on the dryer side to Arrhenatheretalia and in some cases to Brometalia. Changes and reduction of Cnidion type meadows were also generated by changes in the hydrological regime due to drainage. These measures create a lack of water in summer time which together with the poor buffering capacity of soils lead to the deterioration of the site conditions for Cnidion type meadows, and an evolution to the poorer Molinion meadows (Balátová-Tulácková, 1981).

In Romania, alluvial Cnidion type grasslands of large river valleys belonging to the habitat type 6440 were not considered as "existing" in Romania until the last research was conducted (Schneider and Drăgulescu, 2005; Gafta and Montford, 2008) and documented with the association Cnidio-Deschampsietum Passarge (1960) from the floodplains of Râul Negru, a tributary of the human impacted Olt River basin (Sîrbu et al., 1999) and from the Upper Olt area in the Ciuc Depression (Danciu et al., 2009) although they are mentioned as existing (Balátová-Tulácková, 1969) according to data from Puşcaru-Soroceanu (1963). As typical floodplain grasslands are mentioned as representative, the associations of *Elymus (Agropyron) repens* with various charactertistics on the larger and smaller floodplains, the association of *Elymus (Agropyron) repens* and *Alopecurus pratensis*, the association of *Poa trivialis*, the association of *Agrostis alba* and the association of *Alopecurus pratensis* are in different variants. This has last been studied in detail and described from the large floodplains on the Cibin River and some smaller tributaries as the Ruscior and Strâmb streams in the area of Sibiu Depressions (Schneider-Binder, 1978). As *Alopecurus pratensis* is the characteristic species of the Cnidion alliance, as are well represented *Viola persicifolia, Clematis integrifolia, Allium angulosum, Gratiola officinalis, Scutellaria galericulata, Lythrum virgatum, Filipendula ulmaria, Galium rubioides*, and *Veronica longifolia*. With high abundance-dominance values, it became clear that these meadows belong to the Cnidion type meadows.

The floodplain grasslands of Romania are mainly considered as taking part of the Agropyro-Rumicion alliances, Agrostion albae, Deschampsion caespitosae, and Arrhenatherion (Puşcaru-Soroceanu, 1963; Sanda et al., 2008; Coldea et al., 2012). As the boundaries of the Cnidion alliance and the interlocking with the above mentioned alliances are not clear and well known in South-Eastern Europe, further studies are needed. In this context the present study will contribute to the understanding and better delineation of the Cnidion type grasslands with a presentation from the lower Danube floodplains.

MATERIAL AND METHODS

During field researches (2004-2008) on the lower Danube, upstream the town of Giurgiu, river kilometres 510-524, flooded meadows between river banks and the flood protection dykes have been studied. Samples were taken according to the method of Braun-Blanquet (1964) with the seven degree scale of abundance-dominance values for covering degrees, the number of species in each sample, and locality. The size of the sampling area has been in 25 m^2 (5 m x 5 m) with some exceptions. The species where analysed according to their indicator values for wetness according to Ellenberg et al. (2001) and Sanda et al. (1983). Also, new long term observations were taken into account for indicator value considerations. Discussions concerning conservation management measures were taken into account as were the indicator values for mowing compatibility (Briemle and Ellenberg, 1994) as the species present different sensitivity vis-à-vis mowing frequency. For comparison, older and recent author's data (2012) from the area of Sibiu Depression has been taken into account (Schneider-Binder, 1978, 1998), as well data from older literature (Pușcaru-Soroceanu, 1963) and recent publications. They were included in synthetic tables with frequency values (I-V) for showing commonalities and differences of flooded meadows from various regions. The nomenclature of the species listed in the tables follows Ciocârlan (2009), Oprea (2005) and Sârbu et al. (2013).

RESULTS AND DISCUSSIONS

On the lower Danube, temporary flooded meadows similar to those described by Bálatová-Tulcaková from the Morava Basin (1965, 1966, 1967, 1969, 1979, 1984) are distributed during field researches on small areas and can be found only as fragments, or strips along the dykes. It seems they have never occupied large areas on the lower Danube; being bound as replacing communities to the hardwood forest level of the floodplain (middle and higher level) edified by oak (*Quercus robur, Quercus pedunculiflora*), elm (*Ulmus laevis, U. minor*), ash (*Fraxinus excelsior, F. angustifolia*) and in a transition situation from soft- to hardwood forest by Black poplar (*Populus nigra*) and elm (*Ulmus laevis*).

In the large river floodplain of the lower Danube, the hardwood forest level is naturally not of large extend and is concentrated to the high natural riverbank levees (in Romanian "grinduri de mal"), which are relatively small for the lowland stretch of the Danube (Schneider-Binder, 2010) in comparison with the whole extent of the floodplain. This is characterized by large wetlands including larger and smaller floodplain lakes, small water courses and flood channels, galleries with willow-like (*Salix alba*) softwood forests along the river courses, large reed beds and small grasslands. Small patches of grasslands edified by *Elymus repens* are natural, but most of the grasslands' development is due to human activities. This is similar to the Cnidion type meadows which evolved after cutting parts of the Querco-Ulmetum hardwood floodplain forests included as habitat type "91F0 Riparian mixed forests of *Quercus robur*, *Ulmus laevis* and *Ulmus minor*, *Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (Ulmenion minoris)" in the list of habitats of community interest. The floodplain forests are covered naturally by only small, belt-like parts on the lower Danube, located on the riverbank levees; they are clearly visible in the field, and also clearly visible on older maps of the area. These maps show the lower Danube, the small forested area along the Danube River and the pre-terrace Gârla Pasărea (long water course) of the floodplain (Fig. 1).

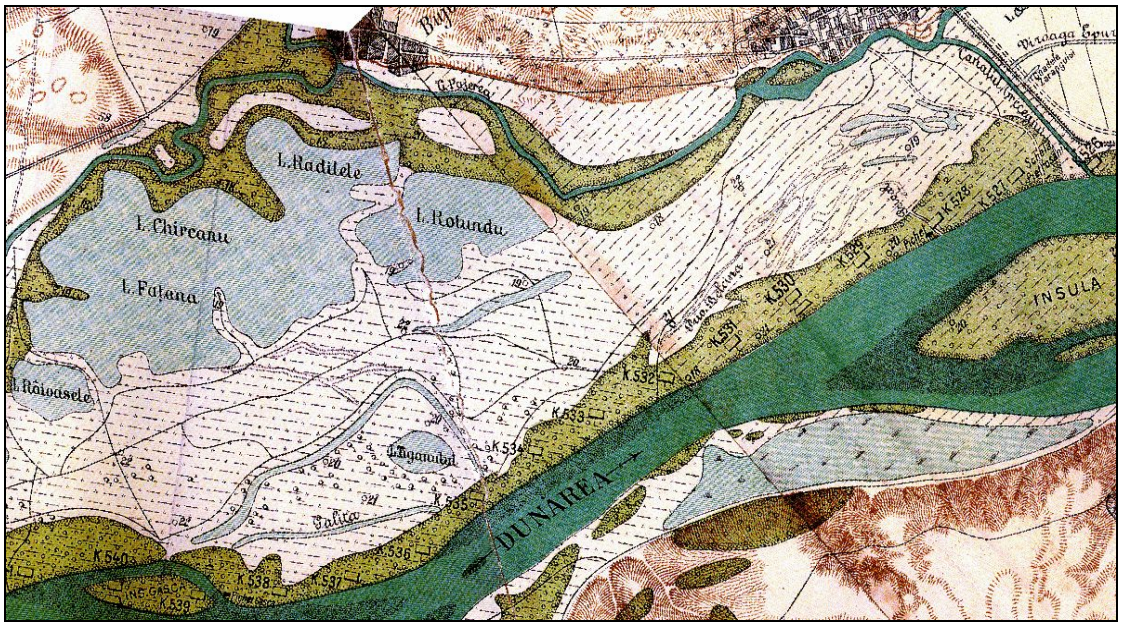

Figure 1: The Danube stretch upstream of Gâsca Island with small forest vegetation on river bank levees of the Danube and the Gârla Pasărea on the foot of the terrace, according to the "Map of the Danube course", Bucharest, 1934, edited by the Romanian Hydraulic Service, Scale 1: 50.000, volume III, km 770-390 (***, 1934)**.**

In this area, small agricultural lands arise (especially small meadows of Agropyro-Rumicion) on lower places, and Cnidion on the higher places; even if the difference in height between both is of only a few centimetres. In this area, it has been possible for the development of small flooded grasslands with characteristic species of the Cnidion dubii alliance. According to Ivan (1983) the long period of flooding in a year excluded the development of larger areas of meadows edified by *Alopecurus pratensis*, typical for lowlands. Although they occur in small areas in strong contact with still existing small patches of remained hardwood floodplain forests (habitat type 92 F0) and are characterized in the studied area by *Carex tomentosa, Clematis integrifolia, Lythrum virgatum, Scutellaria hastifolia, Gratiola officinalis, Carex praecox, Veronica longifolia, Elymus repens* and *Alopecurus pratensis.* Present as well are species of tall herbaceous fringes which are strongly related to the Cnidion type meadows, as well as the Agropyro-Rumicion species, and Molinio-Arrhenatheretea among other species, which occurs partly with high abundance-dominance values (Tab. 1).

As the characteristic species of the Cnidion alliance are almost present and partly with high abundance-dominance values and high frequency, the phytocoenoses of these studied flooded meadows upstream of Giurgiu near the villages Cetăţuia and Pietroşani can be considered as taking part of the Cnidion dubii alliance. Through the species combination of *Clematis integrifolia* and *Carex tomentosa*, present with high constancy and accompanied by species characteristic for fringes of South-Eastern Europe (such as G*lycyrrhiza echinata, Cynanchum acutum* and *Asparagus pseudoscaber*) this association can be considered as a new South-Eastern association taking part of the Cnidion alliance and characteristic for the lower Danube. The sample number three is typical and representative for this association.

Table 1: Clematido-Caricetum tomentosae ass. nova.

Number of samples	1	2	3	4	5	6	7	8	9	10	11	12	
Samplings size	25	25	25	25	25	25	25	25	9	25	25	25	
Covering degree %	100	85	95	100	90	100	80	100	100	95	100	85	
Species													F
Clematis integrifolia	2.5	2.5	2.5	2.4	2.5	+	+	2.5	+	+	1.3	+	V
Carex tomentosa	3.5	2.5	4.5	3.3	+	3.5	3.5	3.5	4.5	+	2.5	2.4	V
Lythrum virgatum	+	+	+	.	.	.	2.2	.	+	.	.	1.5	III
Scutellaria hastifolia	+	+	.	.	.	.	.	+	.	+	.	.	II
Carex praecox	.	.	+	.	.	.	+	.	.	2.5	+	.	II
Galium rubioides	.	.	+	.	.	.	.	+	.	.	4.5	+	II
Veronica longifolia	+	+	+	.	.	.	.	.	.	.	.	+	II
Gratiola officinalis	+	2.5	.	.	.	.	.	.	.	.	.	.	I
Tall herbaceous fringe species accompanying Cnidion type meadows													
Aristolochia clematitis	+	.	+	+	+	+	+	+	.	2.3	2.5	2.3	V
Thalictrum flavum	+	+	+	.	.	.	+	.	.	.	.	.	II
Euphorbia lucida	+	.	.	.	.	+	.	.	.	.	.	+	II
Glycyrrhiza echinata	2.4	2.5	1.2	.	.	.	+	+	.	1.2	.	.	III
Cynanchum acutum	+	+	.	+	.	.	.	.	.	.	.	.	II
Asparagus pseudosc.	+	.	+	.	3.5	.	+	.	.	.	.	.	II
Agropyro-Rumicion = Lolio-Potentillion													
Elymus repens	1.3	1.4	1.3	1.5	+	1.5	+	3.4	3.5	+	2.5	3.5	V
Carex hirta	.	.	+	+	.	+	+	+	+	.	.	+	III
Althaea officinalis	1.3	+	+	.	.	+	+	+	.	.	+	.	III
Molinio-Arrhenatheretea													
Symphytum officinale	+	+	+	.	+	+	.	+	+	.	+	1.5	IV
Alopecurus pratensis	3.5	1.5	1.2	.	.	4.5	.	2.3	.	3.5	+	+	IV
Arrhenatherum elatius	.	.	.	3.5	.	.	2.3	.	.	+	+	.	II
Poa pratensis	.	.	.	+	+	.	.	.	.	+	.	.	II
Vicia sepium	.	.	.	+	+	.	.	.	.	2.4	.	.	II
Other species													
Cichorium intybus	.	.	+	.	.	+	1.3	+	+	+	.	+	III
Cirsium arvense	.	.	.	.	.	+	+	.	.	.	+	+	II
Convolvulus arvensis	.	.	.	+	.	.	.	.	.	+	.	+	II
Erigeron canadensis	.	.	+	.	.	.	+	.	+	.	.	+	II
Lathyrus tuberosus	.	.	+	.	.	+	.	.	.	.	.	+	II
Lactuca serriola	.	.	+	.	+	.	+	.	.	.	.	.	II
Matricaria tenuifolia	.	.	+	.	.	.	.	.	+	.	.	+	II
Sorghum halepense	+	.	.	.	.	.	.	+	.	.	+	.	II
Bromus inermis	+	1.4	.	2.3	+	.	.	.	.	.	.	.	II
Morus alba	1.2	.	+	+	.	.	+	+	.	.	+	.	III
Phragmites communis	.	+	.	+	.	.	+	.	.	.	.	.	II
Galium aparine	.	.	.	.	3.5	.	.	.	.	.	.	.	I

Table 1 (continuing): Clematido-Caricetum tomentosae ass. nova.

Low abundance-dominance (+) in one or two samples, as well low frequency (I):
Iris pseudacorus (1), *Mentha longifolia* (1), *Bidens frondosa* (1), *Plantago media* (1, 2)
Pastinaca sativa (1, 7), *Plantago major* (1, 7), *Plantago media* (2), *Lotus tenuis* (3)
Plantago lanceolata (3), *Sonchus asper* (3, 7), *Anthemis arvensis* (4), *Dactylis glomerata* (4)
Papaver rhoeas (4), *Senecio vernalis* (4, 7), *Anthriscus sylvestris* (5), *Humulus lupulus* (5)
Lysimachia nummularia (5), *Populus alba* (5), *Quercus robur* (5), *Ulmus laevis* (5), *Urtica dioica* (5)
Agrostis stolonifera (6), *Rumex crispus* (6), *Poa trivialis* (6, 8), *Rorippa sylvestris* (6, 10)
Crepis setosa (7), *Caucalis daucoides* (7), *Trifolium echinatum* (7), *Ulmus minor* (7)
Dipsacus laciniatus (7, 9), *Taraxacum officinale* (7, 9), *Serratula tinctoria* (8)
Xanthiums strumarium (8), Erigeron annuus (8, 11), Bromus mollis (10), *Erodium cicutarium* (10)
Geranium robertianum (10), *Sonchus arvensis* (10), *Tragopogon dubius* (10)

Locality and data of sampling:
1: Cetăţuia, Giurgiu County, recent Danube floodplain, river-km 521, 43’42,576, 25, 45, 194, 30.07.2006; 2: Cetăţuia, Giurgiu County, recent Danube floodplain, river-km 524, 43’42,066, 25, 43,714, 30.07.2006; 3: Cetăţuia, Danube River-km 521, near Șaica, 43’42,556, 25, 45,165; 30.07.2006; 4: Cetăţuia, near Șaica, river-km 518, 28.05.2004; 5: Cetăţuia, Șaica, river-km. 517, 28.05.2004; 6: Șaica area, river-km 518, old floodplain, near the flood protection dyke, 20.07.2004; 7: Danube river-km 520, 22.07.2004; 8: Danube river-km 521, 27.07.2004; 9: Șaica area, river-km. 521, 27.07.2004; 10: Danube river-km 518, 27.07.2004; 11, 12: Șaica area, Danube river-km 522, 27-07.2004.

Through the high abundance and frequency of the sedge *Carex tomentosa* this association can be considered as a connecter to the Cnidio-Violetum pumilae caricetosum tomentosae Bal.-Tul. and Hübl 1974, described from the Danube in Austria, near Orth/Donau (Balátová-Tulácková and Hübl, 1974; Balátová-Tulácková, 1988). The frequency of *Clematis integrifolia* and the other above mentioned species underlines a more continental character of these Cnidion type of meadows.

In strong relation with the above described Clematido-Caricetum tomentosae meadow type are flood-grasslands with changing wetness, but on more wet sites, characterized by high abundance-dominance values of *Elymus repens* (Tab. 2). Together with the couch grass, (*Elymus repens*) occurs Cnidion species in these phytocoenoses, which indicates the closeness of these phytocoenoses to the above mentioned association. Present are *Clematis integrifolia* with frequency IV and *Scutellaria hastifolia, Veronica longifolia, Galium rubioides, Carex tomentosa* with frequency II. Present as well are species of Molinietalia, Arrhenatheretalia, Molinio-Arrhenatheretea and Lolio-Potentillion anserinae (Agropyro-Rumicion). Considering the species composition, the phytocoenoses with high abundance-dominance of *Elymus repens* can be considered as a sub-association of Clematido-Caricetum tomentosae with transition to phytocoenoses of the alliance of flood-grasslands Agropyro-Rumicion = Lolio-Potentilletum anserinae Tx. 1947.

The grasslands dominated by *Elymus repens*, but accompanied by species of Cnidion and of Molinietalia as well Molinio-Arrhenatheretea are recommended to be included in the Cnidion alliance (Dierschke, 2012). Such types of grasslands have been described from the Northern Upper Rhine (Dister, 1980).

Table 2: Clematido-Caricetum tomentosae subass. Elymetosum repentis; 1, 2, 3: Şaica, river-km 517.5, Cetăţuia, 4.06.2004; 4, 5: Şaica, river-km 518.5, Cetăţuia, 27.07.2004; 6, 7: Şaica oxbow lake, river-km 518, Cetăţuia, 28.05.2004; 8: Şaica, river-km 519, Cetăţuia, 29.05.2004; Giurgiu County.

	Number of samples	1	2	3	4	5	6	7	8	
	Sampling size m^2	25	25	25	25	25	25	25	20	
	Covering degree %	100	85	100	100	85	90	100	100	
										F
	Elymus repens	3.5	4.5	4.5	5.5	4.5	4.5	4.5	5.5	V
	Clematis integrifolia	+	.	1.2	+	+	.	1.3	+	IV
	Scutellaria hastifolia	.	+	+	.	+	.	.	.	II
	Veronica longifolia	.	.	.	+	+	.	.	.	II
	Galium rubioides	.	.	.	.	.	.	+	+	II
	Carex tomentosa	+	+	.	.	.	.	.	+	II
Molinietalia										
	Symphytum officinale	.	+	+	.	+	.	.	.	II
Tall herbaceous vegetation associated to Cnidion and couch grass associations										
	Aristolochia clematitis	3.5	1.5	+	+	+	+	+	+	V
	Glycyrrhiza echinata	.	.	.	.	1.4	.	.	.	I
	Cynanchum acutum	.	.	.	.	+	+	.	.	II
	Asparagus pseudoscaber	.	.	+	.	.	.	+	+	II
	Euphorbia lucida	.	.	.	.	+	+	+	.	II
Arrhenatheretalia, Molinio-Arrhenatheretea										
	Arrhenatherum elatius	.	+	+	.	.	2.3	.	.	II
	Poa pratensis	.	.	+	.	.	1.5	+	.	II
	Alopecurus pratensis	+	.	.	2.2	.	.	.	.	II
	Dactylis glomerata	.	.	+	.	.	+	.	.	II
	Carex praecox	+	+	.	.	.	.	.	.	II
	Vicia sepium	+	2.5	.	.	.	+	+	+	III
Lolio-Potentillion anserinae (Agropyro-Rumicion)										
	Althaea officinalis	.	.	.	+	+	.	.	.	II
	Carex hirta	+	.	1.2	.	.	.	+	+	III
Other species										
	Glecoma hederacea	.	+	+	.	.	+	+	.	III
	Galium aparine	3.5	+	3.5	.	.	.	2.5	+	III
	Cirsium arvense	+	.	.	.	+	.	.	.	II
	Dipsacus laciniatus	.	.	.	+	+	.	.	.	II
	Phragmites communis	.	.	.	.	2.2	1.3	.	.	II
	Bromus inermis	.	.	.	.	+	+	+	.	II
	Papaver rhoeas	.	.	+	.	.	+	.	.	II
	Lactuca serriola	.	.	.	.	.	+	+	.	II
	Ulmus minor	.	.	.	.	.	+	.	+	II
	Populus nigra	.	.	+	+	.	+	.	.	II
	Amorpha fruticosa	+	.	+	.	+	.	.	.	II

Table 2 (continuing): Clematido-Caricetum tomentosae subass. Elymetosum repentis;

Species noted with + in one sampling area (and frequency class I):
1: *Anthriscus sylvestris, Carex spicata, Sonchus arvensis.*
2: *Conyza canadensis, Morus alba, Urtica dioica*.
3: *Carex echinata, Cornus sanguinea, Leonurus cardiaca, Lycopus europaeus*.
Lysimachia nummularia, Melandrium album, Pyrus pyraster, Sonchus asper.
4: *Cichorium intybus, Echinocloa crus-galli, Lathyrus pratensis, Lotus tenuis,*
Pastinaca sativa, Plantago major, Poa trivialis, Ranunculus repens
Sium latifolium, Trifolium fragiferum.
5: *Iris pseudacorus, Sorghum halepense*.
6: *Achillea collina, Bromus sterilis, Carduus acanthoides, Carex flacca, Coronilla varia,*
Convolvulus arvensis, Daucus carota, Erigeron annuus, Geranium columbinum,
Lepidium ruderale, Leucanthemum vulgare, Lolium perenne, Plantago lanceolata,
Quercus robur (regeneration), *Tragopogon dubius, Trifolium campestrei*.
7: *Rorippa sylvestris, Ulmus laevis,* 8: *Crataegus monogyna*.

Comparing floodplain meadows of different parts of the lower Danube River basin can have stated commonalities, but as well remarkable differences (Tab. 3). Older samples from floodplains of the Oltenia region, in particular from the floodplains of Jiu and Olt rivers, from the Muntenia region tributaries of the Danube and the Danube floodplain in forms of synthetic tables. Unfortunately, without mentioning the number of field samples (Puşcaru-Soroceanu, 1963; Tab. 3, columns 1, 2 and 3), visible differences are compared with Cnidion type meadows. This concerns phytocoenoses structure, species composition and frequency values of species. At the same time, it can be stated that Cnidion type meadows were not mentioned at that time, and this was probably because the meadows area near the hardwood floodplain forests or replacing the small patches of hardwood floodplain forests on the lower Danube were not remarked. The Cnidion species (at that time all included to the Molinietalia) in the Oltenia region are mentioned with poor representation; only *Oenanthe banatica* and *Gratiola officinalis*. Species of Molinietalia are lacking apart from *Poa trivialis* ssp. *sylvicola* (Tab. 3, column 1). In general, the floodplain grasslands of Oltenia and Muntenia region (Tab. 3, columns 1 and 2) are poor in species, only some of the Molinio-Arrhenatheretea classes such as *Alopecurus pratensis* and *Poa pratensis* are well represented. A better representation has the species of the Agropyro-Rumicion alliance, but with high frequency and *Elymus repens* and *Agrostis stolonifera* occur. Furthermore, they are characterised by halophilous species and some Festuco-Brometea species which show summer dryness due to the continental climate.

The only floodplain grassland given in a synthetic table from the Danube floodplain (Puşcaru-Soroceanu, 1963) is poorer than the two above discussed (Tab. 3, column 3). This grassland type is dominant, as well *Elymus repens* and species of Agropyro-Rumicion such as *Mentha pulegium, Trifolium fragiferum, Trifolium hybridum* and *Inula britannica*. The occurrence of such grasslands corresponds to the softwood level and the transition to the hardwood forest level. The studied Cnidion type floodplain meadows (Tab. 3, column 4) occur on the hardwood forest level and are only of small extends; not mentioned before.

Next to the Cnidion type meadows of the Middle Danube are those described from the Ozun floodplain of Râul Negru/Upper Olt basin (Danciu et al., 2009), characterized by high frequency of *C. dubium, V. pumila* and *D. caespitosa* and *A. pratensis* (Tab. 3, columns 5 and 6).

Table 3: Comparison of the different types of floodplain meadows.

			Number of columns	1	2	3	4	5	6	7
			Number of samples	-	-	-	12	7	7	7
	U	mc								
Cnidion										
	8 ~	5	*Cnidium dubium*	-	-	-	-	V	V	-
	7 ~	4	*Viola pumila*	-	-	-	-	V	III	-
	8 ~	4	*Allium angulosum*	-	-	-	-	II	III	-
	8 =	3 x	*Scutellaria hastifolia*	-	-	-	II	I	I	II
	8 ~	4 x	*Gratiola officinalis*	I	-	-	I	-	-	I
	8 =	3 x	*Oenanthe banatica*	II	-	-	-	-	-	I
	7 ~	3 x	*Clematis integrifolia*	-	-	-	V	-	-	I
	4	3	*Galium rubioides*	-	-	-	II	-	-	II
	8 ~	3 x	*Lythrum virgatum*	-	-	-	III	-	-	I
Differential species for Clematido-Caricetum tomentosae										
	4 ~	3 x	*Aristolochia clematitis*	-	-	-	V	-	-	-
	3 ~	3 x	*Glycyrrhiza echinata*	-	-	-	III	-	-	-
	4 ~	-	*Cynanchum acutum*	-	-	-	II	-	-	-
	3 ~	-	*Asparagus pseudoscaber*	-	-	-	II	-	-	-
Molinion, Molinietalia										
	7 ~	3	*Carex tomentosa*	-	-	-	V	II	-	-
	x	3	*Serratula tinctoria*	-	-	-	I	V	-	-
	x ~	4	*Stachys officinalis*	-	-	-	-	V	-	I
	7 ~	5	*Deschampsia caespit.*	-	-	-	-	V	II	III
	7 ~	4	*Lychnis flos-cuculi*	I	-	-	-	III	III	I
	8	3 x	*Thalictrum lucidum*	-	-	-	-	I	I	I
	8 ~	3	*Iris sibirica*	-	-	-	-	-	-	II
	6 ~	3 x	*Gladiolus imbricatus*	-	-	-	-	-	-	II
	8 ~	4 x	*Cirsium canum*	-	-	-	-	-	-	III
	4	-	*Poa trivialis sylvicola*	III	-	-	-	-	-	-
Filipendulion										
	8 ~	3	*Veronica longifolia*	-	-	-	II	-	-	IV
	8 ~	3	*Thalictrum flavum*	-	-	-	II	-	-	-
	7 ~	3	*Euphorbia lucida*	-	-	-	II	-	-	-
	8 ~	3	*Lysimachia vulgaris*	-	-	-	-	-	III	III
	8	3	*Filipendula ulmaria*	-	-	-	-	-	-	IV
	8 ~	3	*Lythrum salicaria*	-	-	-	-	-	III	I
Arrhenatherion										
	4	7	*Galium mollugo*	-	-	-	-	-	-	II
	x	6	*Arrhenatherum elatius*	-	-	-	-	-	-	II
	5	5	*Campanula patula*	-	-	-	-	-	-	III
	6	6	*Crepis biennis*	-	-	-	-	-	-	II
	5	8	*Trifolium repens*	III	I	-	-	-	I	I
	5	8	*Lolium perenne*	II	II	-	-	-	-	I

Arrhenatheretalia										
	4	6	*Leucanthemum vulgare*	-	-	-	-	II	II	III
	4	5	*Knautia arvensis*	-	-	-	-	-	-	IV
	4	7	*Achillea millefolium*	-	IV	-	-	-	I	IV
	5	6	*Vicia sepium*	-	-	-	II	-	-	-
Molinio-Arrhenatheretea										
	6	7	*Alopecurus pratensis*	V	V	-	IV	V	V	IV
	5	9	*Poa pratensis*	IV	V	-	II	V	II	I
	x	7	*Plantago lanceolata*	V	II	-	I	II	-	III
	x	6	*Rumex acetosa*	I	-	I	-	III	I	I
	6	6	*Festuca pratensis*	I	-	-	-	V	I	IV
	6 ~	5	*Sanguisorba officinalis*	-	-	-	-	V	I	II
	7	6	*Symphytum officinale*	I	-	-	IV	I	I	V
	4	4	*Plantago media*	I	-	III	I	-	-	-
	7	6	*Poa trivialis*	-	-	-	I	-	-	III
	6 ~	5	*Colchicum autumnale*	-	-	-	-	V	I	I
	6 ~	4 x	*Rhinanthus angustifolius*	-	-	-	-	V	III	-
	6	6	*Vicia cracca*	-	-	-	-	V	IV	-
	5	4	*Stellaria graminea*	-	-	-	-	IV	I	IV
	6	5	*Lathyrus pratensis*	-	-	-	-	V	-	III
	6	6	*Ranunculus acris*	-	-	-	-	III	-	V
	5	9	*Prunella vulgaris*	-	I	-	-	-	I	I
	5	7	*Trifolium pratense*	I	-	-	-	-	I	IV
Agropyro-Rumicion										
	6 ~	5	*Carex hirta*	-	-	-	III	II	III	I
	x ~	7	*Elymus repens*	I	V	V	V	V	III	III
	7 ~	9	*Agrostis stolonifera*	I	III	-	-	-	-	III
	7 =	3 x	*Althaea officinalis*	-	-	-	III	-	-	-
	4	5	*Rorippa sylvestris*	II	II	-	I	-	-	I
	6 ~	6	*Trifolium resupinatum*	III	-	-	-	-	-	-
	7 =	-	*Mentha pulegium*	II	-	III	-	-	-	-
	7 =	6	*Trifolium fragiferum*	I	I	III	-	-	-	-
	6	7	*Trifolium hybridum*	I	I	III	-	III	III	III
	7 ~	6	*Rumex crispus*	I	II	I	I	I	II	IV
	6	8	*Potentilla reptans*	III	I	I	-	V	IV	I
	7 =	-	*Rorippa austriaca*	I	II	-	-	-	III	-
	7 =	4	*Inula britannica*	-	II	III	-	II	III	-
	7 ~	7	*Festuca arundinacea*	-	-	-	-	-	-	III
Halophilous differential species Elymus repens-Alopecurus ass.										
	x =	-	*Juncus gerardi*	-	IV	-	-	-	-	-
	6 =	-	*Aster tripolium*	-	II	-	-	-	-	-
	6 ~	-	*Puccinellia distans*	-	II	-	-	-	-	-
	4	-	*Cynodon dactylon*	II	IV	III	-	-	-	-
	4	4	*Polygonum aviculare*	-	I	IV	-	-	-	-

Table 3 (continuing): Comparison of the different types of floodplain meadows.

Phragmition, Phragmitetalia										
	8 ~	5	*Phalaris arundinacea*	-	-	-	-	II	I	-
	9 =	5	*Poa palustris*	-	-	-	-	III	V	-
	10	3	*Eleocharis palustris*	I	I	-	-	-	-	I
	10	3	*Phragmites communis*	-	II	-	II	-	-	III
	9 =	4	*Galium palustre*	-	-	-	-	III	III	-
	8 =	3	*Carex vulpina*	-	-	-	-	III	IV	II
Festuco-Brometea and subunits										
	3 ~	4	*Filipendula vulgaris*	-	-	-	-	V	II	I
	4 ~	5	*Galium verum*	-	-	-	-	V	II	I
	2	-	*Achillea setacea*	-	IV	-	-	-	-	-
	3	6 x	*Festuca pseudovina*	-	III	-	-	-	-	-
	3	-	*Taraxacum erythrosperm.*	-	II	-	-	-	-	-
	3	-	*Poa bulbosa*	II	I	-	-	-	-	-
	4	7	*Medicago lupulina*	-	I	-	-	-	-	I
	3	6 x	*Festuca rupicola*	-	-	-	-	II	-	-
Species in different phytocoenological classes										
	5	8	*Dactylis glomerata*	-	-	-	I	-	-	III
	x ~	6	*Bromus hordeaceus*	I	I	-	I	-	-	I
	7 ~	8	*Ranunculus repens*	IV	I	-	-	I	V	II
	6 ~	6	*Lysimachia nummularia*	-	-	-	I	I	III	-
Accompaning species of other phytocoenological units										
	4	6	*Lotus corniculatus*	IV	II	-	-	IV	III	V
	5	8	*Taraxacum officinale*	IV	II	IV	I	-	-	I
	3 ~	-	*Carex praecox*	-	III	-	II	II	-	I
	x	5	*Centaurea jacea*	-	-	-	-	-	-	III
	x	5	*Polygonum amph. f. t.*	-	-	-	-	-	-	III
	5	5	*Plantago major*	I	-	-	I	-	-	II
	4	4	*Cichorium intybus*	-	II	-	III	-	-	-
	5	-	*Xanthium strumarium*	-	-	IV	-	-	-	-
	2	-	*Centaurea iberica*	-	-	IV	-	-	-	-
	x	5	*Ranunculus auricomus*	-	-	-	-	V	III	I
	6	8	*Glechoma hederacea*	-	-	-	-	II	II	-
	x	6	*Agrostis capillaris*	-	-	-	-	IV	-	-
	4 ~	5 x	*Ranunculus polyanth.*	-	-	-	-	II	-	-
	6 ~	4	*Carex pallescens*	-	-	-	-	II	-	-
	9	6	*Agrostis canina*	-	-	-	-	II	-	-
	9 =	-	*Veronica scutellata*	-	-	-	-	-	III	-
	4	-	*Vicia hirsuta*	-	-	-	-	-	-	III
	x	3	*Carex spicata*	I	III	-	-	-	-	-
	3	5	*Medicago falcata*	I	I	-	-	-	-	-
	4	3	*Trifolium medium*	-	-	-	-	II	I	-

Column 1: samples from the Oltenia region, mainly from the Olt and Jiu rivers, ass. of *Alopecurus pratensis* (Pușcaru-Soroceanu, 1963; table 122, 1963);

Column 2: samples from the rivers in the Muntenia region, ass. of *Elymus repens* and *Alopecurus pratensis* (Pușcaru-Soroceanu, 1963; table 117, 1963);

Column 3: samples from the Danube floodplain, ass. of *Elymus repens*, variant of the Lower Danube floodplain (Puşcaru-Soroceanu, 1963; table 116, 1963);

Column 4: Samples from the Danube River-km 510-524 (Tab. 1);

Column 5: Cnidio-Deschampsietum Passarge 1960 (Danciu et al., 2009), Râul Negru Lunca Ozunului;

Column 6: Ranunculo repentis-Alopecuretum pratensis Ellmauer 1933, Râul Negru Lunca Ozunului (Danciu et al., 2009);

Column 7: Alopecuretum pratensis Ruşcior meadow, Sibiu Depression, 17.06.2012.

"x" after the indicator value of mowing compatibility is given for the species with values considered according to field observations of the author.

The sign "~" after a number in the table is an indicator for strong changes.

The sign "=" after a number is a flooding indicator for a species which occurs on more or less regularly flooded soils.

Analysing the associations described from the Sibiu Depression with large floodplains on the Cibin River and some smaller tributaries such as the Ruşcior and Strâmb streams (Schneider-Binder, 1978, 1991, 1998), with characteristic species of the Cnidion alliance such as *Viola persicifolia, Clematis integrifolia, Allium angulosum, Gratiola officinalis, Scutellaria galericulata, Lythrum virgatum, Filipendula ulmaria, Galium rubioides, Veronica longifolia,* as well as the Eurasian-continental species *Plantago maxima* and with a high abundance-dominance of *Alopecurus pratensis*; it became clear, that Cnidion type meadows existed in the past on larger extend in those floodplains. Due to the drainage of the Cibin River area, the Ruşcior floodplains and transformation into agricultural lands, as well as an actual intensive grazing in some places, the area has been reduced to small patches or disappeared completely. On the Ruşcior canal were found in 2012 fragments of Cnidion type meadows with some Cnidion species such are *Scutellaria hastifolia, Gratiola officinalis, Clematis integrifolia, Oenanthe banatica, Lythrum virgatum* and *Galium rubioides* exist. Also, species of Molinietalia such as *Iris sibirica, Gladiolus imbricatus, Cirsium canum* and *Deschamspia caespitosa* were found together with accompanying tall herbaceous species such are *Veronica longifolia* and *Filipendula ulmaria* (Tab. 3, column 7). Edifying species are also those of the Agropyro-Rumicion alliance and species of Molinio-Arrhenatheretea; in particular *Alopecurus pratensis.*

In the Southern part of the Cibin River floodplain, near the locality of Tălmaciu, existed meadows of the Cnidion, but were modified by human intervention through drainage. The presence of the species *Cnidium dubium* has been documented near Tălmaciu in the year 2009 in a meadow considered as a transition stage from Cnidion to Molinion. Such changes and transformations of the Cnidion type temporary flooded meadows to Molinion type meadows and are caused by cutting off from the river dynamics, drainage and related changes of the hydrological regime, as it has been observed; as also on the middle Danube on the Morava and Dyije rivers (Balátová-Tulácková, 1981; Seffer et al., 2008).

The Cnidion type meadows include a great number of characteristic river valley species ("Stromtalarten") which, due to human intervention by drainage and transformation into agricultural lands, became very rare. This is why there is a need for special attention by protection and conservation management. Changes of land use have negative effects for these meadows in both cases, i.e. by intensification and as well by the abandonment of mowing and use. Through intensification of land use, the species sensitive to mowing (mc = mowing compatibility 3) or sensitive to mowing earlier than mid-July (mc = 4) are decreasing and at least endangered by disappearing. Species with five moderate compatibility (mc = 5, with first mowing not before beginning of July) will persist with longer time in these meadows (Briemle and Ellenberg, 1994). The abandonment of use by stopping the mowing leads also to a decrease of Cnidion meadow species; the meadows entering in a succession process with an increase of tall herbaceous plants as well of scrubs.

For a sustainable conservation of the species, and the habitat type 6440 of Cnidion type meadows, restoration of the hydrological regime is needed, as is the application of a conservation management with a mowing frequency corresponding to this type of meadows, (at least once or in some cases twice a year (Seffer et al., 2008)), as it is applied as well on Cnidion type meadows from rivers such are the Elbe and its tributaries (Passarge, 1964; Schneider-Binder unpublished field data, 1995).

CONCLUSIONS

As the Cnidion type flooded meadows are supposed to a certain river dynamic with changing water levels, also are the species' composition of the phytocoenoses which are supposed to a certain dynamic; and changes in the abundance-dominance with shifting to the drier or the more wet side in dependence of the hydrological regime along a year.

On the lower Danube and its tributaries in spring time and early summer, the conditions are wet; but in the summer time, due to the continental climate, they are at dry conditions. This is visible also by the occurrence in the phytocoenoses of species of the classe Festuco-Brometea and some halophilous species of other phytocoenological units.

To have a clear picture about the manifold variants of floodplain meadows, supposed to natural or near natural flooding regime, it is necessary to give more attention to these meadows even if they exist on relatively small surfaces. Further detailed studies are needed not only on the larger tributaries of the lower Danube River basin, but also on the smaller tributaries (second and third category). Also, comparative studies with such types of meadows from other European rivers are needed for the knowledge of the different geographical variants and the transition stages between them. It is necessary to study the meadows in relation with the flooding regime, but also under the aspect of their use, giving particular attention to its intensity. A restoration of the hydrological regime of the rivers and streams on which occurred or still occurs, on a small area of Cnidion type meadows is the base for their re-development.

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AN UPDATED CHECKLIST OF PARASITIC HELMINTHS OF MARINE FISH FROM TURKEY

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ABSTRACT

An updated checklist carried out indicated the occurrence of 161 helminth species from wild marine fish species in Turkey, which includes 49 monogeneans, 63 digeneans, 18 cestodes, 17 nematodes, 11 acanthocephalans and three annelids, from 88 different fish (86 native, two migratory) species. Since the publication of the checklist of helminth parasites of marine fishes in Turkey over nine years ago (Öktener, 2005), there have been a number of new records. This update includes these additional records and has allowed the correction of those errors and omissions that were present in the previous version. The parasite species list is arranged by phylum and class, providing parasite species name, host fish, location of host fish capture and author, and date of published record. The host list consists of all parasite species listed by host species. All parasites and their hosts are confirmed with the recent systematic accounts and full taxonomic account.

RESUMEN: Elenco actualizado de parásitos helmintos de peces marinos de Turquía.

Un elenco actualizado indica la existencia de 161 especies de helmintos de peces marinos silvestres de Turquia, los cuales incluyen 49 monogeneos, 63 digeneos, 18 cestodos, 17 nematodos, 11 acantocéfalos y tres anélidos que parasitan 88 especies distintas de peces marinos de Turquía (86 de ellos nativos y dos migratorios). Desde la publicación de un elenco de parásitos helmintos de peces marinos en Turquía, hace 9 años (Öktener, 2005) nuevas especies han sido registradas. Esta actualización contempla dichos registros y ha permitido la corrección de aquellos errores y omisiones que estaban presentes en las versiones anteriores. La lista de parásitos está organizada según filum y clase, mostrando el nombre de la especie del parásito, del pez hospedero, la localización de donde éste fue capturado, así como también del autor y la fecha de publicación del registro. Asimismo, la lista contiene las especies de parásitos ordenadas según la especie hospedera. Los nombres de todos los parásitos y de sus hospederos están en conformidad con los protocolos de sistemática más recientes.

REZUMAT: Conspectul speciilor de helminți paraziți la ihtiofauna marină din Turcia.

Conspectul la zi indică prezența a 161 specii de helminți din care 49 specii sunt trematode din clasa Monogenea, 63 din clasa Digenea, 18 cestode, 17 nematode, 11 acantocefali, trei anelide găsite la 88 specii diferite de pești (86 autohtone și două în pasaj) din fauna sălbatică marină a Turciei. De la ultima ediție a conspectului speciilor de helminți paraziți la ihtiofauna marină a Turciei acum nouă ani (Öktener, 2005), au fost semnalate specii noi. Această versiune include ultimele descoperiri și corectează erorile și omisiunile versiunii precedente. Conspectul este prezentat după încrengătură și clasă, cu numele speciei parazite, gazda, locul capturării peștelui gazdă, autorul și data publicării. Lista de specii gazdă conține speciile parazite găsite la acestea. Paraziții și gazdele lor fac obiectul confirmării prin note sistematice recente sau chei de identificare complete.

INTRODUCTION

In Turkey, the total length of the sea coast is 8,333 km, including the Black Sea, the Mediterranean Sea, the Aegean Sea and the Marmara Sea.

The Black and Mediterranean shores do not have inlets or promontories, in comparison to the Aegean Sea, which has an indented coastline, including bays, gulfs, deltas and also islands.

Marmara Sea connects the Mediterranean Sea to the Black Sea (Kılıç, 1999). The examination of literature on Turkish seas by Frick et al. (2007) revealed reports of 434 native species (plus 46 immigrated or introduced ones), with the Gobiidae and Sparidae being the largest families.

Articles in various publications have mentioned parasites of wild, farmed and imported fish by Turkish researchers between 1931 and 2014.

All information about parasites of marine fish has been compiled by Öktener (2005), based on parasite-host list and host-parasite list.

The author compiled a significant checklist of the metazoan parasites (114 helminths, 95 named and 19 unnamed) of marine fish from Turkey area.

After this significant checklist, several publications have been made by Turkish and foreign scientists. These specific studies yielded some new distributional records and added new species.

This checklist is done to update previously published lists of helminths of marine fishes from Turkey. Finally, this paper is also intended to show and update the parasite richness of fishes of Turkey.

MATERIAL AND METHODS

Information from all the available references on helminths of marine fishes in Turkey (journal publications, reports of research projects, theses, proceedings of congresses, symposium proceedings) from 1931 to 2014 were gathered to provide host-parasite and parasite-host lists.

In the literature dealing with the parasites of marine fishes in Turkey, there appear incorrect spellings of parasite names, host names and species author's names, and incorrect attributions of dates of species authorship.

The scientific names of all parasites and their synonyms were checked with the main electronic sites concerned with classification (ITIS, 2014; WoRMS Editorial Board, 2014; Gibson et al., 2003). Where wrong spellings of parasite genus or species names have been consistently applied, these are noted in the table (Tab. 1).

The scientific names of fishes were checked according to Frick et al. (2007) and electronic sites; Froese and Pauly (2014a), WoRMS Editorial Board (2014), Eschmeyer (2014).

Similarly, misspellings of host species names, with the few exceptions where these have been widely applied, have been corrected without comment using information obtained from FishBase (Froese and Pauly, 2014b) (Tab. 2).

Table 1: Changes of current valid names and synonymies.

Synonyms and incorrect spellings	Valid names
Microcotyle mugilis Vogt, 1879	*Solostamenides mugilis* (Vogt, 1879)
Microcotyle erytrini Van Beneden, 1880	*Microcotyle erythrini* Van Beneden and Hesse, 1880
Microcotyle chrysophrii Van Beneden, 1880	*Sparicotyle chrysophrii* (Van Beneden and Hesse, 1863)
Cyclocotyla bellones (Otto, 1821)	*Diclidophora bellones* (Otto, 1823)
Octostoma scombri Kuhn, 1829	*Kuhnia scombri* (Kuhn, 1829)
Furnestina echeneis (Wagener, 1857)	*Lamellodiscus echeneis* (Wagener, 1857)
Bucephalus varicus Monter, 1940	*Bucephalus margaritae* Ozaki and Ishibashi, 1934
Paracryptogonimus aloysiae (Stossich, 1885)	*Siphoderina aloysiae* (Stossich, 1885); Miller and Cribb, 2008
Lepidapedon şengünii Akandere, 1972	*Prodistomum polonii* (Molin, 1859); Bray and Gibson, 1990
Lepidapedon riccii Akandere, 1972	*Prodistomum polonii* (Molin, 1859); Bray and Gibson, 1990
Lecithochirium gravidium Loss, 1907	*Lecithochirium rufoviride* (Rudolphi, 1818)
Lecithostaphylus retroflexum (Molin, 1859)	*Lecithostaphylus retroflexus* Molin, 1859; Odhner, 1911
Haplocladus typicus Odhner, 1911	*Monascus filiformis* (Rudolphi, 1819)
Opecoelides furcatus (Odhner, 1928)	*Opecoeloides furcatus* (Bremser in Rudolphi, 1819)
Allopodocotyle pedicellatum (Stossich, 1887)	*Allopodocotyle pedicellata* (Stossich, 1887); Pritchard, 1966
Bucephalopsis haemaena Lacaze-Duthier, 1854	*Bucephalus marinus* Vlasenko, 1931
Spinectus oviflagellis (Fourment, 1883)	*Spinitectus oviflagellis* Fourment, 1883
Echinocephalus spinosissimus Hornell, 1905	*Echinocephalus spinosissimus* von Linstow, 1905
Anguillicola crassus Kuwahara, Niimi and Itagaki, 1974	*Anguillicoloides crassus* (Kuwahara, Niimi and Itagaki, 1974)
Solearhynchus soleae (Porta, 1905)	*Solearhynchus rhytidotes* (Meyer, 1933)
Stibarobdella loricata (Harding, 1924)	*Stibarobdella macrothela* (Schmarda, 1861)

Table 1 (continuing): Changes of current valid names and synonymies.

Synonyms and incorrect spellings	Valid names
Lecithochirium musculus (Looss, 1907)	*Lecithochirium musculus* (Looss, 1907) Nasir and Diaz, 1971
Lepidapedon elongatum (Lebow, 1908)	*Lepidapedon elongatum* (Lebour, 1908) Nicoll, 1910
Mesometra orbicularis (Rudolphi, 1819) Lühe 1901	*Mesometra orbicularis* (Rudolphi, 1819)
Opechona bacillaris (Molin, 1859)	*Opechona bacillaris* (Molin, 1859); Dollfus, 1927
Pachycreadium carnosum (Rudolphi, 1819)	*Pachycreadium carnosum* (Rudolphi, 1819); Cortini and Ferretti, 1959
Pronoprymna ventricosum (Rudolphi, 1819)	*Pronoprymna ventricosa* (Rudolphi, 1819)
Robphildollfusium fractum (Rudolphi, 1819); Paggi and Orecchia, 1963	*Robphildollfusium fractum* (Rudolphi, 1819)
Stephanostomum bicoronatum (Stossich, 1883)	*Stephanostomum bicoronatum* (Stossich, 1883); Fuhrmann, 1928
Stephanostomum minutum (Loss, 1899)	*Stephanostomum minutum* (Looss, 1901); Manter, 1940
Steringotrema pagelli van Beneden, 1871	*Steringotrema pagelli* (Van Beneden, 1871); Odhner, 1911
Didymobothrium rudolphi (Monticelli, 1890)	*Didymobothrium rudolphii* Nybelin, 1922
Paradilepis scolecina Rudolphi, 1935	*Paradilepis scolecina* (Rudolphi, 1819)
Neoechinorhynchus agilis Rudolphi, 1819	*Neoechinorhynchus (Hebesoma) agilis* (Rudolphi, 1819)
Pseudoechinorhynchus clavula Dujardin, 1845	*Acanthocephalus clavula* Dujardin, 1845
Bothriocephalus scorpii (Mueller, 1776)	*Bothriocephalus scorpii* (Müller, 1776)
Proteocephalus macrocephalus Creplin, 1825	*Proteocephalus macrocephalus* (Creplin, 1825)
Acanthocephalus anguillae Müller, 1780	*Acanthocephalus anguillae* (Müller, 1780)
Acanthocephaloides propinquus Dujardin, 1845	*Acanthocephaloides propinquus* (Dujardin, 1845)
Longicollum pagrosomi (Yamaguti, 1935)	*Longicollum pagrosomi* Yamaguti, 1935
Pontobdella muricata Linnaeus, 1758	*Pontobdella muricata* (Linnaeus, 1758)

Table 2: Changes of current valid names, synonymies and incorrect spellings of fish species.

Synonyms and incorrect spellings	Valid names
Pomatomus saltator	*Pomatomus saltatrix*
Sparus auratus	*Sparus aurata*
Merlangius merlangus euxinus	*Merlangius merlangus*
Trachynotus ovatus	*Trachinotus ovatus*
Puntazzo puntazzo	*Diplodus puntazzo*
Spicara flexuosa	*Spicara maena*
Spoondyliosoma cantharus	*Spondyliosoma cantharus*
Sparus pagrus	*Pagrus pagrus*
Pagellus acerna	*Pagellus acarne*
Trigla lucerna	*Chelidonichthys lucerna*
Pagrus coeruleostictus	*Pagrus caeruleostictus*
Sprattus sprattus phalericus	*Sprattus sprattus*
Solea vulgaris	*Solea solea*
Alosa pontica	*Alosa immaculata*
Epinephelus gigas	*Epinephelus marginatus*
Ophidium barbatum	*Ophidion barbatum*
Eutynnus alleteratus	*Euthynnus alletteratus*
Gobius copitis	*Gobius cobitis*
Solea nasuta	*Pegusa nasuta*
Platichthyes flesus	*Platichthys flesus*
Pleuronectes flesus luscus	*Platichthys flesus*
Squalus blainville	*Squalus blainvillei*
Psetta maxima	*Scophthalmus maximus*
Monorchis hispidus	*Monochirus hispidus*

RESULTS AND DISCUSSION

This helminth checklist of marine fish from Turkey includes only Monogenea, Digenea, Cestoda, Nematoda, Acanthocephala, Annelida and it was compiled with the parasite species arranged by phylum, class and alphabetical order, as appropriate.

The host-parasite list/parasite-host list are arranged as follows.

The parasite species list is arranged by phylum and class, providing parasite species name, host fish, location of host fish capture and author, date of published record (Tab. 3).

The host list consists of all the parasite species listed by host species (Tab. 3).

Table 3: Helminth - host list.

Phylum Platyhelminthes		
Class Monogenea		
Atrispinum acarne Maillard and Noisy, 1979		
Pagellus acarne	Aegean Sea	Akmirza (2013c)
Atrispinum salpae Parona and Perugia, 1889		
Salpa salpa	Aegean Sea	Akmirza (2013c)
Atrispinum seminalis Euzet and Maillard, 1973		
Diplodus annularis	Aegean Sea	Akmirza (2013c)
Diplodus vulgaris	Aegean Sea	Akmirza (2013c)
Amphibdella torpedinis Chatin, 1874		
Torpedo marmorata	Aegean Sea	Akmirza (2013c)
Anthocotyle merlucci (Van Beneden, 1863)		
Merluccius merluccius	Marmara Sea	Oğuz (1995)
Sphyraena sphyraena	Aegean Sea	Akmirza (2013c)
Merluccius merluccius	Aegean Sea	Akmirza (2013c)
Aspinatrium trachini (Parona and Perugia, 1889)		
Trachinus draco	Aegean Sea	Akmirza (2004)
Trachinus araneus	Aegean Sea	Akmirza (2013c)
Axine belones Abildgaard, 1794		
Belone belone	Marmara Sea	Öktener (2005)
Benedenia sciaenae Van Beneden, 1856		
Argyrosomus regius	Aegean Sea	Tokşen et al. (2007)
Bivagina alcedinis (Parona and Perugia, 1889)		
Spicara maena	Aegean Sea	Akmirza (2013c)
Spondyliosoma cantharus	Aegean Sea	Akmirza (2013c)
Choricotyle chrysophri (Van Beneden, 1863)		
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Pagellus erythrinus	Aegean Sea	Akmirza (2001)
Spondyliosoma cantharus	Aegean Sea	Akmirza (2013c)
Boops boops	Aegean Sea	Akmirza (2013c)
Diplectenum aequans (Wagener, 1857)		
Dicentrarchus labrax	Aegean Sea	Tareen (1982)
Dicentrarchus labrax	Aegean Sea farm	Tokşen (1999)
Dicentrarchus labrax	Black Sea farm	Öktener et al. (2009)
Dicentrarchus labrax	Beymelek Lagoon	Emre (2010)
Diclidophora bellones (Otto, 1823)		
Boops boops	Aegean Sea	Akmirza (1998b)

Table 3 (continuing): Helminth - host list.

Ergenstrema mugilis Paperna, 1965		
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Gyrodactylus anguillae Ergens, 1960		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Grubea cochlear Diesing, 1858		
Scomber scombrus	Aegean Sea	Tareen (1982)
Gyrodactylus alviga Gaevskaya and Dmitrieva, 1967		
Merlangius merlangus	Black Sea	Çavuş (2011)
Gyrodactylus flesi Malmberg, 1957		
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Kuhnia scombri (Kuhn, 1829) Sproston, 1945		
Scomber scombrus	Aegean Sea	Tareen (1982)
Scomber japonicus	Aegean Sea	Akmirza (1997)
Scomber japonicus	Mediterranean Sea	Akmirza (2003)
Lamellodiscus echeneis (Wagener, 1857)		
Sparus aurata	Aegean Sea farm	Tokşen (1999)
Lamellodiscus ignoratus Palombi, 1943		
Diplodus puntazzo	Aegean Sea	Tokşen et al. (2003)
Lamellodiscus elegans Bychowsky, 1957		
Sparus aurata	Aegean Sea	Tareen (1982)
Ligophorus acuminatus Euzet and Suriano, 1977		
Liza saliens	Aegean Sea	Altunel (1981)
Ligophorus angustus Euzet and Suriano, 1977		
Chelon labrosus	Aegean Sea	Altunel (1982)
Ligophorus chabaudi Euzet and Suriano, 1977		
Mugil cephalus	Aegean Sea	Altunel (1981)
Ligophorus confusus Euzet and Suriano, 1977		
Liza ramada	Aegean Sea	Altunel (1981)
Ligophorus heteronchus Euzet and Suriano, 1977		
Liza saliens	Aegean Sea	Altunel (1981)
Ligophorus imitans Euzet and Suriano, 1977		
Liza ramada	Aegean Sea	Altunel (1981)

Table 3 (continuing): Helminth - host list.

Ligophorus macrocolpus Euzet and Suriano, 1977		
Liza saliens	Aegean Sea	Altunel (1981)
Ligophorus minimus Euzet and Suriano, 1977		
Liza saliens	Aegean Sea	Altunel (1981)
Ligophorus mugilinus (Hargis, 1955)		
Mugil cephalus	Aegean Sea	Altunel (1981)
Ligophorus szidati Euzet and Suriano, 1977		
Liza aurata	Aegean Sea	Altunel (1981)
Mazocraes alosae Herman, 1782		
Alosa immaculata	Aegean Sea	Akmirza (2013c)
Microcotyle erythrini Van Beneden and Hesse, 1863		
Boops boops	Aegean Sea	Akmirza (1998b)
Diplodus sargus	Aegean Sea	Akmirza (2000b)
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Oblada melanura	Aegean Sea	Akmirza (2000b)
Sarpa salpa	Aegean Sea	Akmirza (2000b)
Trachinus araneus	Aegean Sea	Akmirza (2001)
Trachurus mediterraneus	Aegean Sea	Akmirza (2001)
Microcotyle pomatomi Goto, 1899		
Pomatomus saltatrix	Marmara Sea	Sezen, Price (1967)
Metamicrocotyla cephalus (Azim, 1939)		
Mugil cephalus	Aegean Sea	Altunel (1981)
Plectanocotyle gurnardi (Beneden and Hesse, 1863)		
Chelidonichthys lucerna	Aegean Sea	Akmirza (2013c)
Pseudaxine trachuri Parona and Perugia, 1890		
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Pseudodactylogyrus anguillae (Yin and Sproston, 1948)		
Anguilla anguilla	Köyceğiz Lake	Soylu et al. (2013)
Pseudodactylogyrus bini Kikuchi, 1929		
Anguilla anguilla	Sığırcı Lake	Çolak (2013)
Pyragraphorus pyragraphorus (Callum and Callum, 1913)		
Trachinotus ovatus	Mediterranean	Öktener (2005)
Solostamenides mugilis (Vogt, 1879)		
Liza aurata	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1982)

Table 3 (continuing): Helminth - host list.

Mugil cephalus	Marmara Sea	Sezen, Price (1967)
Liza ramada	Marmara Sea	Oğuz (1995)
Mugil cephalus	Bayramdere Lagoon	Öztürk et al. (2003)
Sparicotyle chrysophrii (Beneden and Hesse, 1863)		
Sparus aurata	Aegean Sea	Tareen (1982)
Sparus aurata	Aegean Sea (farm)	Tokşen (1999)
Trochopus gaillimhe Little, 1829		
Eutrigla gurnardus	Marmara Sea	Oğuz (1995)
Trochopus pini (Van Beneden and Hesse, 1863)		
Eutrigla gurnardus	Marmara Sea	Oğuz, Bray (2008)
Tetraonchoides paradoxus Bychowsky, 1951		
Uranoscopus scaber	Marmara Sea	Oğuz (1995)
Tristoma coccineum Cuvier, 1817		
Xiphias gladius	Aegean Sea	Öktener et al. (2010)
Tristoma integrum (Diesing, 1850)		
Xiphias gladius	Aegean Sea	Öktener et al. (2010)
Tristomella laevis (Verrill, 1875) Guiart, 1938		
Xiphias gladius	Aegean Sea	Kayış et al. (2010)
Zeuxapta seriolae (Meserve, 1938)		
Seriola dumerili	Mediterranean Sea	Genç et al. (2007)
Lichia amia	Aegean Sea	Akmirza (2013c)
Class Digenea		
Acanthostomum absconditum (Looos, 1901)		
Dicentrarchus labrax	Beymelek Lagoon	Emre (2010)
Allopodocotyle pedicellata (Stossich, 1887)		
Pagrus pagrus	Aegean Sea	Akmirza (2000b)
Anisocladium fallax (Rudolphi, 1819)		
Uranoscopus scaber	Marmara Sea	Oğuz (1995)
Uranoscopus scaber	Aegean Sea	Akmirza (2001)
Uranoscopus scaber	Black Sea	Tepe et al. (2014)
Anisocladium gracile (Looss, 1901)		
Uranoscopus scaber	Black Sea	Tepe et al. (2014)
Anisocoelium capitellatum (Rudolphi, 1819)		
Uranoscopus scaber	Marmara Sea	Oğuz (1995)

Table 3 (continuing): Helminth - host list.

Scorpaena scrofa	Aegean Sea	Şenol (2004)
Scorpaena porcus	Aegean Sea	Şenol (2004)
Uranoscopus scaber	Black Sea	Tepe et al. (2014)
Anoiktostoma coronatum (Wagener, 1852)		
Sciaena umbra	Aegean Sea	Akmirza (2013a)
Aphanurus stossichi (Looss, 1907)		
Boops boops	Aegean Sea	Akmirza (1998b)
Boops boops	Mediterranean Sea	Kostadinova (2004)
Bacciger bacciger (Rudolphi, 1819)		
Scomber japonicus	Aegean Sea	Akmirza (1997)
Boops boops	Aegean Sea	Akmirza (1998b)
Bacciger israelensis Fischthal, 1980		
Boops boops	Aegean Sea	Akmirza (2013a)
Spicara maena	Aegean Sea	Akmirza (2013a)
Bucephalus marinus Vlasenko, 1931		
Zosterisessor ophiocephalus	Marmara Sea	Oğuz (1995)
Gaidropsarus mediterraneus	Marmara Sea	Oğuz, Bray (2006)
Bucephalus margaritae Ozaki and Ishibashi, 1934		
Lichia amia	Aegean Sea	Akmirza (2013a)
Bucephalus polymorphus Baer, 1827		
Anguilla anguilla	Bafa Lake	Altunel (1979)
Anguilla anguilla	Aegean Sea	Altunel (1980)
Deropristis inflata (Molin, 1819)		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Anguilla anguilla	Karacabey Lagoon	Altunel (1990)
Dicrogaster perpusilla Looss, 1902		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Oedalechilus labeo	Aegean Sea	Altunel (1981)
Mugil cephalus	Küçükçekmec Lake	Akmirza (1993)
Liza ramada	Marmara Sea	Oğuz (1995)
Liza saliens	Marmara Sea	Oğuz, Bray (1995)
Diphtherostomum brusinae (Stossich, 1899)		
Zosterisessor ophiocephalus	Marmara Sea	Oğuz (1995)

Table 3 (continuing): Helminth - host list.

Ectenurus lepidus Looss, 1907		
Scomber japonicus	Aegean Sea	Akmirza (1997)
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Diplodus sargus	Aegean Sea	Akmirza (2000b)
Scomber japonicus	Mediterranean Sea	Akmirza (2003)
Trachurus trachurus	Marmara Sea	Keser et al. (2007)
Elstia stossichianum (Monticelli, 1892)		
Sarpa salpa	Aegean Sea	Akmirza (2013a)
Gaevskajatrema perezi Gibson and Bray, 1982		
Symphodus tinca	Marmara Sea	Oğuz (1995)
Gaevskajatrema pontica (Koval, 1966)		
Symphodus tinca	Marmara Sea	Oğuz (1995)
Haploporus benedeni Stossich, 1887		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Oedalechilus labeo	Aegean Sea	Altunel (1981)
Mugil cephalus	Karacabey Lagoon	Öztürk et al. (2003)
Haplosplanchnus pachysomus Eysenhard, 1829		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza aurata	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Mugil cephalus	Küçükçekmec Lake	Akmirza (1993)
Mugil cephalus	Karacabey Lake	Öztürk et al. (2003)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902		
Gaidropsarus mediterraneus	Marmara Sea	Oğuz (1995)
Gobius cobitis	Marmara Sea	Oğuz (1995)
Symphodus tinca	Marmara Sea	Oğuz (1995)
Zosterisessor ophiocephalus	Marmara Sea	Oğuz (1995)
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Scorpaena porcus	Aegean Sea	Akmirza (2001)
Scorpena scrofa	Aegean Sea	Akmirza (2001)
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Scorpaena porcus	Aegean Sea	Akmirza (2001)
Scorpena scrofa	Aegean Sea	Akmirza (2001)
Symphodus tinca	Aegean Sea	Akmirza (2001)
Gaidropsarus mediterraneus	Aegean Sea	Akmirza (2001)
Conger conger	Aegean Sea	Akmirza (2001)

Table 3 (continuing): Helminth - host list.

Chelidonichthys lucerna	Aegean Sea	Akmirza (2001)
Scorpaena notata	Aegean Sea	Şenol (2004)
Trachinus draco	Aegean Sea	Akmirza (2004)
Scorpaena porcus	Black Sea	Tepe et al. (2014)
Hemiurus communis (Odhner, 1905)		
Boops boops	Aegean Sea	Akmirza (1998b)
Heterophyes heterophyes (Siebold, 1853)		
Mugil cephalus	Aegean Sea	Tareen (1981)
Holorchis pycncnoporus Stossich, 1901		
Lithognathus mormyrus	Aegean Sea	Akmirza (2000b)
Lecithaster helodes Overstreet, 1873		
Liza ramada	Aegean Sea	Altunel (1981)
Lecithochirium grandiporum (Rudolphi, 1819)		
Conger conger	Aegean Sea	Akmirza (2012)
Muraena helena	Aegean Sea	Akmirza (2013a)
Lecithochirium musculus Nasir and Diaz, 1971		
Ophidion rochei	Black Sea	Tepe et al. (2014)
Lecithochirium rufoviride (Rudolphi, 1819) Lühe, 1901		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Lecithocladium excisum (Rudolphi, 1819) Lühe, 1901		
Scomber scombrus	Marmara Sea	Keser et al. (2007)
Lecithostaphylus retroflexus Molin, 1859		
Belone belone	Marmara Sea	Keser (2002)
Lepidapedon elongatum (Lebour, 1908) Nicoll, 1910		
Scomber japonicus	Aegean Sea	Akmirza (1997)
Lepidauchen stenostoma Nicoll, 1913		
Dentex dentex	Aegean Sea	Akmirza (2001)
Lepocreadium album (Stossich, 1890)		
Boops boops	Aegean Sea	Akmirza (1998b)
Diplodus annularis	Aegean Sea	Akmirza (2000b)
Diplodus vulgaris	Aegean Sea	Akmirza (2000b)
Diplodus sargus	Aegean Sea	Akmirza (2000b)
Spoondyliosoma cantharus	Aegean Sea	Akmirza (2000b)
Oblada melanura	Aegean Sea	Akmirza (2000b)
Spicara smaris	Aegean Sea	Akmirza (2001)
Lepocreadium pyriforme Linton, 1900		
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)

Table 3 (continuing): Helminth - host list.

Monascus filiformis (Rudolphi 1819)		
Trachurus trachurus	Marmara Sea	Oğuz (1995)
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Mesometra brachycoelia Lühe 1901		
Sarpa salpa	Mediterranean Sea	Tepe, Oğuz (2013)
Mesometra orbicularis (Rudolphi 1819)		
Sarpa salpa	Mediterranean Sea	Tepe, Oğuz (2013)
Sarpa salpa	Aegean Sea	Akmirza (2013a)
Macvicaria alacris (Looss 1901) Gibson and Bray, 1982		
Symphodus tinca	Marmara Sea	Oğuz (1995)
Nicolla gallica (Dollfus, 1941)		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Opechona bacillaris (Molin 1859) Dollfus, 1927		
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Pomatomus saltatrix	Marmara Sea	Keser (2002)
Scomber scombrus	Marmara Sea	Keser et al. (2007)
Opechona olssoni (Yamaguti, 1934)		
Scomber japonicus	Aegean Sea	Akmirza (1997)
Opecoeloides furcatus (Bremser in Rudolphi, 1819)		
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Pachycreadium carnosum (Rudolphi, 1819)		
Pagellus acarne	Aegean Sea	Akmirza (2013a)
Plagioporus dogieli (Pogorelzeva, 1975)		
Symphodus tinca	Marmara Sea	Oguz (1995)
Proctotrema bacilliovatum (Odhner, 1911)		
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Prodistomum polonii Bray and Gibson, 1990		
Trachurus trachurus	Marmara Sea	Akandere (1972)
Pronoprymna ventricosa (Rudolphi, 1819)		
Alosa immaculata	Black Sea	Çetindağ (1993)
Prosorhynchus aculeatus Odhner, 1905		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Prosorhynchus crucibulum (Rudolphi, 1819)		
Conger conger	Aegean Sea	Akmirza (2012)
Muraena helena	Aegean Sea	Akmirza (2013a)

Table 3 (continuing): Helminth - host list.

Prosorhynchoides haimeana (Lacaze-Duthiers, 1854)		
Zosterisessor ophiocephalus	Marmara Sea	Oguz (1995)
Robphildollfusium fractum Rudolphi, 1819		
Sarpa salpa	Mediterranean Sea	Tepe, Oğuz (2013)
Saccocoelium obesum Looss, 1902		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza aurata	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Liza ramada	Marmara Sea	Oğuz (1995)
Liza saliens	Marmara Sea	Oğuz, Bray (2006)
Saccocoelium tensum Looss, 1902		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza aurata	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Liza ramada	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Mugil cephalus	Küçükçekmec Lake	Akmirza (1993)
Schikhobalotrema sparisomae Manter, 1937		
Mugil cephalus	Aegean Sea	Altunel (1981)
Liza saliens	Aegean Sea	Altunel (1981)
Chelon labrosus	Aegean Sea	Altunel (1981)
Liza ramada	Marmara Sea	Oğuz (1995)
Liza saliens	Marmara Sea	Keser (2002)
Liza saliens	Marmara Sea	Oğuz, Bray (2006)
Liza aurata	Aegean Sea	Akmirza (2013a)
Siphoderina aloysiae Miller and Cribb, 2008		
Sciaena umbra	Aegean Sea	Akmirza (2013a)
Stephanostomum baccatum (Nicoll, 1907)		
Gaidropsarus mediterraneus	Marmara Sea	Oğuz (1995)
Stephanostomum bicoronatum Fuhrmann, 1928		
Umbrina cirrosa	Aegean Sea	Akmirza (2001)
Stephanostomum caducum (Looss, 1901) Manter, 1934		
Merluccius merluccius	Marmara Sea	Oğuz, Bray (2006)
Stephanostomum gaidropsari Bartoli and Bray, 2001		
Gaidropsarus mediterraneus	Marmara Sea	Oğuz (1995)
Stephanostomum minutum Manter, 1940		
Uranoscopus scaber	Black Sea	Tepe et al. (2014)

Table 3 (continuing): Helminth - host list.

Steringotrema pagelli van Beneden, 1871		
Spicara maena	Aegean Sea	Akmirza (2013a)
Tergestia laticollis (Rudolphi, 1819)		
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Class Cestoda		
Acanthobothrium coronatum (Rudolphi, 1819)		
Torpedo marmorata	Aegean Sea	Akmirza (2013d)
Dasyatis sp.	Aegean Sea	Akmirza (2013d)
Acanthobothrium dujardinii Van Beneden, 1849		
Raja clavata	Aegean Sea	Akmirza (2001)
Bothriocephalus claviceps (Goeze, 1782)		
Anguilla anguilla	Bafa Lake	Altunel (1979)
Bothriocephalus scorpii (Müller, 1776)		
Solea solea	Marmara Sea	Keser (2002)
Pegusa nasuta	Aegean Sea	Akmirza (2001)
Scorpaena porcus	Aegean Sea	Akmirza (2001)
Scorpaena scrofa	Aegean Sea	Akmirza (2001)
Scorpaena notata	Aegean Sea	Şenol (2004)
Trachinus draco	Aegean Sea	Akmirza (2004)
Solea solea	Marmara Sea	Keser (2007)
Scophthalmus maximus	Black Sea	Olguner (2008)
Trachinus araneus	Aegean Sea	Akmirza (2013d)
Callitetrarhynchus gracilis (Rudolphi, 1819)		
Eutynnus alleteratus	Aegean Sea	Akmirza (2006)
Clestobothrium crassiceps (Rudolphi, 1819)		
Merluccius merluccius	Marmara Sea	Oğuz (1995)
Didymobothrium rudolphii Nybelin, 1922		
Solea solea	Marmara Sea	Oğuz (1995)
Echeneibothrium variabile Van Beneden 1850		
Scyliorhis canicula	Aegean Sea	Akmirza (2013d)
Raja miraletus	Aegean Sea	Akmirza (2013d)
Echinobothrium typus Van Beneden, 1849		
Raja clavata	Aegean Sea	Akmirza (2001)
Squalus acanthias	Aegean Sea	Akmirza (2013d)
Grillotia erinaceus (Van Beneden, 1858)		
Merlangius merlangus	Black Sea	Tepe et al. (2014)

Table 3 (continuing): Helminth - host list.

Grillotia heptanchi (Vaullegeard, 1899)		
Solea solea	Marmara Sea	Keser (2002)
Paradilepis scolecina Rudolphi, 1935		
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Phyllobothrium lactuca (Van Beneden, 1850)		
Trachinus araneus	Aegean Sea	Akmirza (2001)
Raja clavata	Aegean Sea	Akmirza (2001)
Pegusa nasuta	Aegean Sea	Akmirza (2001)
Phyllobothrium gracile Wedl, 1855		
Raja clavata	Aegean Sea	Akmirza (2001)
Torpedo marmorata	Aegean Sea	Akmirza (2013d)
Progrillotia dasyatidis Beveridge, Neifar, Euzet, 2004		
Gobius niger	Marmara Sea	Oğuz, Bray (2008)
Ophidion rochei	Black Sea	Tepe et al. (2014)
Mullus barbatus	Black Sea	Tepe et al. (2014)
Gaidropsarus mediterraneus	Black Sea	Tepe et al. (2014)
Uranoscopus scaber	Black Sea	Tepe et al. (2014)
Gobius niger	Black Sea	Tepe et al. (2014)
Proteocephalus macrocephalus (Creplin, 1825)		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Anguilla anguilla	Karacabey Lagoon	Altunel (1990)
Tetrarhynchobothrium tenuicolle Diesing, 1854		
Squalus acanthias	Aegean Sea	Akmirza (2013d)
Phylum Nemathelminthes		
Anguillicoloides crassus (Kuwahara et al. 1974)		
Anguilla anguilla	Ceyhan River	Genç et al. (2005)
Anguilla anguilla	Sığırcı Lake	Çolak (2013)
Anisakis simplex (Rudolphi, 1809)		
Scomber japonicus	Aegean Sea	Akmirza (1997)
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Sardina pilchardus	Aegean Sea	Oğuz et al. (2000)
Merlangius merlangus	Aegean Sea	Oğuz et al. (2000)
Trachurus trachurus	Aegean Sea	Oğuz et al. (2000)
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Diplodus annularis	Aegean Sea	Akmirza (2000b)
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Oblada melanura	Aegean Sea	Akmirza (2000b)
Boops boops	Aegean Sea	Akmirza (2000b)
Engraulis encrasicholus	Marmara Sea	Tuncel (2003)
Scomber japonicus	Mediterranean Sea	Akmirza (2003)

Table 3 (continuing): Helminth - host list.

Scomber scombrus	Marmara Sea	Keser et al. (2007)
Mullus barbatus		Özkan (2008)
Engraulis encrasicholus		Özkan (2008)
Trachurus trachurus		Özkan (2008)
Trachurus trachurus		Ütük et al. (2012)
Trachurus trachurus		Özkan (2008)
Conger conger	Aegean Sea	Akmirza (2012)
Merluccius merluccius	Aegean Sea	Akmirza (2013b)
Alosa immaculata	Aegean Sea	Akmirza (2013b)
Serranus hepatus	Aegean Sea	Akmirza (2013b)
Zeus faber	Aegean Sea	Akmirza (2013b)
Uranoscopus scaber	Aegean Sea	Akmirza (2013b)
Sphyraena sphyraena	Aegean Sea	Akmirza (2013b)
Pomatomus saltatrix	Aegean Sea	Akmirza (2013b)
Anisakis pegreffii Campana-Rouget and Biocca, 1955		
Trachurus trachurus		Ütük et al. (2012)
Trachurus mediterraneus	Black Sea	Tepe, Oğuz (2013)
Cucullanus hians (Dujardin, 1845)		
Conger conger	Aegean Sea	Akmirza (2012)
Cucullanus longicollis (Stossich, 1899)		
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Cucullanus micropapillatus Tornquist, 1931		
Symphodus sp.	Aegean Sea	Akmirza (2013b)
Dichelyne tripapillatus (Gendre, 1927)		
Diplodus vulgaris	Aegean Sea	Akmirza (2000b)
Diplodus sargus	Aegean Sea	Akmirza (2000b)
Oblada melanura	Aegean Sea	Akmirza (2000b)
Symphodus tinca	Aegean Sea	Akmirza (2001)
Gaidropsarus mediterraneus	Aegean Sea	Akmirza (2001)
Dichelyne minutus Rudolphi, 1819		
Platichthys flesus	Ekinli Lagoon Lake	Oğuz (1989)
Platichthys flesus	Marmara Sea	Oğuz 1996b
Sprattus sprattus	Black Sea	Avsar (1997)
Platichthys flesus	Karacabey Lagoon	Aydoğdu (2003)
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Merlangius merlangus		Özkan (2008)
Echinocephalus spinosissimus von Linstow, 1905		
Raja clavata	Aegean Sea	Akmirza (2001)
Hysterothylacium aduncum (Rudolphi, 1802)		
Trachurus mediterraneus		Merdivenci (1983)

Table 3 (continuing): Helminth - host list.

Engraulis encrasicholus		Merdivenci (1983)
Merlangius merlangus	Black Sea	Doğanay (1994)
Merluccius merluccius	Marmara Sea	Oğuz (1995)
Gobius niger	Marmara Sea	Oğuz (1995)
Trachurus trachurus	Marmara Sea	Oğuz (1995)
Scomber japonicus	Aegean Sea	Akmirza (1997)
Sprattus sprattus	Black Sea	Telli, Doran (1997)
Trachurus mediterraneus	Aegean Sea	Akmirza (1998a)
Engraulis encrasicholus	Marmara Sea	Tuncel (2003)
Liza saliens	Marmara Sea	Keser (2002)
Sparus aurata	Marmara Sea	Keser (2002)
Pomatomus saltatrix	Marmara Sea	Keser (2002)
Solea solea	Marmara Sea	Keser (2002)
Rhinobatos rhinobatos	Mediterranean Sea	Genç et al. (2005)
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Alosa immaculata	Black Sea	Özer et al. (2007)
Trachurus trachurus	Black Sea	Özkan (2008)
Alosa immaculata	Black Sea	Olguner (2008)
Scophthalmus maximus	Black Sea	Olguner (2008)
Spicara smaris	Black Sea	Olguner (2008)
Pagellus erythrinus	Aegean Sea	Akmirza (2013b)
Lophius piscatorius	Aegean Sea	Akmirza (2013b)
Trachurus mediterraneus	Black Sea	Tepe, Oğuz (2013)
Belone belone	Black Sea	Tepe, Oğuz (2013)
Caspialosa sp.	Black Sea	Tepe, Oğuz (2013)
Sciaena umbra	Black Sea	Tepe, Oğuz (2013)
Scorpaena porcus	Black Sea	Tepe, Oğuz (2013)
Liza aurata	Black Sea	Tepe, Oğuz (2013)
Gobius niger	Black Sea	Tepe, Oğuz (2013)
Sarda sarda	Black Sea	Tepe, Oğuz (2013)
Uranoscopus scaber	Black Sea	Tepe, Oğuz (2013)
Mullus barbatus	Black Sea	Tepe, Oğuz (2013)
Gaidropsarus mediterraneus	Black Sea	Tepe, Oğuz (2013)
Syngnathus acus	Black Sea	Tepe, Oğuz (2013)
Trachinus draco	Black Sea	Tepe, Oğuz (2013)
Uranoscopus scaber	Black Sea	Tepe, Oğuz (2013)
Ophidion rochei	Black Sea	Tepe, Oğuz (2013)
Solea solea	Black Sea	Tepe, Oğuz (2013)
Hysterothylacium fabri (Rudolpi, 1819)		
Boops boops	Aegean Sea	Akmirza (1998b)
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Diplodus annularis	Aegean Sea	Akmirza (2000b)
Spoondyliosoma cantharus	Aegean Sea	Akmirza (2000b)
Pagellus erythrinus	Aegean Sea	Akmirza (2000b)
Oblada melanura	Aegean Sea	Akmirza (2000b)
Trachinus draco	Aegean Sea	Akmirza (2004)

Table 3 (continuing): Helminth - host list.

Alosa immaculata	Aegean Sea	Akmirza (2013b)
Phycis phycis	Aegean Sea	Akmirza (2013b)
Coris julis	Aegean Sea	Akmirza (2013b)
Trachurus mediterraneus	Aegean Sea	Akmirza (2013b)
Pagellus acarne	Aegean Sea	Akmirza (2013b)
Squalus blainvillei	Aegean Sea	Akmirza (2013b)
Symphodus sp.	Aegean Sea	Akmirza (2013b)
Philometra filiformis (Stossich, 1898)		
Pagellus erythrinus	Mediterranean Sea	Moravec (2004)
Philometra globiceps Rudolphi, 1819		
Uranoscopus scaber	Black Sea	Tepe, Oğuz (2013)
Trachurus mediterraneus	Black Sea	Tepe, Oğuz (2013)
Philometra lateolabracis (Yamaguti, 1935)		
Epinephelus marginatus	Mediterranean Sea	Moravec (2004)
Mycteroperca rubra	Mediterranean Sea	Moravec (2004)
Epinephelus aeneus	Mediterranean Sea	Genç et al. (2005)
Philometra saltatrix Ramachandran, 1973		
Pomatomus saltatrix	Mediterranean Sea	Moravec (2004)
Spinitectus oviflagellis Fourment, 1883		
Gaidropsarus mediterraneus	Marmara Sea	Oğuz (1995)
Spiroxys contortus Rudolphi, 1819		
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Phylum Acanthocephala		
Acanthocephalus anguillae (Müller, 1780)		
Anguilla anguilla	Sığırcı Lake	Çolak (2013)
Acanthocephalus lucii (Mueller, 1777)		
Pegusa nasuta	Aegean Sea	Akmirza (2001)
Diplodus vulgaris	Aegean Sea	Akmirza (2001)
Scorpaena porcus	Aegean Sea	Akmirza (2001)
Anguilla anguilla	Sığırcı Lake	Çolak (2013)
Acanthocephaloides propinquus (Dujardin, 1845)		
Gobius niger	Marmara Sea	Oğuz (1995)
Gobius cobitis	Marmara Sea	Oğuz (1995)
Merluccius merluccius	Marmara Sea	Oğuz (1995)
Solea solea	Marmara Sea	Oğuz (1995)
Scorpaena scrofa	Marmara Sea	Oğuz (1995)
Uranoscopus scaber	Marmara Sea	Oğuz (1995)
Eutrigla gurnardus	Marmara Sea	Oğuz (1995)

Table 3 (continuing): Helminth - host list.

Acanthocephaloides irregularis Amin, Oğuz, Heckmann, Tepe and Kvach, 2011		
Scorpaena porcus	Black Sea	Tepe, Oğuz (2013)
Longicollum pagrosomi Yamaguti, 1935		
Trachurus trachurus	Marmara Sea	Oğuz (1995)
Neoechinorhynchus (Hebesoma) agilis (Rudolphi, 1819)		
Mugil cephalus	Aegean Sea	Altunel (1983)
Liza aurata	Aegean Sea	Altunel (1983)
Liza saliens	Aegean Sea	Altunel (1983)
Liza ramada	Aegean Sea	Altunel (1983)
Chelon labrosus	Aegean Sea	Altunel (1983)
Mugil cephalus	Küçükçekmec Lake	Akmirza (1993)
Liza saliens	Marmara Sea	Keser (2002)
Liza aurata	Black Sea	Tepe, Oğuz (2013)
Neoechinorhynchus rutili (Müller, 1780)		
Platichthys flesus	Sarıkum Lagoon	Öztürk (2005)
Pomphorhynchus laevis (Müller, 1776)		
Symphodus tinca	Aegean Sea	Akmirza (2001)
Pseudoechinorhynchus clavula Dujardin, 1845		
Anguilla anguilla	Aegean Sea	Altunel (1980)
Solearhynchus rhytidotes (Meyer, 1933)		
Solea solea	Marmara Sea	Oğuz (1995)
Telosentis exiguus (von Linstow, 1901)		
Platichthys flesus	Ekinli Lagoon Lake	Oğuz (1989)
Phylum Annelida		
Pontobdella muricata (Linnaeus, 1758)		
Raja sp.	Marmara Sea	Ergüven (1992)
Torpedo marmorata	Aegean Sea	Sağlam et al. (2003)
Raja clavata	Aegean Sea	Sağlam et al. (2003)
Raja clavata	Black Sea	Öktener (2010)
Stibarobdella macrothela (Schmarda, 1861)		
Trachinus draco	Aegean Sea	Akmirza (2004)
Trachelobdella lubrica (Grube, 1840)		
Scorpaena porcus	Aegean Sea	Sağlam et al. (2003)
Scorpaena scrofa	Aegean Sea	Sağlam et al. (2003)
Labrus bergylta	Marmara Sea	Öktener (2010)

RESULTS AND DISCUSSION (Host - Helminth List).

***Pagellus acarne* (Risso, 1827)**
Atrispinum acarne Maillard and Noisy, 1979
Pachycreadium carnosum (Rudolphi, 1819) Cortini and Ferretti, 1959
Hysterothylacium fabri (Rudolpi, 1819)

***Sarpa salpa* (Linnaeus, 1758)**
Atrispinum salpae Parona and Perugia, 1889
Microcotyle erythrini Van Beneden and Hesse, 1863
Elstia stossichianum (Monticelli, 1892)
Mesometra brachycoelia Lühe 1901
Mesometra orbicularis (Rudolphi, 1819)
Robphildollfusium fractum (Rudolphi, 1819)

***Diplodus annularis* (Linnaeus, 1758)**
Atrispinum seminalis Euzet and Maillard, 1973
Lepocreadium album (Stossich, 1890)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium fabri (Rudolpi, 1819)

***Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817)**
Atrispinum seminalis Euzet and Maillard, 1973
Lepocreadium album (Stossich, 1890)
Cucullanus tripapillatus (Gendre, 1927)
Acanthocephalus lucii (Mueller, 1777)

***Torpedo marmorata* Risso, 1810**
Amphibdella torpedinis Chatin, 1874
Acanthobothrium coronatum (Rudolphi, 1819)
Phyllobothrium gracile Wedl, 1855
Pontobdella muricata (Linnaeus, 1758)

***Merluccius merluccius* (Linnaeus, 1758)**
Anthocotyle merlucci (Van Beneden, 1863)
Stephanostomum caducum (Looss, 1901) Manter, 1934
Clestobothrium crassiceps (Rudolphi, 1819)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)
Acanthocephaloides propinquus (Dujardin, 1845)

***Sphyraena sphyraena* (Linnaeus, 1758)**
Anthocotyle merlucci (Van Beneden, 1863)
Anisakis simplex (Rudolphi, 1809)

***Trachinus draco* Linnaeus, 1758**
Aspinatrium trachini (Parona and Perugia, 1889)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Bothriocephalus scorpii (Müller, 1776)
Hysterothylacium aduncum (Rudolphi, 1802)
Hysterothylacium fabri (Rudolpi, 1819)
Stibarobdella macrothela (Schmarda, 1861)

***Trachinus araneus* Cuvier, 1829**
Aspinatrium trachini (Parona and Perugia, 1889)
Microcotyle erythrini Van Beneden and Hesse, 1863
Bothriocephalus scorpii (Müller, 1776)
Phyllobothrium lactuca (Van Beneden, 1850)

***Belone belone* (Linnaeus, 1761)**
Axine belones Abildgaard, 1794
Lecithostaphylus retroflexus Molin, 1859
Hysterothylacium aduncum (Rudolphi, 1802)

***Argyrosomus regius* (Asso, 1801)**
Benedenia sciaenae Van Beneden, 1856

***Spicara maena* (Linnaeus, 1758)**
Bivagina alcedinis (Parona and Perugia, 1889)
Bacciger israelensis Fischthal, 1980
Steringotrema pagelli (Van Beneden, 1871) Odhner, 1911

***Pagellus erythrinus* (Linnaeus, 1758)**
Choricotyle chrysophri (Van Beneden, 1863)
Microcotyle erythrini Van Beneden and Hesse, 1863
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum
Hysterothylacium fabri (Rudolphi, 1802)
Philometra filiformis (Stossich, 1898)

***Spondyliosoma cantharus* (Linnaeus, 1758)**
Bivagina alcedinis (Parona and Perugia, 1889)
Choricotyle chrysophri (Van Beneden, 1863)
Lepocreadium album (Stossich, 1890)
Hysterothylacium fabri (Rudolpi, 1819)

***Boops boops* (Linnaeus, 1758)**
Choricotyle chrysophri (Van Beneden, 1863)
Diclidophora bellones (Otto, 1823)
Microcotyle erythrini Van Beneden and Hesse, 1863
Aphanurus stossichi (Looss, 1907)
Bacciger bacciger (Rudolphi, 1819)
Bacciger israelensis Fischthal, 1980
Hemiurus communis (Odhner, 1905)
Lepocreadium album (Stossich, 1890)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium fabri (Rudolpi, 1819)

***Dicentrarchus labrax* (Linnaeus, 1758)**
Diplectenum aequans (Wagener, 1857)
Acanthostomum absconditum (Looos, 1901)

***Liza ramada* (Risso, 1827)**
Ergenstrema mugilis Paperna, 1965
Ligophorus confusus Euzet and Suriano, 1977
Ligophorus imitans Euzet and Suriano, 1977

Solostamenides mugilis (Vogt, 1879)
Dicrogaster perpusilla Looss, 1902
Haploporus benedeni Stossich, 1887
Haplosplanchnus pachysomus (Eysenhardt, 1829) Looss, 1902
Lecithaster helodes Overstreet, 1873
Saccocoelium obesum Looss, 1902
Saccocoelium tensum Looss, 1902
Schikhobalotrema sparisomae Manter, 1937
Neoechinorhynchus agilis Rudolphi, 1819

***Chelon labrosus* (Risso, 1827)**

Ergenstrema mugilis Paperna, 1965
Ligophorus angustus Euzet and Suriano, 1977
Solostamenides mugilis (Vogt, 1879)
Dicrogaster perpusilla Looss, 1902
Haploporus benedeni Stossich, 1887
Haplosplanchnus pachysomus (Eysenhardt, 1829) Looss, 1902
Saccocoelium obesum Looss, 1902
Saccocoelium tensum Looss, 1902
Schikhobalotrema sparisomae Manter, 1937
Neoechinorhynchus (Hebesoma) agilis (Rudolphi, 1819)

***Scomber scombrus* Linnaeus, 1758**

Grubea cochlear Diesing, 1858
Kuhnia scombri (Kuhn, 1829) Sproston, 1945
Lecithocladium excisum (Rudolphi, 1819) Lühe, 1901
Opechona bacillaris (Molin, 1859) Dollfus, 1927
Anisakis simplex (Rudolphi, 1809)

***Merlangius merlangus* (Linnaeus, 1758)**

Gyrodactylus alviga Gaevskaya and Dmitrieva, 1967
Grillotia erinaceus (Van Beneden, 1858)
Anisakis simplex (Rudolphi, 1809)
Dichelyne minutus Rudolphi, 1819
Hysterothylacium aduncum (Rudolphi, 1802)

***Anguilla anguilla* (Linnaeus, 1758)**

Gyrodactylus anguillae Ergens, 1960
Pseudodactylogyrus bini Kikuchi, 1929
Pseudodactylogyrus anguillae (Yin and Sproston, 1948)
Bucephalus polymorphus Baer, 1827
Deropristis inflata (Molin, 1819)
Lecithochirium rufoviride (Rudolphi, 1819) Lühe, 1901
Nicolla gallica (Dollfus, 1941)
Prosorhynchus aculeatus Odhner, 1905
Bothriocephalus claviceps (Goeze, 1782)
Proteocephalus macrocephalus (Creplin, 1825)
Anguillicoloides crassus (Kuwahara, Niimi and Itagaki, 1974)
Acanthocephalus anguillae (Müller, 1780)
Acanthocephalus lucii (Mueller, 1777)
Acanthocephalus clavula Dujardin, 1845

***Platichthys flesus* (Linnaeus, 1758)**
Gyrodactylus flesi Malmberg, 1957
Paradilepis scolecina (Rudolphi, 1819)
Dichelyne minutus Rudolphi, 1819
Hysterothylacium aduncum (Rudolphi, 1802)
Spiroxys contortus Rudolphi, 1819
Neoechinorhynchus rutili (Müller, 1780)
Telosentis exiguus (von Linstow, 1901)

***Scomber japonicus* Houttuyn, 1782**
Kuhnia scombri (Kuhn, 1829) Sproston, 1945
Bacciger bacciger (Rudolphi, 1819)
Ectenurus lepidus Looss, 1907
Lepidapedon elongatum (Lebour, 1908) Nicoll, 1910
Opechona olssoni (Yamaguti, 1934)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)

***Sparus aurata* Linnaeus, 1758**
Lamellodiscus echeneis (Wagener, 1857)
Lamellodiscus elegans Bychowsky, 1957
Sparicotyle chrysophrii (Van Beneden and Hesse, 1863)
Hysterothylacium aduncum (Rudolphi, 1802)

***Diplodus puntazzo* (Walbaum, 1792)**
Lamellodiscus ignoratus Palombi, 1943

***Liza saliens* (Risso, 1810)**
Ligophorus acuminatus Euzet and Suriano, 1977
Ligophorus heteronchus Euzet and Suriano, 1977
Ligophorus macrocolpus Euzet and Suriano, 1977
Ligophorus minimus Euzet and Suriano, 1977
Solostamenides mugilis (Vogt, 1879)
Dicrogaster perpusilla Looss, 1902
Haploporus benedeni Stossich, 1887
Haplosplanchnus pachysomus (Eysenhardt, 1829) Looss, 1902
Saccocoelium obesum Looss, 1902
Saccocoelium tensum Looss, 1902
Schikhobalotrema sparisomae Manter, 1937
Hysterothylacium aduncum (Rudolphi, 1802)
Neoechinorhynchus (Hebesoma) agilis (Rudolphi, 1819)

***Mugil cephalus* Linnaeus, 1758**
Ligophorus chabaudi Euzet and Suriano, 1977
Ligophorus mugilinus (Hargis, 1955)
Metamicrocotyla cephalus (Azim, 1939)
Solostamenides mugilis (Vogt, 1879)
Dicrogaster perpusilla Looss, 1902
Haploporus benedeni Stossich, 1887
Haplosplanchnus pachysomus (Eysenhardt, 1829) Looss, 1902
Heterophyes heterophyes (Siebold, 1853)
Saccocoelium obesum Looss, 1902

Saccocoelium tensum Looss, 1902
Schikhobalotrema sparisomae Manter, 1937
Neoechinorhynchus (Hebesoma) agilis (Rudolphi, 1819)

***Liza aurata* (Risso, 1810)**
Ligophorus szidati Euzet and Suriano, 1977
Solostamenides mugilis (Vogt, 1879)
Haplosplanchnus pachysomus (Eysenhardt, 1829) Looss, 1902
Saccocoelium obesum Looss, 1902
Saccocoelium tensum Looss, 1902
Schikhobalotrema sparisomae Manter, 1937
Hysterothylacium aduncum (Rudolphi, 1802)
Neoechinorhynchus (Hebesoma) agilis (Rudolphi, 1819)

***Alosa immaculata* Bennett, 1835**
Mazocraes alosae Herman, 1782
Pronoprymna ventricosa (Rudolphi, 1819)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)
Hysterothylacium fabri (Rudolpi, 1819)

***Diplodus sargus* (Linnaeus, 1758)**
Microcotyle erythrini Van Beneden and Hesse, 1863
Ectenurus lepidus Looss, 1907
Lepocreadium album (Stossich, 1890)
Cucullanus tripapillatus (Gendre, 1927)

***Oblada melanura* (Linnaeus, 1758)**
Microcotyle erythrini Van Beneden and Hesse, 1863
Lepocreadium album (Stossich, 1890)
Anisakis simplex (Rudolphi, 1809)
Cucullanus tripapillatus (Gendre, 1927)
Hysterothylacium fabri (Rudolpi, 1819)

***Trachurus mediterraneus* (Steindachner, 1868)**
Microcotyle erythrini Van Beneden and Hesse, 1863
Pseudaxine trachuri Parona and Perugia, 1890
Ectenurus lepidus Looss, 1907
Lepocreadium pyriforme Linton, 1900
Monascus filiformis (Rudolphi, 1819)
Opechona bacillaris (Molin, 1859) Dollfus, 1927
Tergestia laticollis (Rudolphi, 1819)
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)
Hysterothylacium fabri (Rudolpi, 1819)
Philometra globiceps Rudolpi, 1819

***Pomatomus saltatrix* (Linnaeus, 1766)**
Microcotyle pomatomi Goto, 1899
Opechona bacillaris (Molin, 1859) Dollfus, 1927
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)

Philometra saltatrix Ramachandran, 1973

***Chelidonichthys lucerna* (Linnaeus, 1758)**

Plectanocotyle gurnardi (Van Beneden and Hesse, 1863)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902

***Trachinotus ovatus* (Linnaeus, 1758)**

Pyragraphorus pyragraphorus (Mac Callum and Mac Callum, 1913)

***Eutrigla gurnardus* (Linnaeus, 1758)**

Trochopus gaillimhe Little, 1829
Trochopus pini (Van Beneden and Hesse, 1863)
Acanthocephaloides propinquus (Dujardin, 1845)

***Xiphias gladius* Linnaeus, 1758**

Tristoma coccineum Cuvier, 1817
Tristoma integrum (Diesing, 1850)
Tristomella laevis (Verrill, 1875) Guiart, 1938

***Uranoscopus scaber* Linnaeus, 1758**

Tetraonchoides paradoxus Bychowsky, 1951
Anisocladium fallax (Rudolphi, 1819)
Anisocladium gracile (Looss, 1901)
Anisocoelium capitellatum (Rudolphi, 1819)
Stephanostomum minutum (Looss, 1901) Manter, 1940
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)
Philometra globiceps (Rudolphi, 1819)
Acanthocephaloides propinquus (Dujardin, 1845)

***Seriola dumerili* (Risso, 1810)**

Zeuxapta seriolae (Meserve, 1938)

***Lichia amia* (Linnaeus, 1758)**

Zeuxapta seriolae (Meserve, 1938)
Bucephalus margaritae Ozaki and Ishibashi, 1934

***Pagrus pagrus* (Linnaeus, 1758)**

Allopodocotyle pedicellata (Stossich, 1887) Pritchard, 1966

***Scorpaena scrofa* Linnaeus, 1758**

Anisocoelium capitellatum (Rudolphi, 1819)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Bothriocephalus scorpii (Müller, 1776)
Acanthocephaloides propinquus (Dujardin, 1845)
Trachelobdella lubrica (Grube, 1840)

***Scorpaena porcus* Linnaeus, 1758**

Anisocoelium capitellatum (Rudolphi, 1819)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Bothriocephalus scorpii (Müller, 1776)
Hysterothylacium aduncum (Rudolphi, 1802)
Acanthocephalus lucii (Müller, 1777)
Acanthocephaloides propinquus (Dujardin, 1845)
Trachelobdella lubrica (Grube, 1840)

***Sciaena umbra* Linnaeus, 1758**
Anoiktostoma coronatum (Wagener, 1852) Stossich, 1889
Siphoderina aloysiae (Stossich, 1885) Miller and Cribb, 2008
Hysterothylacium aduncum (Rudolphi, 1802)

***Zosterisessor ophiocephalus* (Pallas, 1814)**
Bucephalus marinus Vlasenko, 1931
Diphtherostomum brusinae (Stossich, 1899)
Prosorhynchoides haimeana (Lacaze-Duthiers, 1854)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902

***Gaidropsarus mediterraneus* (Linnaeus, 1758)**
Bucephalus marinus Vlasenko, 1931
Stephanostomum baccatum (Nicoll, 1907)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Stephanostomum gaidropsari Bartoli and Bray, 2001
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004
Cucullanus tripapillatus (Gendre, 1927)
Hysterothylacium aduncum (Rudolphi, 1802)
Spinitectus oviflagellis Fourment, 1883

***Oedalechilus labeo* (Cuvier, 1829)**
Dicrogaster contractus Looss, 1902
Haploporus benedenii (Stossich, 1887) Looss, 1902

***Trachurus trachurus* (Linnaeus, 1758)**
Ectenurus lepidus Looss, 1907
Monascus filiformis (Rudolphi 1819)
Prodistomum polonii (Molin, 1859) Bray and Gibson, 1990
Anisakis simplex (Rudolphi, 1809)
Anisakis pegreffii Campana-Rouget and Biocca, 1955
Hysterothylacium aduncum (Rudolphi, 1802)
Longicollum pagrosomi Yamaguti, 1935

***Symphodus tinca* (Linnaeus, 1758)**
Gaevskajatrema perezi (Mathias, 1926) Gibson and Bray, 1982
Gaevskajatrema pontica (Koval, 1966)
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Plagioporus dogieli (Pogorelzeva, 1975)
Macvicaria alacris (Looss, 1901) Gibson and Bray, 1982
Cucullanus tripapillatus (Gendre, 1927)
Pomphorhynchus laevis (Müller, 1776)

***Gobius cobitis* Pallas, 1814**
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004

***Conger conger* (Linnaeus, 1758)**
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Lecithochirium grandiporum (Rudolphi, 1819) Lühe, 1901
Prosorhynchus crucibulum (Rudolphi, 1819)
Anisakis simplex (Rudolphi, 1809)
Cucullanus hians (Dujardin, 1845)

***Scorpaena notata* Rafinesque, 1810**
Helicometra fasciata (Rudolphi, 1819) Odhner, 1902
Bothriocephalus scorpii (Müller, 1776)

***Lithognathus mormyrus* (Linnaeus, 1758)**
Holorchis pycncnoporus Stossich, 1901

***Muraena helena* Linnaeus, 1758**
Lecithochirium grandiporum (Rudolphi, 1819) Lühe, 1901
Prosorhynchus crucibulum (Rudolphi, 1819)

***Ophidion rochei* Müller, 1845**
Lecithochirium musculus (Looss, 1907) Nasir and Diaz, 1971
Hysterothylacium aduncum (Rudolphi, 1802)
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004

***Dentex dentex* (Linnaeus, 1758)**
Lepidauchen stenostoma Nicoll, 1913

***Spicara smaris* (Linnaeus, 1758)**
Lepocreadium album (Stossich, 1890)
Hysterothylacium aduncum (Rudolphi, 1802)

***Mullus surmuletus* Linnaeus, 1758**
Opecoeloides furcatus (Bremser in Rudolphi, 1819)
Proctotrema bacilliovatum (Odhner, 1911)
Anisakis simplex (Rudolphi, 1809)
Cucullanus longicollis (Stossich, 1899)
Hysterothylacium fabri (Rudolpi, 1819)

***Umbrina cirrosa* (Linnaeus, 1758)**
Stephanostomum bicoronatum (Stossich, 1883) Fuhrmann, 1928

***Sardina pilchardus* (Walbaum, 1792)**
Anisakis simplex (Rudolphi, 1809)

***Engraulis encrasicholus* (Linnaeus, 1758)**
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)

***Mullus barbatus* Linnaeus, 1758**
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004
Anisakis simplex (Rudolphi, 1809)
Hysterothylacium aduncum (Rudolphi, 1802)

***Serranus hepatus* (Linnaeus, 1758)**
Anisakis simplex (Rudolphi, 1809)

***Zeus faber* Linnaeus, 1758**
Anisakis simplex (Rudolphi, 1809)

***Symphodus* sp.**
Cucullanus micropapillatus Tornquist, 1931
Hysterothylacium fabri (Rudolpi, 1819)

***Sprattus sprattus* (Linnaeus, 1758)**
Dichelyne minutus Rudolphi, 1819
Hysterothylacium aduncum (Rudolphi, 1802)

***Raja clavata* Linnaeus, 1758**
Acanthobothrium dujardinii Van Beneden, 1849
Acanthobothrium ponticum Borcea, 1934
Echinobothrium typus Van Beneden, 1849
Phyllobothrium lactuca (Van Beneden, 1850)
Phyllobothrium gracile Wedl, 1855
Echinocephalus spinosissimus von Linstow, 1905
Pontobdella muricata (Linnaeus, 1758)

***Gobius niger* Linnaeus, 1758**
Progrillotia dasyatidis Beveridge, Neifar and Euzet, 2004
Hysterothylacium aduncum (Rudolphi, 1802)
Acanthocephaloides propinquus (Dujardin, 1845)

***Solea solea* (Linnaeus, 1758)**
Bothriocephalus scorpii (Müller, 1776)
Didymobothrium rudolphii Nybelin, 1922
Grillotia heptanchi (Vaullegeard, 1899)
Hysterothylacium aduncum (Rudolphi, 1802)
Acanthocephaloides propinquus (Dujardin, 1845)
Solearhynchus rhytidotes (Meyer, 1933)

***Rhinobatos rhinobatos* (Linnaeus, 1758)**
Hysterothylacium aduncum (Rudolphi, 1802)

***Scophthalmus maximus* (Linnaeus, 1758)**
Bothriocephalus scorpii (Müller, 1776)
Hysterothylacium aduncum (Rudolphi, 1802)

***Caspialosa* sp.**
Hysterothylacium aduncum (Rudolphi, 1802)

***Sarda sarda* (Bloch, 1793)**
Hysterothylacium aduncum (Rudolphi, 1802)

***Lophius piscatorius* Linnaeus, 1758**
Hysterothylacium aduncum (Rudolphi, 1802)

***Phycis phycis* (Linnaeus, 1766)**
Hysterothylacium fabri (Rudolpi, 1819)

***Coris julis* (Linnaeus, 1758)**
Hysterothylacium fabri (Rudolpi, 1819)

***Squalus blainville* (Risso, 1827)**
Hysterothylacium fabri (Rudolpi, 1819)

***Epinephelus marginatus* (Lowe, 1834)**
Philometra lateolabracis (Yamaguti, 1935)

***Mycteroperca rubra* (Bloch, 1793)**
Philometra lateolabracis (Yamaguti, 1935)

***Epinephelus aeneus* (Geoffroy Saint-Hilaire, 1817)**
Philometra lateolabracis (Yamaguti, 1935)

***Dasyatis* sp.**
Acanthobothrium coronatum (Rudolphi, 1819)

***Pegusa nasuta* (Pallas, 1814)**
Bothriocephalus scorpii (Müller, 1776)
Phyllobothrium lactuca (Van Beneden, 1850)
Acanthocephalus lucii (Müller, 1777)

***Eutynnus alleteratus* (Rafinesque, 1810)**
Callitetrarhynchus gracilis (Rudolphi, 1819)

***Scyliorhinus canicula* (Linnaeus, 1758)**
Echeneibothrium variabile Van Beneden 1850

***Raja miraletus* Linnaeus, 1758**
Pontobdella muricata (Linnaeus, 1758)

***Squalus acanthias* Linnaeus, 1758**
Echinobothrium typus Van Beneden, 1849
Tetrarhynchobothrium tenuicolle Diesing, 1854

***Raja* sp.**
Pontobdella muricata Linnaeus, 1758

***Labrus bergylta* Ascanius, 1767**
Trachelobdella lubrica (Grube, 1840)

***Syngnathus acus* Linnaeus, 1758**
Hysterothylacium aduncum (Rudolphi, 1802)

Although parasites at species and genera level were reported from marine fish, only species level will be considered in here (Tab. 3). Other parasites at genera level (unnamed species) will be omitted in here. The reports from different host fish will be shown (Tab. 4), because they may be new species or the same species.

This checklist presents the occurence of 63 digeneans at species level, after nine years (Tab. 3). Digenea is most largest group with 59 species from 47 host fish species. There have been 45 genera of digeneans reported with the following genera being the most prevalent: *Helicometra* (eleven hosts), *Lepocreadium* (eight hosts), *Haploporus* (five hosts), *Dicrogaster* (five hosts), *Saccocoelium* (five hosts), *Haplosplanchnus* (five hosts), *Schikhobalotrema* (five hosts), *Stephanostomum* (four hosts), *Ectenurus* (four hosts), *Opechona* (four hosts), *Bacciger* (three hosts), *Bucephalus* (four hosts), *Lecithochirium* (four hosts). Adult digeneans were reported especially from intestine, stomach and rarely from gall bladder, muscle. Also, ten unnamed species (at genera level) were reported from different host fish (*Ascocotyle* sp., *Allocreadium* sp., *Bathycreadium* sp., *Centrodema* sp., *Hemiurus* sp., *Lecithaster* sp., *Paramacroderoides* sp., *Piriforma* sp., *Schikhobalotrema* sp., *Stephanostomum* sp.) (Tab. 4.).

This checklist presents the occurence of 49 monogeneans at species level, after nine years (Tab. 3). Monogenea are next-largest group with 49 species from 40 host fish species. *Ligophorus* genus is the most abundant among the monogenea. *Ligophorus* genus with 10 species is reported from mugilids. The majority of monogeneans selected gill filaments as infection sites. A few monogenea (gyrodactylus and benedenia) selected body surface. Another seven monogenea (genera level) were reported from different hosts (*Dactylogyrus* sp., *Diplectenum* sp., *Gyrodactylus* sp., *Lamellodiscus* sp., *Ligophorus* sp. and *Microcotyle* sp.) (Tab. 4.).

Table 4: Unnamed helminth species (at genera level) reported from marine fishes of Turkey.

Phylum Platyhelminthes		
Class Monogenea		
***Microcotyle* sp.**		
Sparus aurata	Sea bream farm (Aegean Sea)	Hoşsucu (1986)
Dentex dentex	Common dentex farm (Aegean Sea)	Çilli (2008)
Oblada melanura	Mediterranean Sea	Konaş (2009)
***Ligophorus* sp.**		
Mugil cephalus	Aegean Sea	Altunel (1981)
***Diplectenum* sp.**		
Sargocentron rubrum	Mediterranean Sea	Konaş (2009)
***Lamellodiscus* sp.**		
Sparus aurata	Sea bream farm (Aegean Sea)	Hoşsucu (1986)
Diplodus vulgaris	Mediterranean Sea	Konaş (2009)
Diplodus sargus	Mediterranean Sea	Konaş (2009)
Siganus luridus	Mediterranean Sea	Konaş (2009)
***Dactylogyrus* sp.**		
Dicentrarchus labrax	Hurmaboğazı Lagoon Lake	Canlı (2010)
***Gyrodactylus* sp.**		
Chelon labrosus	Aegean Sea	Altunel (1982)
Merlangius merlangus	Black Sea	Yaman (1997)
Monogenea sp.		
Platichthys flesus	Ekinli Lagoon Lake	Oğuz (1989)

Table 4 (continuing): Unnamed helminth species (at genera level) reported from marine fishes of Turkey.

Phylum Platyhelminthes		
Class Digenea		
***Allocreadium* sp.**		
Sarpa salpa	Aegean Sea	Akmirza (2000b)
***Bathycreadium* sp.**		
Phycis phycis	Aegean Sea	Akmirza (2013)
***Centrodema* sp.**		
Sarpa salpa	Mediterranean Sea	Tepe and Oğuz (2013)
***Hemiurus* sp.**		
Scomber japonicus	Fish Market (Eskişehir)	Yetim (1985)
***Lecithaster* sp.**		
Pomatomus saltatrix	Fish Market (Eskişehir)	Yetim (1985)
***Paramacroderoides* sp.**		
Pomatomus saltatrix	Fish Market (Eskişehir)	Yetim (1985)
***Piriforma* sp.**		
Zosterissessor ophiocephalus	Marmara Sea	Oğuz (1995)
***Schikhobalotrema* sp.**		
Chelon labrosus	Aegean Sea	Altunel (1981)
***Stephanostomum* sp.**		
Merluccius merluccius	Marmara Sea	Oğuz (1995)
***Ascocotyle* sp.**		
Platichthys flesus	Sarıkum Lagoon Lake	Öztürk (2005)

Table 4 (continuing): Unnamed helminth species (at genera level) reported from marine fishes of Turkey.

Phylum Platyhelminthes		
Class Cestoda		
***Diphyllobothrium* sp.**		
Scophthalmus rhombus		Merdivenci (1983)
***Grillotia* sp.**		
Epinephelus aeneus	Mediterranean Sea	Genc et al. (2005)
Epinephelus marginatus	Mediterranean Sea	Genc et al. (2005)
Solea solea	Marmara Sea	Keser et al. (2007)
***Monobothrium* sp.**		
Mugil cephalus	Black Sea	Yetim (1985)
***Nybelina* sp.**		
Mullus barbatus		Sezen and Price (1969)
Merlangius merlangius	Black Sea	Yetim (1985)
Platichthys flesus	Ekinli Lagoon	Oğuz (1989)
***Rhynchobothrium* sp.**		
Gobius niger	Marmara Sea	Oğuz (1995)
***Tetraphyllidean* sp.**		
Gobius niger	Marmara Sea	Oğuz and Bray (2008)
Gobius cobitis	Marmara Sea	Oğuz and Bray (2008)
Merluccius merluccius	Marmara Sea	Oğuz and Bray (2008)
Eutrigla gurnardus	Marmara Sea	Oğuz and Bray (2008)
Solea solea	Marmara Sea	Oğuz and Bray (2008)
Scorpaena scrofa	Marmara Sea	Oğuz and Bray (2008)
***Trypanorhynch* sp.**		
Epinephelus aeneus	Mediterranean Sea	Genç (2000)
Epinephelus marginatus	Mediterranean Sea	Genç (2000)
Epinephelus costae	Mediterranean Sea	Genç (2000)
Mycteroperca rubra	Mediterranean Sea	Genç (2000)

Table 4 (continuing): Unnamed helminth species (at genera level) reported from marine fishes of Turkey.

Phylum Nemathelminthes		
***Ascarophis* sp.**		
Scorpaena scrofa	Aegean Sea	Şenol (2004)
Scorpaena notata	Aegean Sea	Şenol (2004)
Scorpaena porcus	Aegean Sea	Şenol (2004)
Scorpaena porcus	Black Sea	Tepe et al. (2014)
***Capillaria* sp.**		
Platichthys flesus	Sarıkum Lagoon Lake	Öztürk (2005)
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
***Cucullanus* sp.**		
Merlangius merlangius	Fish Market (Eskişehir)	Yetim (1985)
***Echinocephalus* sp.**		
Dasyatis sp.	Aegean Sea	Akmirza (2013)
***Hysterothylacium* sp.**		
Engraulis encrasicholus	Black Sea	Oytun (1963)
Platichthys flesus	Ekinli Lagoon Lake	Oğuz (1989)
Sparus aurata	Mediterranean Sea	Genç (2000)
Diplodus cervinus	Mediterranean Sea	Genç (2000)
Diplodus vulgaris	Mediterranean Sea	Genç (2000)
Diplodus sargus	Mediterranean Sea	Genç (2000)
Pagellus erythrinus	Mediterranean Sea	Genç (2000)
Pagrus auriga	Mediterranean Sea	Genç (2000)
Pagrus coeruleostictus	Mediterranean Sea	Genç (2000)
Dentex dentex	Mediterranean Sea	Genç (2000)
Trachurus mediterraneus		Şahin (2006)
Merlangius merlangius		Şahin (2006)
Dicentrarchus labrax	Beymelek Lagoon Lake	Emre (2010)
***Nematoda* sp.**		
Liza aurata	Aegean Sea	Altunel (1983)
Liza saliens	Aegean Sea	Altunel (1983)
Liza ramada	Aegean Sea	Altunel (1983)
***Philometra* sp.**		
Epinephelus marginatus	Mediterranean Sea	Cengizler and Sarıhan (1995)
Epinephelus aeneus	Mediterranean Sea	Genç (2000)
Epinephelus costae	Mediterranean Sea	Genç (2000)
Mycteroperca rubra	Mediterranean Sea	Genç (2000)
***Rhabdochona* sp.**		
Anguilla anguilla	Karacabey Lagoon Lake	Altunel (1990)

Table 4 (continuing): Unnamed helminth species (at genera level) reported from marine fishes of Turkey.

Phylum Acanthocephala		
***Acanthocephalus* sp.**		
Diplodus sargus	Aegean Sea	Akmirza (2000b)
***Echinorhynchus* sp.**		
Mullus surmuletus	Aegean Sea	Akmirza (2000a)
Merluccius merluccius	Marmara Sea	Oğuz (1995)
***Neoechinorhynchus* sp.**		
Mugil cephalus	Karacabey Lagoon Lake	Öztürk and Aydoğdu (2003)
Phylum Annelida		
***Hirudinea* sp.**		
Platichthys flesus	Ekinli Lagoon Lake	Oğuz (1989)

The checklist contains 18 species and seven unnamed species (genera level) of Cestoda. 19 species of cestoda were reported from 36 host fish species. In terms of host distribution, some cestoda (13 genera) may be ranked as follows: *Bothriocephalus* (nine hosts), *Phyllobothrium* (four hosts), *Acanthobothrium* (three hosts). *Bothriocephalus* is the dominant cestode species in terms of host range and location. Cestodes were reported from stomach, intestine, pyloric caeca, liver, body cavity, gonad, gall bladder, external mesenteries of internal organs of hosts. Another eight unnamed cestoda (genera level) reported from different host fish (*Grillotia* sp., *Monobothrium* sp., *Nybelina* sp., *Rhynchobothrium* sp., *Tetraphyllidean* sp., and *Trypanorhynch* sp.) (Tab. 4).

The checklist contains 17 species and eight unnamed species (genera level) of Nematoda. 17 nematode species were reported from 55 host species. Some genera of nematoda (eight genera) may be ranked as follows: *Hysterothylacium* (37 hosts), *Anisakis* (21 hosts), *Cucullanus* (eight hosts), *Philometra* (seven hosts). Adult nematodes were reported from body cavity, pyloric caeca, liver, intestine, mesentery, coelom, stomach, swimbladder, surfaces of visceral organs, muscle, ovarium, testis of hosts. Other eight unnamed nematoda (genera level) were reported from different host fish (*Ascarophis* sp., *Capillaria* sp., *Cucullanus* sp., *Echinocephalus* sp., *Hysterothylacium* sp., *Nematoda* sp., *Philometra* sp., and *Rhabdochona* sp.) (Tab. 4)

The checklist contains 11 species and three unnamed species (genera level) of Acanthocephala. Some genera of Acanthocephala are distributed as follows: *Acanthocephaloides* (eight hosts), *Neoechinorhynchus* (six hosts), *Acanthocephalus* (five hosts). 11 acanthocephala species were reported from 19 host species. Other three unnamed acanthocephala (genera level) were reported from different host fish (*Acanthocephalus* sp., *Echinorhynchus* sp., and *Neoechinorhynchus* sp.). (Tab. 4)

The checklist contains three species and one unnamed species (genera) of Hirudinids. Hirudinids were reported on body surface, fins, gills, mouth. Three species were reported from eight host species.

Since the helminths checklist of marine fishes from Turkey, published by Öktener (2005), parasites species number have nowadays seriously increased. Especially, platyhelminth species number that risen from 74 to 130 (Tab. 5).

Table 5: Change of number of named and unnamed helminth species reported from fish species occurring after Öktener (2005).

	Öktener (2005)		Present Study	
	Named sp.	Unnamed sp.	Named sp.	Unnamed sp.
Monogenea	28	2	49	7
Digenea	38	7	63	10
Cestoda	8	4	18	8
Nematoda	12	4	17	8
Acanthocephala	7	2	11	3
Hirudinea	2	0	3	1
	95	19	161	37
Total	114		198	

CONCLUSIONS

This checklist is done to update the list of the helminths of marine fishes from Turkey territory.

Finally, it was also intended to reveal and update parasite richness according to actual scientific iterature.

It was felt that a critical checklist of the marine fish parasites known from Turkey area to date would support to solve some disputes among scientists, and benefit parasitologists, zoologists, and ecologists.

It is hoped that this work will stimulate future parasitological investigations of fishes of Turkish territory.

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IDENTIFICATION AND STUDY OF FISH SPECIES IN KARKHEH RIVER (IRAN)

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KEYWORDS: Iran, Karkheh River, fish identification, biodiversity.

ABSTRACT

For the investigation of fish from Karkheh River, sampling was performed in a six month period from August 2014 to January 2015. All sampled fish were measured for biometrical values (length and weight). General results of the sampling and identification of the fish showed the presence of 14 species from four fish families of Cyprinidae, Mugilidae, Siluridae and Macrostomidae, out of which the Cyprinidae family were the most frequent of the sampled fish. The most significant abundance belongs to *Cyprinus carpio*. The fish sampled in the present study were: *Liza abu, Ctenopharyngodon idella, Barbel* sp., *Cyprinion macrostomum, Barbus sharpeyi, Hypophthalmichthys molitrix, Barbus esocinus, Barbus barbulus, Barbus luteus, Barbus grypus, Cyprinus carpio, Silurus triostegus, Mastacembelus circumcinctus* and *Capoeta trutta.* Shannon Index results showed that the fish biodiversity in the studyed area followed a uniform path and additionally that the considered area at the studied period has good fish biodiversity.

RESUMEN: Identificación y estudio de especies ícticas en el Río Karkheh (Irán).

Con el fin de estudiar los peces del Río Karkheh, se realizaron muestreos a lo largo de un semestre, de agosto de 2011 a enero de 2015. Se tomaron medidas biométricas (peso y talla) de todos los peces colectados. Se identificaron 14 especies pertenecientes a cuatro familias: Cyprinidae, Mugilidae, Siluridae y Macrostomidae, siendo la familia Cyprinidae la más común en los muestreos. La especie *Cyprinus carpio* fue la más abundante. Las especies identidicadas en este estudio fueron: *Liza abu, Ctenopharyngodon idella, Barbel* sp., *Cyprinion macrostomum, Barbus sharpeyi, Hypophthalmichthys molitrix, Barbus esocinus, Barbus barbulus, Barbus luteus, Barbus grypus, Cyprinus carpio, Silurus triostegus, Mastacembelus circumcinctus* y *Capoeta trutta*. Tras aplicar el índice de Shannon, se evidencia que la biodiversidad es uniforme y que ésta, al momento y lugar de la colecta, es comparativamente alta.

REZUMAT: Identificarea și studiul speciilor de pești din râul Karkheh (Iran).

Pentru investigarea peștilor din râul Karkheh s-au prelevat probe de-a lungul a șase luni începând din august 2014 și până în ianuarie 2015. Toți peștii colectați au fost măsurați în lungime și cântăriți. Rezultatele generale din urma prelevării și identificării peștilor au arătat existența a 14 specii aparținând a patru familii: Cyprinidae, Mugilidae, Siluridae și Macrostomidae, dintre care familia Cyprinidae a avut frecvența cea mai mare în probele colectate. Specia cu cea mai mare abundență a fost *Cyprinus carpio.* Speciile de pești prelevate în acest studiu au fost: *Liza abu, Ctenopharyngodon idella, Barbel* sp., *Cyprinion macrostomum, Barbus sharpeyi, Hypophthalmichthys molitrix, Barbus esocinus, Barbus barbulus, Barbus luteus, Barbus grypus, Cyprinus carpio, Silurus triostegus, Mastacembelus circumcinctus* și *Capoeta trutta.* Rezultatele testului Shannon au arătat faptul că biodiversitatea speciilor de pești din aria studiată respectă un model uniform și de asemenea faptul că această arie dispunea de o biodiversitate foarte bună în momentul prelevării probelor.

INTRODUCTION

Fish species have the highest diversity among all vertebrates. Almost 24,618 species were identified and about 9,966 (40.48%) of these fish species are freshwater fish (Nelson, 1984, 1994). The study of fish species in aquatic ecosystems is valuable due to different aspects of evolutionary studies such as: ecology, environmental protection, aquatic reservoirs management, stock assessment and requirements of fish species (Lagler et al., 1962).

Due to the increasing effects of environmental pollution and anthropogenic activities on aquatic ecosystems, the study of the inhabitant species in watershed management context is crucial for environmental protection (Curtean-Bănăduc et al., 2007).

In spite of the large size of Iran and the presence of enormous rivers, lakes, lagoons, bays and other water bodies, unfortunately little data is available for species of different freshwater ecosystems. Among the available data one could refer to Berg (1948, 1949), Vladykov (1964), Coad (1980, 1982, 1995), Armantrout (1980), and Saadati (1977).

The Karkheh River in Khuzestan province is one of the largest and most important rivers of Iran (Fig. 1). Due to the high water discharge and the flood receiving situation of this river, two dams were built on it called Karkheh 1 and Karkheh 2.

The Karkheh River (Figs. 1, 2, 3 and 4) is one of the rivers with large amounts of traditional fishing, fish being sold annually in regional markets. The building of the two dams on this river could also affect the fish community.

In order to understand the effects of environmental pollutants and anthropogenic activities on the aquatic life of this region, with the added effects of unauthorized catches (catch by unauthorized tools and catches during unauthorized seasons), and also to determine the status of fish species in this river, we carried out a fish identification and frequency analysis. Many of these fish species could be useful for proliferation in breeding facilities for economic and ornamental purposes. The aim of this study was to identify the fish species of the Karkheh River near these two dams over a six month period.

MATERIAL AND METHODS

For the study of fish species of the Karkheh River, after a site visit, three sampling sites were established (Tab. 1. and Fig. 2) and the fish catch was done using cast nets with different mesh sizes for catching fish of different dimensions.

Fish were sampled from August 2014 to January 2015. Biometrical parameters of sampled fish were measured with a biometrical ruler and digital scale. For identification of fish species the gross characteristics such as dorsal fin, body shape and others were used along with the atlas book of fresh water fishes of Iran.

Biodiversity was defined using Shannon index (Shannon and Wiener, 1963).

Table 1: Geographic coordinates of sampling sites.

Sampling site	Geographic coordinates	
	Latitude	Longitude
Station 1	3651967.28	761807.69
Station 2	3639928.58	777819.51
Station 3	3638556.18	780641.95

Figure 1: Iran's rivers and lakes map, the Karkheh River showed by the circle.

Figure 2: Karkheh River habitat in a plain sector.

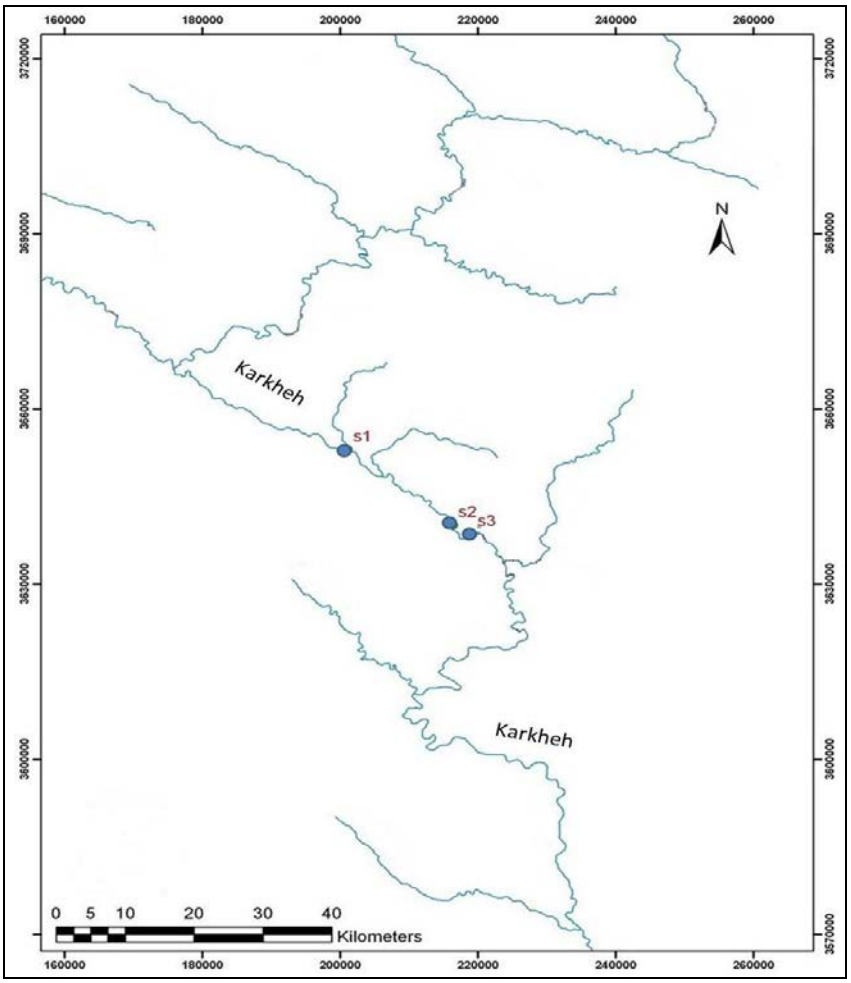

Figure 3: Karkeh River map with three sampling sites showed by blue circles (S1, S2 and S3).

Figure 4: Karkheh River habitat in mountain sector.

RESULTS AND DISCUSSION

Results of the sampling of fish species at all sampling sites over the six month period of the present study showed that sampled fish belong to four fish families including: Cyprinidae, Mugilidae, Siluridae and Macrostomidae. The most frequent fish species were representatives of the Cyprinidae family with: *Cyprinus carpio*, *Barbus grypus*, *Barbus luteus*, *Barbus barbulus*, *Barbus esocinus*, *Hypophthalmichthys molitrix*, *Barbus sharpeyi*, *Cyprinion macrostomus*, *Ctenopharyngodon idella* and *Capoeta trutta*. The identified fish species of Mugilidae, Siluridae and Macrostomidae families were *Liza abu*, *Silurus triostegus* and *Mastacembelus circumcinctus* respectively (Fig. 5).

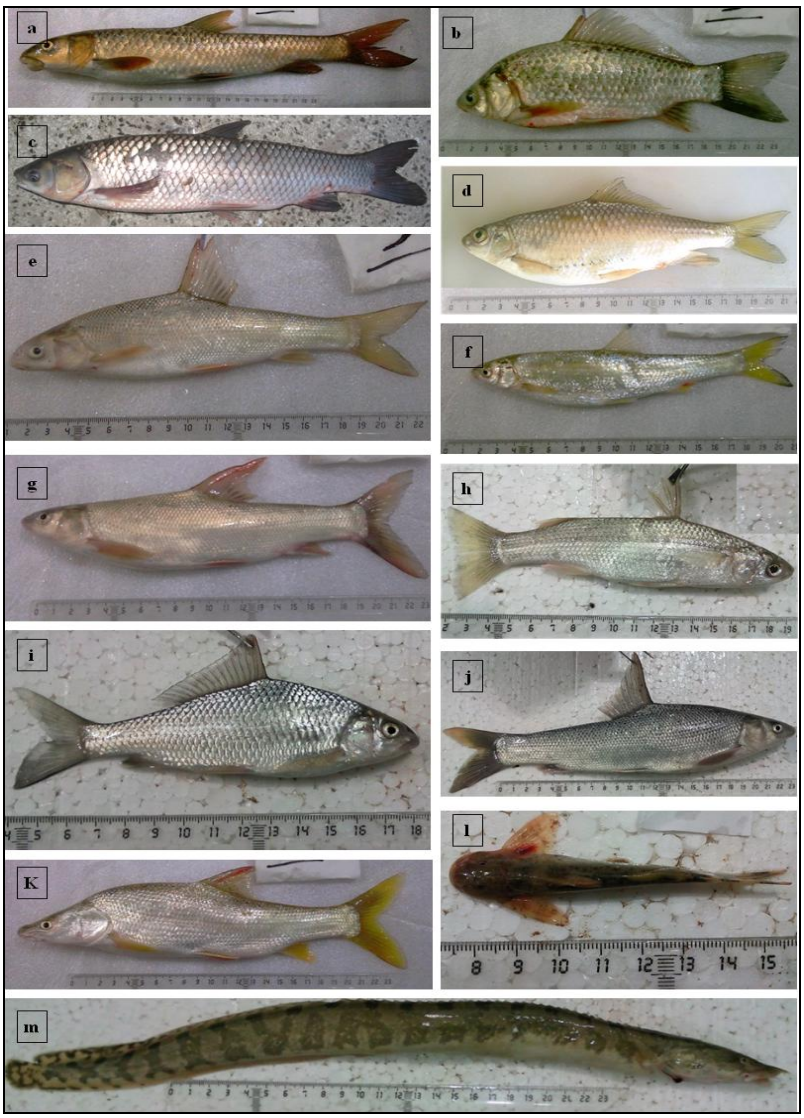

Figure 5: Fish species sampled from the Karkheh River, Iran. *Barbus grypus* (a); *Cyprinus carpio* (b); *Ctenopharyngodon idella* (c); *Cyprinion macrostomus* (d); *Barbus esocinus* (e); *Barbel* sp. (f); *Hypophthalmichthys molitrix* (g); *Liza abu* (h); *Barbus sharpeyi* (i); *Capoeta trutta* (j); *Barbus sharpeyi* (k); *Silurus triostegus* (l); *Mastacembelus circumcinctus* (m).

Mean abundance results of sampled species from each sampling month are shown in figure 6.

Results of the mean abundance of sampled species during the total six months of sampling showed that the species with the highest number of individuals in the Karkheh River was the common carp, *Cyprinus carpio* (Fig. 7).

Biodiversity results using Shannon index showed that the biodiversity of fish species of the Karkheh River was almost steady during the six months sampling period of the present study (Fig. 8).

Understanding the different components of the biosphere and various aspects of ecosystems is the first step for the management and protection of environment.

Accordingly, the study and the identification of animals and plants living in ecosystems are of special significance for the management of environmental resources.

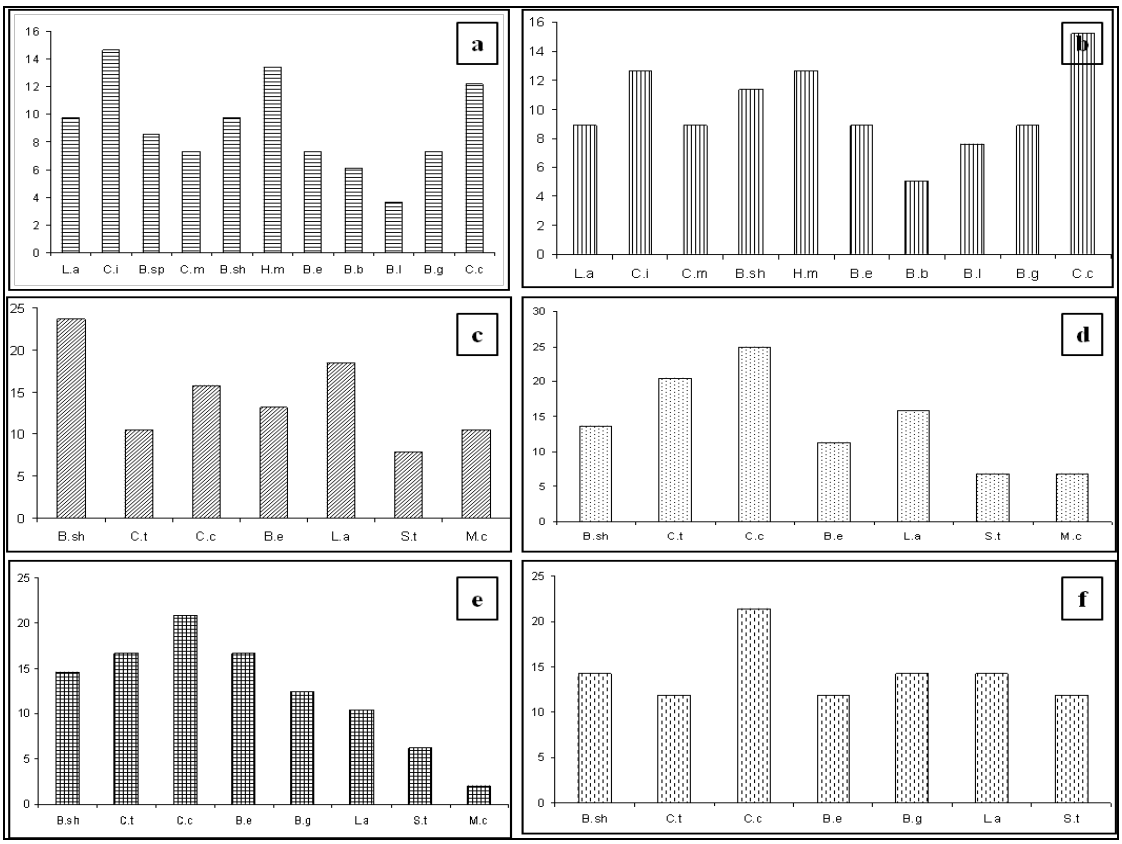

Figure 6: Abundance of sampled fish species in six month sampling period.
August (a); September (b); October (c); November (d); December (e); January (f).
Abbreviations stand for species names: *Liza abu, Ctenopharyngodon idella, Barbel* sp., *Cyprinion macrostomum, Barbus sharpeyi, Hypophthalmichthys molitrix, Barbus esocinus, Barbus barbulus, Barbus luteus, Barbus grypus, Cyprinus carpio, Silurus triostegus, Mastacembelus circumcinctus* and *Capoeta trutta.*

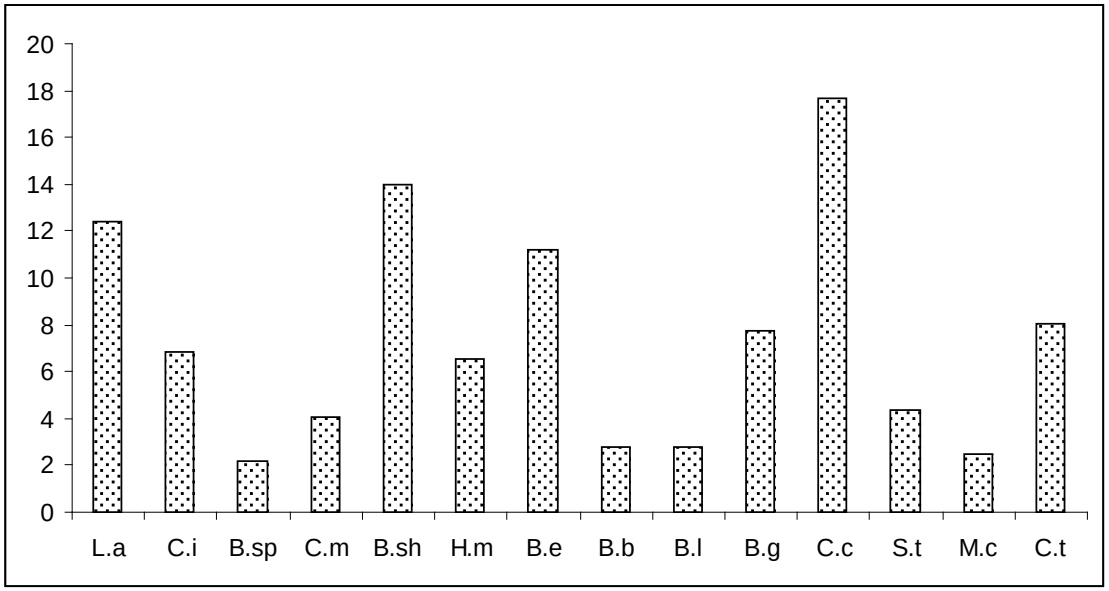

Figure 7: Total abundance of fish species during the six month period of study in the Karkheh River. The most abundant fish species during the study period was common carp, *Cyprinus carpio*. Abbreviations stand for species names: *Liza abu, Ctenopharyngodon idella, Barbel* sp., *Cyprinion macrostomum, Barbus sharpeyi, Hypophthalmichthys molitrix, Barbus esocinus, Barbus barbulus, Barbus luteus, Barbus grypus, Cyprinus carpio, Silurus triostegus, Mastacembelus circumcinctus* and *Capoeta trutta.*

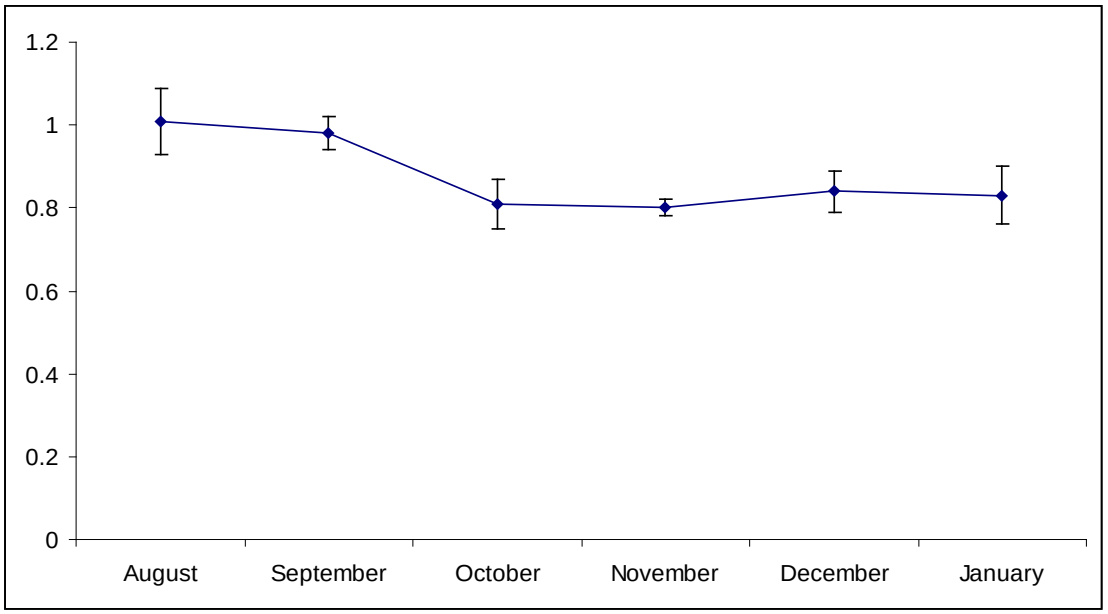

Figure 8: Shannon Index of the sampled species from the Karkheh River during the six months study period.

CONCLUSIONS

According to the species identification, abundance and Shannon index. One could conclude that the Karkheh River in the studied area has a good biodiversity of freshwater fish during the sampling season. This would be a good reason for better environmental management and protection of this area for species conservation within this valuable ecosystem.

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USE OF POACHERS' CATCHES FOR STUDYING FISH FAUNA IN THE WATER BODIES OF THE TRANSCARPATHIAN REGION (UKRAINE)

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KEYWORDS: Transcarpathia, Tisa River, poaching, fishing gears, catchability.

ABSTRACT

We compared techniques used by poachers to capture fishes in the streams and stagnant water bodies of the Tisa River basin in Ukraine, which included: gill nets, lift nets, screen nets, electrofishing devices, spears, concussion, and beach seine. In total, 38 species were observed in poachers' catches, among which the most abundant were nase (*Chondrostoma nasus*), Carpathian barbel (*Barbus carpathicus*), chub (*Squalius cephalus*), crucian carp (*Carassius gibelio*), and minnow (*Phoxinus phoxinus*). The highest diversity of species was observed in gill nets (25 species in rivers and 10 in stagnant waters), lift nets (20 species in rivers and eight in stagnant waters), and electrofishing (19 species). Poachers' catches can provide information on fish species' compositions and relative abundance in montane rivers; but there are biases associated with each technique.

RÉSUMÉ: Utilisation des prises des braconniers pour l'étude de l'ichtyofaune dans les plans d'eau de la région de Zakarpattya/Transcarpatie (Ukraine).

Nous avons comparé les techniques utilisées par les braconniers pour capturer des poissons dans les cours d'eau et les plans d'eau du bassin de la rivière Tisa en Ukraine, qui comprennent les filets maillants, les filets soulevés, les filets de pêche écran, les dispositifs de pêche électrique, les harpons, la concussion et la pêche à la senne. Au total, 38 espèces ont été observées dans les prises des braconniers dont les plus abondantes ont été le nase (*Chondrostoma nasus*), le barbeau carpatique (*Barbus carpathicus*), le chevesne (*Squalius cephalus*), le carassin (*Carassius gibelio*) et le vairon (*Phoxinus phoxinus*). La diversité des espèces la plus élevée a été observée dans les filets maillants (25 espèces dans les rivières et 10 espèces dans les eaux d'eau stagnante), les filets soulevés (20 espèces dans les rivières et huit dans les eaux stagnantes) et la pêche électrique (19 espèces). Les captures des braconniers peuvent fournir des informations sur les compositions d'espèces de poissons et l'abondance relative des espèces dans les rivières de montagne, malgré des biais existant associés à chaque technique.

REZUMAT: Utilizarea capturilor braconierilor pentru studiul ihtiofaunei din corpurile de apă din Zakarpatia, regiunea transcarpatică (Ucraina).

Am comparat tehnici folosite de braconieri pentru a prinde pești atât în ecosisteme lotice, cât și lentice din bazinul Tisei, în Ucraina. Se utilizează setci, plase acționate prin ridicare, plase sită, aparate pentru electrofishing, sulițe, explozibil și năvodul utilizat de pe maluri. În total, au fost observate 38 specii, capturate de braconieri, printre care cele mai abundente au fost: scobarul (*Chondrostoma nasus*), mreana (*Barbus carpathicus*), cleanul (*Squalius cephalus*), carasul (*Carassius gibelio*) și boișteanul (*Phoxinus phoxinus*). Cea mai mare diversitate a speciilor a fost observată în setci (25 specii în râuri și 10 în apele stătătoare), plase acționate prin ridicare (20 specii în râuri și opt în apele stătătoare) și electrofishing (19 specii). Capturile braconierilor pot furniza informații cu privire la compoziția specifică a ihtiofaunei și abundența relativă a speciilor din râurile montane, dar fiecare tehnică are limite asociate.

INTRODUCTION

Watercourses of the Tisa River basin (Danube River system) flow from the western slopes of the Carpathian Mountains and within Ukraine, they include about 9,500 rivers and streams for a total length of more than 19,000 km (Shmidt, 1978). These lotic systems are rather unique ecosystems, including the highest diversity of fish species in Ukraine, many being endemic. According to different authors (Movchan, 2000), from 49 to 61 taxa of species and sub-species rank and inhabit water bodies of the Tisa River basin within Ukraine. Stocks of some fish species were commercially exploited as recently as the first half of the 20th century (Protasov, 1948), but most of them have significantly declined due to various factors; the majority of which are due to human impact in the area (Movchan, 2000). Little information is available on the current state of local fish communities because no complex scientific surveys have been conducted in these rivers. In Ukraine, much more attention is given to fishes of large water bodies, and stocks of which are exploited commercially.

Fish sampling provides necessary information for fisheries, scientists and managers on fish abundance, species' composition, stock state, and other factors. However, collecting data in the field can be expensive, time consuming and is often limited to few water bodies or sampling sites. Therefore, in addition to fish surveys research, samples of recreational or commercial creels are often used to collect information about fisheries (Malvestuto, 1996; Fabrizio and Richards, 1996).

Recreational fishing in rivers of the Ukrainian Carpathians is very popular among local people and tourists. According to Ukrainian Recreational Fishing Regulations, only angling gears are allowed for fish capture in these rivers. However, due to the lack of control and the remoteness of many mountain rivers, illegal fishing is a widespread activity in this region. The most common poachers' gears used include various nets (gill nets, drift nets, lift nets, etc.) and electrofishing devices. Less common fishing methods include using spears and concussion (Didenko et al., 2011). If illegal fishing gears (gill nets) are found by local fish protection inspectors, or if poachers are caught on the fishing site with their gears and catch, a protocol of offence is filed; it includes information such as the number of fishes caught, a description of the fishing gear used, and occasionally the length and weight of the fish species caught. The data can provide additional information for fisheries and biologists, especially when they are unable to sample fish over the entire region.

Thus, the aim of this study was to investigate the possibility of using poachers' catches for studying fish fauna in the Ukrainean Carpathian Rivers and to compare the efficiency of different illegal fishing gears.

MATERIALS AND METHODS

Different types of data were collected during 2008-2011 in the Transcarpathian (Zakarpattya) region of Ukraine.

We analyzed poachers' catches and fishing gears (if possible) confiscated by Regional Fish Protection Inspectorate in different areas of the Transcarpathian region, as well as protocols of offence registered for each poaching event (Figs. 1 and 2).

Catches from rivers and stagnant water bodies (lakes, ponds, canals) were treated separately.

Catches of the following illegal fishing gears and techniques were analyzed (see also Didenko and Velykopolsky, 2011):

- gill nets, which ranged in dimensions of 20-100 m in length, 1.0-2.0 m in depth, a bar mesh size of 10 to 40 mm (54 protocols at 31 sites in eight rivers; 21 protocols at 19 sites in 17 stagnant water bodies);
- lift nets, which were constructed of a 1.0 × 1.0 to 4.0 × 4.0 m, 10-30 mm bar mesh on a horizontally oriented rectangular sheet of netting, mounted on two crossed metal or plastic arcs attached to a handle. Fish were caught by abruptly lifting the net out of the water after they were concentrated over the net at intervals of one to 30 minutes (27 protocols at 18 sites in 10 rivers; 11 protocols at nine sites in nine stagnant water bodies);
- screen nets, which consisted of a vertically oriented sheet of netting attached to a metallic bottom line and top line attached with ropes to a handle. Dimensions of screen nets ranged from lengths of 0.7-1.5 m, depths of 0.7-1.5 m, and bar mesh sizes of 10 to 30 mm. Fish were captured by holding the net under the water above the bottom or in the water column in current for periods of five to 30 minutes. Fish in screen nets were caught by gilling or wedging (36 protocols at 16 sites in four rivers);
- electrofishing devices, which were usually home-made and portable apparatuses with various constructions and power characteristics (16 protocols of offence at 15 sites in seven rivers);
- spears, which were usually constructed of a rake or table fork attached to an elongated handle (12 protocols of offence at seven sites in seven rivers);
- concussion consisted of striking large stones protruding from the water with a sledge hammer as strongly as possible. Concussed fish were then collected by dip nets and by hand (11 protocols of offence at nine sites in four rivers);
- beach seines (length three to 20 m, height 0.5-2.0 m, mesh size from 10 x 10 to 30 x 30 mm), which were used mainly in stagnant water bodies (nine protocols at seven sites in five stagnant water bodies).

The seized fish were identified and counted. Due to the fact that different fishing gears of the same type were not standardized (e.g. nets had different mesh sizes and dimensions) and fishing efforts were not known, catches were pooled by numbers of species caught in each gear type (all rivers together). Then we calculated the composition percentage of species captured using each fishing gear type.

Next, poachers' gears was compared by species captured and by rivers, to see if there were differences among methods in its ability to catch different species and if there were differences among rivers. While comparing different gears, we used the number of species caught per gear, per fishing site, and per day/night as a unit of catchability. For the comparison of rivers, we excluded those for which only one site was fished.

A one-way analysis of variance (ANOVA) was performed to test the differences among fishing gear and among rivers. A multiple comparisons procedure (Tukey-Kramer, $\alpha = 0.05$) was used to compare all possible pairs of means of fish caught by each method and separately in each river. Data (number of fish caught) were log transformed to satisfy the assumptions of normality of ANOVA. All statistical calculations were performed with JMP IN 5.0 software.

RESULTS AND DISCUSSION

In total, 38 species belonging to 10 families (Thymallidae, Salmonidae, Cyprinidae, Nemacheilidae, Ictaluridae, Esocidae, Lotidae, Percidae, Cottidae and Centrarchidae) were observed in poachers' catches (Figs. 1 and 2; Tabs. 1 and 2). Of them, 34 species were recorded for rivers and 13 species for stagnant waters. The most abundant were cyprinids, which were represented by 23 species (60.5%). Percids were represented by five species (13.2%), salmonids by three species (7.9%), and the others by one species (2.6% each). Among the fish caught in poachers' fishing gears, 10 species are listed as endangered in the current edition of the Red Book of Ukraine (*Thymallus thymallus, Hucho hucho, Telestes souffia, Barbus barbus, Barbus carpathicus, Romanogobio uranoscopus, Lota lota, Gymnocephalus schraetser, Zingel zingel,* and *Zingel streber*).

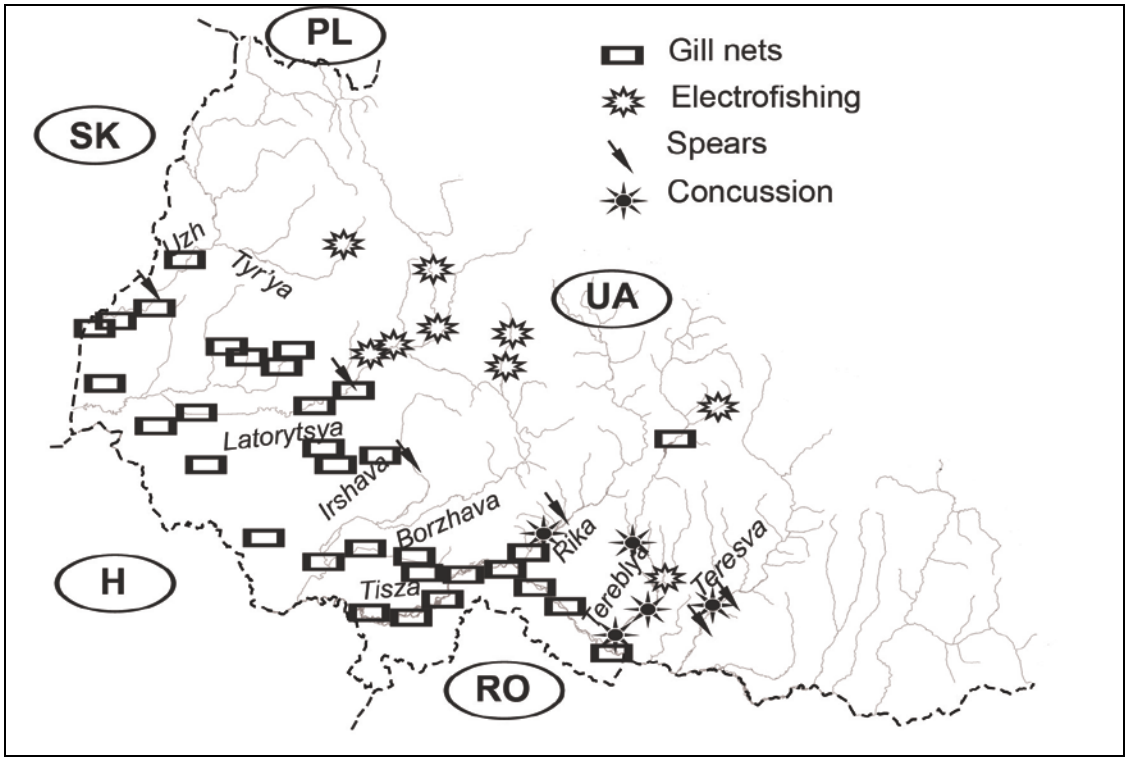

Figure 1: Sites locations of poaching events with gill nets, electrofishing, spears and concussion in the Zakarpattya region of Ukraine.

Four species (*Cyprinus carpio, Hypophthalmichthys* sp., *Ctenopharyngodon idella*, and *Lepomis gibbosus*) were caught only in stagnant waters. Nine species (*Squalius cephalus, Rutilus rutilus, Scardinius erythrophthalmus, Abramis brama, Carassius gibelio, Ameiurus nebulosus, Esox lucius, Lota lota* and *Perca fluviatilis*) were observed in catches from both rivers and stagnant water bodies. The remaining 23 species were recorded only for rivers.

The highest diversity of species was observed in gill net catches, 25 species in rivers and 10 in stagnant waters (Tabs. 1 and 2). The most abundant were *Chondrostoma nasus, Squalius cephalus, Barbus carpathicus,* and *Carassius gibelio* each of which composed more than 8% of the catch by numbers. In stagnant waters the most abundant were *Carassius gibelio* and *Cyprinus carpio,* which are typical pond fishes.

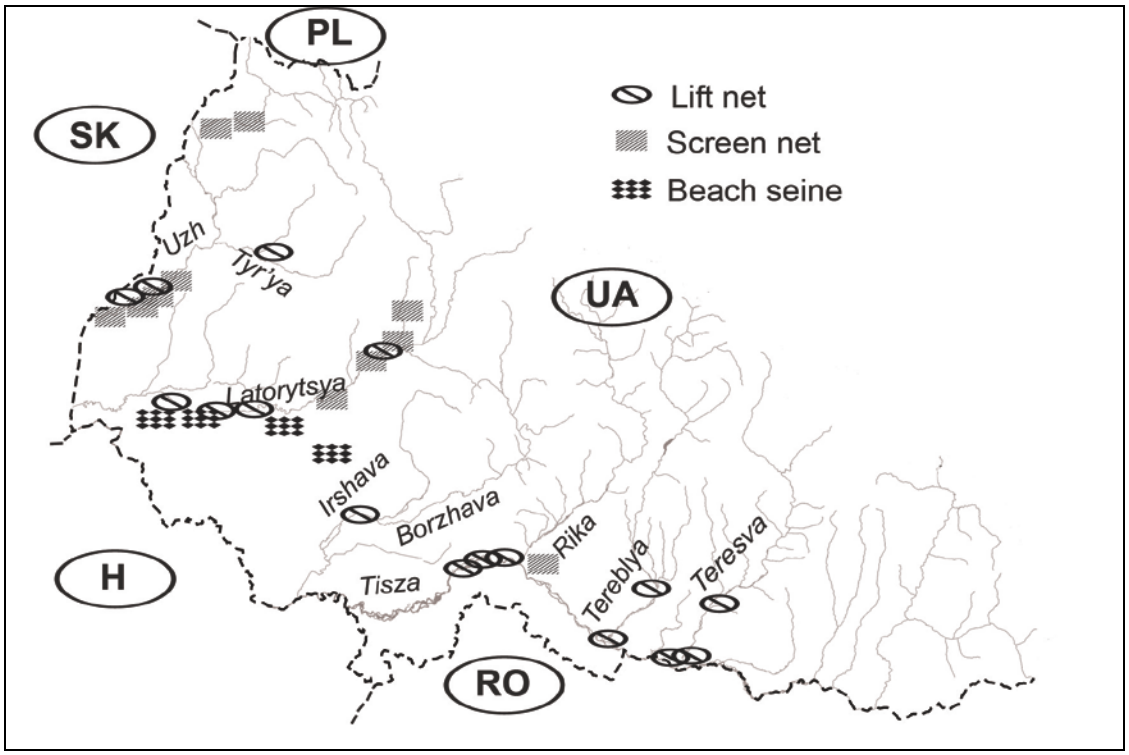

Figure 2: Site locations of poaching events with lift net, screen net and beach seine in the Zakarpattya region of Ukraine.

Table 1: Species' compositions (%) of poachers' fishing gears in rivers and streams of the Tisa River basin in the Zakarpattya region of Ukraine; the average for 2008-2011.

Species	Fishing gears/techniques					
	Gill nets	Lift net	Screen net	Concu-sion	Spearing	Electro-fishing
Hucho hucho	0.28	0.31	-	-	1.52	-
Oncorhynchus mykiss	-	-	-	-	-	0.91
Salmo trutta m. *fario*	-	-	-	-	-	1.37
Thymallus thymallus	-	0.61	0.45	0.65	-	1.82
Chondrostoma nasus	37.01	18.38	48.21	0.65	20.45	46.58
Squalius cephalus	11.30	3.37	8.48	3.68	14.39	8.36
Leuciscus leuciscus	-	-	-	-	-	3.12
Leuciscus idus	0.28	-	-	-	-	-

Table 1 (continuing): Species' compositions (%) of different poachers' fishing gears in rivers and streams in Tisa Basin in the Zakarpattya area of Ukraine; an average for 2008-2011.

Species	Fishing gears/techniques					
	Gill nets	Lift net	Screen net	Concu-sion	Spearing	Electro-fishing
Telestes souffia	1.13	0.77	-	4.98	0.76	3.27
Vimba vimba	1.84	1.07	-	-	-	0.15
Barbus barbus	4.66	0.61	6.70	1.95	5.30	1.44
Barbus carpathicus	9.04	8.12	26.34	29.00	55.30	12.39
Romanogobio uranoscopus	0.14	0.31	0.45	1.30	0.76	-
Gobio carpathicus	0.56	0.61	-	0.22	-	0.76
Rutilus rutilus	0.28	1.07	0.45	-	-	2.36
Scardinius erythrophthalmus	0.28	-	5.80	-	-	-
Blicca bjoerkna	4.24	0.61	-	-	-	-
Abramis brama	4.52	0.31	-	-	-	-
Alburnus alburnus	3.11	48.09	2.23	1.73	0.76	3.34
Alburnoides bipunctatus	-	6.43	-	2.16	0.76	4.18
Phoxinus phoxinus	-	3.52	-	47.19	-	6.61
Aspius aspius	0.56	-	-	-	-	-
Tinca tinca	-	0.15	-	-	-	-
Carassius gibelio	8.33	4.90	-	0.87	-	0.08
Barbatula barbatula	-	-	-	5.41	-	-
Ameiurus nebulosus	0.71	-	-	-	-	-
Esox lucius	3.39	0.15	-	-	-	-
Lota lota	1.27	-	-	-	-	0.15
Cottus poecilopus	-	-	-	-	-	3.04

Table 1 (continuing): Species' compositions (%) of different poachers' fishing gears in rivers and streams in Tisa Basin in the Zakarpattya area of Ukraine; the average for 2008-2011.

Species	Fishing gears/techniques					
	Gill nets	Lift net	Screen net	Concu-sion	Spearing	Electro-fishing
Perca fluviatilis	3.81	**0.61**	**0.89**	**0.22**	-	-
Gymnocephalus cernua	0.14	-	-	-	-	-
Gymnocephalus schraetser	1.69	-	-	-	-	-
Zingel zingel	1.27	-	-	-	-	-
Zingel streber	0.14	-	-	-	-	0.08

Table 2: Species' percent compositions (%) of different poachers' fishing gears in stagnant water bodies in the Zakarpattya region of Ukraine; an average for 2008-2011. ** Includes *Hypophthalmichthys molitrix* and *Hypophthalmichthys nobilis* and their hybrids.

Species	Fishing gear/techniques		
	Gill nets	Lift net	Beach seine
Squalius cephalus	-	0.48	-
Rutilus rutilus	3.46	0.48	42.77
Scardinius erythrophthalmus	-	0.48	-
Abramis brama	4.07	0.96	-
Cyprinus carpio	16.54	0.48	-
Carassius gibelio	71.60	90.43	33.96
Ctenopharyngodon idella **	0.12	-	-
Hypophthalmichthys ssp. **	0.49	-	0.63
Ameiurus nebulosus	2.72	5.26	10.06
Esox lucius	0.62	-	12.58
Lota lota	-	0.48	-
Lepomis gibbosus	0.25	-	-
Perca fluviatilis	0.12	-	-

These data are consistent with the data obtained during a fish research survey conducted on Teresva and Irshava Carpathian rivers, with the use of gill nets of 21-40 mm mesh sizes (Didenko et al., 2010). In both studies, the most abundant species were *Chondrostoma nasus* (36.2% in the research survey - average for two studied rivers, and 37.0% in poachers' gear), *Squalius cephalus* (9.0% in the research survey and 11.3% in poachers' gears) and *Barbus carpathicus* (13.7% in the research survey and 9.0% in poachers' gear). However, 37 species in total were caught by research gill nets and 29 were observed in poachers' gill nets. In the research catches, the species that ranked the 4th and 5th in the abundance list were *Alburnoides bipunctatus* (6.9%) and *Alburnus alburnus* (6.0%), while only *Alburnus alburnus* was observed in poachers' gear (3.1%, ranked the 10th). *Carassius gibelio* was much more abundant in poachers' gill nets (8.3%, ranked the 4th), than in research ones (2.0%, ranked the 13th). Poachers select more valuable and larger fish and therefore often set their nets in sheltered sites and among aquatic vegetation hidden from direct sight where crucian carp is more common; while such rheophil species as *Alburnus alburnus* and *Alburnoides bipunctatus* prefer open waters and are furthermore often discarded.

Twenty species were caught via the lift net in rivers, among which the most abundant were *Alburnus alburnus*, *Chondrostoma nasus* and *Barbus carpathicus* (Tab. 1). Eight species were observed in lift net catches in stagnant waters, among which the most abundant was *Carassius gibelio* (Tab. 2).

Lift net catches significantly differed from gill net catches. The lift nets were found to be effective for catching small schooling species such as *Alburnus alburnus*, which inhabit the water column; as well as juveniles of larger species such as: *Chondrostoma nasus*, *Barbus carpathicus* and *Carassius gibelio*. These gears can be used in a wider range of habitats, from lentic environments to shallow montane streams. However, large and fast fishes usually escape from these nets.

Various types of lift nets are successfully used for sampling fish larvae (Mehner et al., 1996; Rooker et al., 1996), and adults (Pot, 1984; Pyka, 1999), especially in tropical water bodies (Whitfield, 1993; Mtsambiwa, 1996; Ahmed and Hambrey, 2005), where they are often used as traditional fishing gears by local people. This active fishing gear can be useful for collecting information on species' composition and collecting fish for additional purposes when no data on their abundance is necessary such as study of fish diets and diseases.

Ten species were caught by the screen nets (Tab. 1). Screen nets were found to be the least effective as they caught the lowest amount of fishes among the analyzed fishing gears. Similar to gill nets, the most frequently captured fishes were *Chondrostoma nasus*, *Barbus carpathicus* and *Squalius cephalus*, which is probably because both types of gears are vertically oriented nets and have similar biases related to fish selection.

Fourteen species were caught by concussion with the aid of sledge hammers and the dominant species among them were *Phoxinus phoxinus* and *Barbus carpathicus* (Tab. 1). Concussion of fish with the aid of sledge hummers seems to be less selective than spearing. This method can be used in similar biotopes as spears, but it requires large stones to serve as resonators, which transform the energy of the hit into shock waves that travel through the water. Concussion is more suitable for very shallow mountain streams, which are rich in such stones. As it can be seen from the species' composition observed in catches obtained by this technique, it seems that some fishes are more vulnerable to concussion than others. The most sensitive seems to be minnow and Carpathian barbel, which significantly exceeded all other species in catches using this method. However, it may also be due to the fact that concussion was used in streams where these species dominated.

Nine species were caught using spears, among which the *Barbus carpathicus* predominated significantly, while other abundant species included *Chondrostoma nasus* and *Squalius cephalus*. Hand spears are rarely used as gear for fish sampling and only for studies when no data on fish abundance is necessary (Webb and Kingsford, 1992). Poachers use them in very shallow streams with transparent water that allows direct observation of the target fish. Usually these habitats are located in mountain and sub-mountain regions of the Carpathians. During the fishing process, the poacher stays on the river bank, on large stones or wades cautiously in the water looking for fish. The spear is a highly selective gear because the person usually selects the largest individuals if several fish are in the field of view. Additionally, this fishing method is species-selective (only nine species caught) and is directed mainly towards the bottom dwelling and relatively large fish such *Chondrostoma nasus* and *Squalius cephalus*, which are easier to hit by spear. However, small bottom dwelling species such as *Cottus poecilopus* and *Cottus gobio* may remain inaccessible for this gear because they usually hide under stones or snags and are not seen from the waters' surface. It seems that fast swimming species inhabiting the water column such as salmonids, *Alburnus alburnus* and *Alburnoides bipunctatus* are difficult to capture with spears. The exception is *Hucho hucho*, large individuals of which capture is possible with the aid of spearing on their spawning grounds when this fish becomes less alert.

In electrofishing catches, 19 species were observed, among which *Chondrostoma nasus* and *Barbus carpathicus* (Tab. 1) dominated. Electrofishing devices were found to be the least selective gear and the only one that captured *Thymallus thymallus, Salmo trutta* m. *fario* and *Oncorhynchus mykiss*. They are widely used worldwide and are the most effective gears for fish sampling in mountain rivers (Reynolds, 1996; Dunham et al., 2009), but are legally prohibited in Ukraine, including their use for scientific purposes. Electrofishing was found to be the most effective technique for fishing as it caught the highest number of fish (all species combined) per poacher per fishing trip. Lower numbers of species caught by this method in comparison with gill nets can be explained by the fact that poachers most often use portable electrofishing devices, which can be applied in a limited number of biotopes such as very shallow mountain and sub-mountain streams (usually < 50 cm depth) characterized by lower biodiversity than lower sections of rivers where gill net are commonly used. Poachers also tend to use these gears in more remote areas because more severe penalties are imposed for fishing with them.

In beach seine catches, methods used mainly on shallows of stagnant water bodies with relatively flat bottoms, five species were observed, among which the most abundant were *Rutilus rutilus* and *Carassius gibelio*. Beach seines are widely used throughout the world for commercial fishery and research fish sampling both in rivers and stagnant waters with various goals including studies of fish abundance and species composition (Hayes et. al., 1996; Port et al., 2006; Horváth et al., 2012). They can very easily be made and deployed by illegal fishermen.

Such species as *Leuciscus idus, Aspius aspius, Ctenopharyngodon idella, Hypophthalmichthys* spp., *Ameiurus nebulosus, Lepomis gibbosus, Gymnocephalus cernua, Gymnocephalus schraetser* and *Zingel zingel* were caught only in gill nets. A single occurrence of *Tinca tinca* was observed in the lift net only. *Salmo trutta, Oncorhynchus mykiss, Leuciscus leuciscus* and *Cottus poecilopus* were observed only in electrofishing catches, while *Barbatula barbatula* was caught only by concussion.

Fishing methods differed in the number of fishes captured ($P < 0.001$). The difference of electrofishing catchability from other gears was significant (except concussion), while screen netting differed significantly only from electrofishing and concussion, but the difference between various netting gears and spearing was insignificant ($P > 0.05$). Netting techniques and spearing captured relatively equal numbers of fish, all species combined. Electrofishing captured the highest number of fishes while screen net captured the lowest.

The number of fishes caught differed statistically significantly by rivers, but remained moderate ($P = 0.024$). A significant difference was observed only between Tereblya River, where the largest number of fish were caught, and Borzhava River, where the lowest number of fish were caught ($P > 0.05$).

As for differences between different rivers, they can be attributed to fishing gears and techniques used as well as different species' compositions and fish densities. The highest amount of fish caught in Tereblya River is due to the fact that mostly lift nets and concussions were deployed here, which captured large quantities of small juvenile fish. In Borzhava River, with the lowest amount of fish catches, the catches were obtained using gill nets and lift nets.

CONCLUSIONS

An analysis of catches from illegal fishing gears can provide information on fish species' composition and relative abundances of species in mountain rivers when such fishing activity occurs in the water body of interest and where research fish surveys cannot be conducted. This information is relatively easy to obtain and is of low cost for fisheries' scientists. However, there are biases associated with the analyzed fishing gears because poachers typically select the most valuable and large fishes, while small and coarse species can be underrepresented in their catches. Therefore, only general inferences can be made from such data.

According to our results, 38 species were caught by illegal fishing gears in rivers and stagnant waters of the Tisa basin within Ukraine and the most abundant were *Chondrostoma nasus, Barbus carpathicus, Squalius cephalus, Carassius gibelio* and *Phoxinus phoxinus* (depending on habitat). As no research fish surveys were conducted in these rivers with the use of non-selective gears such as electrofishing, it was not possible to compare these results with scientific data.

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ABUNDANCE OF THE ALIEN SPIONID *STREBLOSPIO GYNOBRANCHIATA* IN RELATION TO SEDIMENT COMPOSITION ALONG THE SOUTHERN COAST OF THE CASPIAN SEA

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KEYWORDS: density, *Streblospio gynobranchiata*, total organic matter, sediment.

ABSTRACT

Seasonal and inter-annual variations in the density of the invasive polychaete *Streblospio gynobranchiata* were noted in the south Caspian Sea when sediment conditions were examined at five and 14 meters depths in 2005 and 2010. There was no clear trend in changing density in line one but in line two, in all seasons except summer, density of *S. gynobranchiata* decreased significantly. Maximum densities of 2,040 ind./m^{-2} and 1,013 ind./m^{-2} were obtained in 2005 and 2010, respectively. Although the percentage of total organic matter as a food resource increased from 2005 to 2010, the density of *S. gynobranchiata* decreased slightly in the same period. It seems that in this invasion phase the population of *S. gynobranchiata* has decreased to a balance condition. There is evidence that the changing density of this species is also being affected by other biotic/abiotic factors like intra/interspecific competitors and pollutants.

RÉSUMÉ: L'abondance des populations du polychète envahissant *Streblospio gynobranchiata* selon les caractéristiques du sédiment sur les côtes Sud de la Mer Caspienne.

Nous avons étudié les variations saisonnières et interannuelles de la densité des populations du polychète *Streblospio gynobranchiata* au sud de la Mer Caspienne selon les caractéristiques du sédiment aux profondeurs de cinq et 14 mètres en 2005 et en 2010. Aucune tendance claire n'a été identifiée pour la ligne un mais pour la ligne deux, la densité de *S. gynobranchiata* a baissé de manière significative durant toutes les saisons, excepté l'été. Les densités maximales ont été de 2040 ind./m^{-2} en 2005 et de 1013 ind./m^{-2} en 2010. Même si le taux de matière organique totale - source de nourriture - a été plus grand en 2010, la densité de l'espèce a baissé légèrement durant l'année 2010. Il semble que, durant cette phase d'invasion, les populations étudiées ont baissé aux valeurs d'équilibre. De même, il a été suggéré que les variations de la densité de cette espèce sont contrôlées par d'autres facteurs biotiques ou abiotiques tels la concurrence intra/interspécifique et la pollution.

REZUMAT: Abundența populațională a polichetului invaziv *Streblospio gynobranchiata* în funcție de caracteristicile substratului în zonele costiere sudice ale Mării Caspice.

S-au cercetat variațiile sezoniere și interanuale ale densității populațiilor polichetului invaziv *Streblospio gynobranchiata* în sudul Mării Caspice, în funcție de caracteristicile substratului, la adâncimile de cinci respectiv 14 metri, în anii 2005 și 2010. Nu s-a evidențiat o tendință clară în variațiile densității pentru linia unu dar, pentru linia doi, densitatea *S. gynobranchiata* a scăzut semnificativ în toate anotimpurile cu excepția verii, astfel încât densitățile maxime au fost de 2040 ind./m^{-2} în 2005 și 1013 ind./m^{-2} în 2010. Deși procentul de materie organică totală utilizată ca sursă de hrană a fost mai mare în 2010, valorile densității au fost ușor mai mici în 2010. Se pare că, în această fază a invaziei, populațiile studiate au scăzut până la valori de echilibru. De asemenea, s-a sugerat că variațiile de densitate ale acestei specii sunt controlate de alți factori biotici/abiotici, precum concurența intra/interspecifică și poluarea.

INTRODUCTION

The success of invasive aquatic organisms is aided by a variety of attributes such as high genetic variability, wide environmental tolerance, short generation time, high reproductive capacity, early sexual maturity and a broad diet.

Normally, following some period of time after its introduction, invasive species show an exponential population increase and expansion. Maintenance of the immigrant species at a high population level will be related to interspecific competition with native species and availability of habitat, and also the availability of food. Eventually, the immigrant population may decline, for instance due to increased predation pressure, parasite infestation or loss of genetic vigour (Essink and Dekker, 2002; Neideman et al., 2003).

The south Caspian Sea, with its low diversity of macrofauna, has passed through a stressful condition during last decade. Because of the invasion of *Mnemiopsis leidyi* (Agassiz, 1860) and *Streblospio gynobranchiata* (Rice and Levin, 1998), macrofauna diversity and community structure has changed dramatically (Roohi et al., 2010; Taheri and Yazdani Foshtomi, 2011). Besides, different kinds of pollutants like heavy metals, microbial, rural and agricultural waste water are increasing in this part of the Caspian Sea (Karbassi and Amirnezhad, 2004; Fereidouni et al., 2006).

The presence of the *S. gynobranchiata* species has been found in the south-eastern United States in Florida and the Gulf of Mexico (Rice and Levin, 1998) for the first time. It was reported as an invasive species in the Black Sea (Boltacheva, 2008) and also in the Izmir Bay in 2003 (Cinar et al., 2005). In Izmir Bay (Alsancak Harbour) it became the dominant species and accounted for almost 100 percent of faunal population at some stations with a maximum density of 60,480 ind./m^{-2} (Cinar et al., 2005, 2006). In the autumn of 2004, it was observed at Noor Coast (Iran) in the south Caspian Sea and in a short time it reached 10,311 ind./m^{-2} at 30 meters depth and became the dominant species (Taheri et al., 2009; Taheri and Yazdani Foshtomi, 2011). At Gorgan Bay on the south-east coast of the Caspian Sea, in the spring of 2010 *S. gynobranchiata* represented 64.80 percent of the total density of Annelida with a maximum observed density of 3,617 ind./m^{-2} (Taheri et al., 2012).

Monitoring community structure is useful for coastal management and conservation. The aim of this study is to record the changing densities of *S. gynobranchiata* in the shallow water of the south Caspian Sea in the five years after its first report.

MATERIAL AND METHODS

Mazandaran Province is located in the south of the Caspian Sea along the Iranian coast. The province has a subtropical climate characterised by warm summers and mild winters. The gradient and structure of the seabed are uniform and there is almost no tidal current. The surface salinity down to 30 meters depth has negligible variations (Hadjizadeh Zaker et al., 2007). No major rivers exist in the vicinity of the sampling sites in this area though it is important to note there is rip current phenomenon in this area (Shafiei Sabet and Barani, 2011). Sampling was conducted on the Noor Coast (between Royan and Rostamrood) between 51°59ʾ35” to 52°02ʾ31” E and 36°35ʾ25” to 36°36ʾ29” N in 2005 and along the Noshahr Coast (between Royan and Noshahr) between 51°31ʾ12” to 51°49ʾ54” E and 36°39ʾ28” to 36°35ʾ11” N in 2010 (Fig. 1).

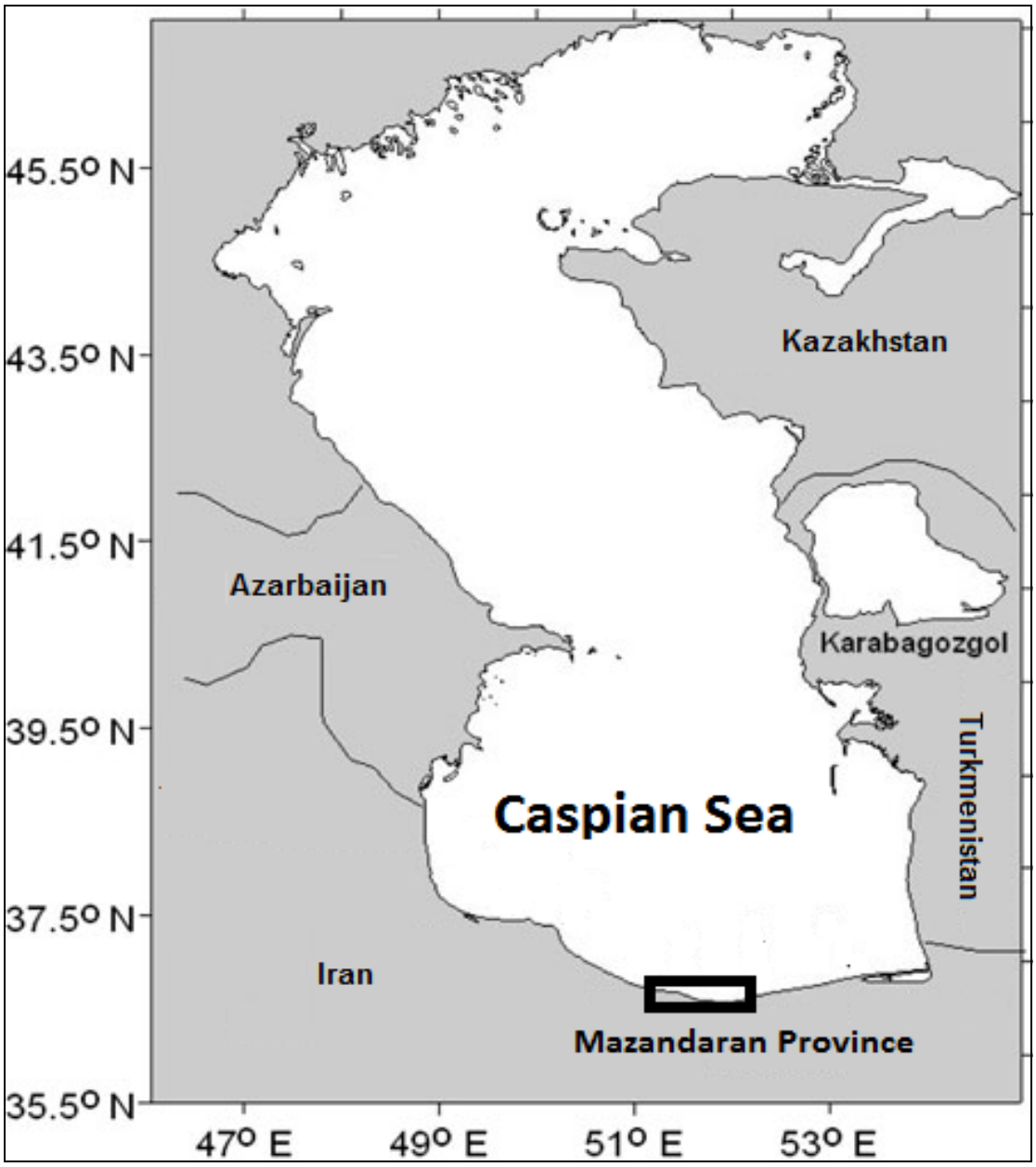

Figure 1: The map of the study area.

Seasonal samplings were carried out at two different depths (five m and 14 m) in four transects during 2005 and 2010. At each station for the macrofauna study, three replicate samples (12 samples in each depth) were collected using a Van Veen grab (250 cm^2). In the field, the contents of each grab were stored in separate plastic containers. Sediment from each container was gently sieved at the laboratory through a 0.5-mm mesh and the retained material was fixed in 4% buffered formalin and stained with Rose Bengal. Then, other macrofauna was separated off and the *S. gynobranchiata* was collected and counted under a stereomicroscope (Taheri and Yazdani Foshtomi, 2011). Another three replicate sediment samples were taken at

each station to measure the percentage of the total organic matter (TOM), again using the Van Veen grab. The surface sediment (four cm) was sub-sampled and stored in clean plastic containers. Total organic matter was determined by loss weight on ignition (four hours at 550°C) after drying (24 hours at 90°C) to a constant weight (Taheri et al., 2012).

Our sampling design provided measurements in two years, four seasons in each year, and 12 samples at each depth. To test for differences in density (univariate) between different seasons and depths, a fully-crossed, three-factor-design was analysed using PERMANOVA. The design included the random factor replicate nested in the fixed factor season, and the fixed factor depth on year. A Euclidean distance-resemblance-matrix was used for similarity matrix. Whenever significant differences were observed, pairwise tests were performed to investigate differences. P-values were obtained from P perm and Monte Carlo P (MC) (Anderson and Robinson, 2003). These analyses were carried out using PRIMER v6 with PERMANOVA+ add-on. All figures were drawn using Excel. Furthermore, correlations between density and sediment variables were tested with Spearman's rank.

RESULTS

In all seasons the percentage of total organic matter (TOM) increased with depth ($p = 0.00$). At a five-meters depth, the highest and lowest TOM values were obtained in summer and winter, respectively. At a 14-meters depth the highest value was observed in autumn while the lowest occurred in the summer. In 2010, although the percentage of TOM increased with depth, there were no seasonal differences at both depths. Inter-annual comparisons showed a clear increase in *S. gynobranchiata* at both depths in all seasons ($p = 0.00$).

During the 2005 sampling period the percentage of sand decreased with depth ($p = 0.00$). There were no seasonal differences in the amount of sand at the five-meters depth but at 14 meters the highest values of sand occurred in spring and summer and the lowest was in the winter. In 2010, sand was also found to decrease with depth ($p = 0.01$) and there were no seasonal differences. Inter-annual comparisons only showed variations in the amount of sand at the five-meters depth except in spring ($p = 0.01$).

The percentage of silt-clay did not show differences at the five-meters depth in 2005. The greatest amounts of silt-clay were obtained in the winter and autumn while the least amount was obtained in the summer. Furthermore, the amount of slit-clay decreased with depth ($p = 0.00$). In 2010, it decreased with depth ($p = 0.01$) with no differences due to seasonality. The inter-annual comparison only showed variations at the five-meters depth except in spring ($p = 0.01$, Tab. 1).

A significant difference in the density of *S. gynoranchiata* was observed in the different seasons during 2005. In line one, the maximum density (144.44 ind./m^{-2}) was observed in summer and autumn while the minimum density was observed (0 ind./m^{-2}) in winter. In line two, the lowest density was obtained in summer (825.93 ind./m^{-2}) and the highest density was obtained in spring. Also, *S. gynoranchiata* densities increased with depth ($p = 0.00$). In 2010 at both depths, the highest density occurred in summer (233.33 and 1,013.89 ind./m^{-2}) while the lowest density was found in the spring (0 and 11.11 ind./m^{-2}). With the exception of spring, density increased with depth in all seasons ($p = 0.00$). An inter-annual comparison in line one showed a higher value in winter 2010 ($p = 0.01$) and a lower value in autumn 2005 ($p = 0.00$) while in line two, except summer in other seasons, density was higher in 2005 ($p = 0.00$). The range of density in 2005 was between 0-144.44 ind./m^{-2} and 825.59-2040.74 ind./m^{-2} in five-and-14-meter depths respectively. In 2010 the range of density was between 0 to 233.33 ind./m^{-2} and 11.11 to 1,013.89 ind./m^{-2} in the similar depths. In general, total density decreased in 2010 (Fig. 2).

Table 1: Sediment variables during study; upper case letters show seasonal variation.

TOM	Year	Winter	Spring	Summer	Autumn
TOM 5 meters	2005	1.66 ± 0.21 ^{C}	2.32 ± 0.44 ^{B}	2.73 ± 0.27 ^{A}	2.35 ± 0.17 ^{B}
	2010	4.80 ± 0.71 ^{A}	5.62 ± 1.21 ^{A}	4.84 ± 1.22 ^{A}	5.32 ± 0.94 ^{A}
TOM 14 meters	2005	2.90 ± 0.92 ^{AB}	3.38 ± 0.21 ^{B}	3.53 ± 0.15 ^{C}	2.83 ± 0.14 ^{A}
	2010	6.64 ± 1.37 ^{A}	6.33 ± 1.17 ^{A}	6.30 ± 1.77 ^{A}	5.83 ± 0.78 ^{A}
Sand 5 meters	2005	97.46 ± 1.14 ^{A}	97.46 ± 0.61 ^{A}	97.59 ± 0.45 ^{A}	97.70 ± 0.67 ^{A}
	2010	92.41 ± 5.11 ^{A}	97.50 ± 2.07 ^{A}	92.68 ± 4.24 ^{A}	93.03 ± 5.48 ^{A}
Sand 14 meters	2005	78.92 ± 14.49 ^{C}	93.44 ± 0.89 ^{A}	92.98 ± 1.61 ^{A}	90.93 ± 1.39 ^{B}
	2010	75.95 ± 13.72 ^{A}	89.60 ± 7.53 ^{A}	87.67 ± 8.63 ^{A}	96.15 ± 0.68 ^{A}
Silt-clay 5 meters	2005	2.57 ± 0.61 ^{A}	2.38 ± 0.35 ^{A}	2.62 ± 0.90 ^{A}	2.30 ± 0.26 ^{A}
	2010	6.95 ± 2.87 ^{A}	1.57 ± 0.72 ^{A}	5.16 ± 4.80 ^{A}	6.26 ± 2.40 ^{A}
Silt-clay 14 meters	2005	15.65 ± 7.62 ^{A}	6.43 ± 0.80 ^{AB}	5.48 ± 1.04 ^{B}	7.39 ± 0.63 ^{A}
	2010	20.32 ± 7.18 ^{A}	9.92 ± 3.88 ^{A}	11.16 ± 4.49 ^{A}	2.09 ± 0.50 ^{A}

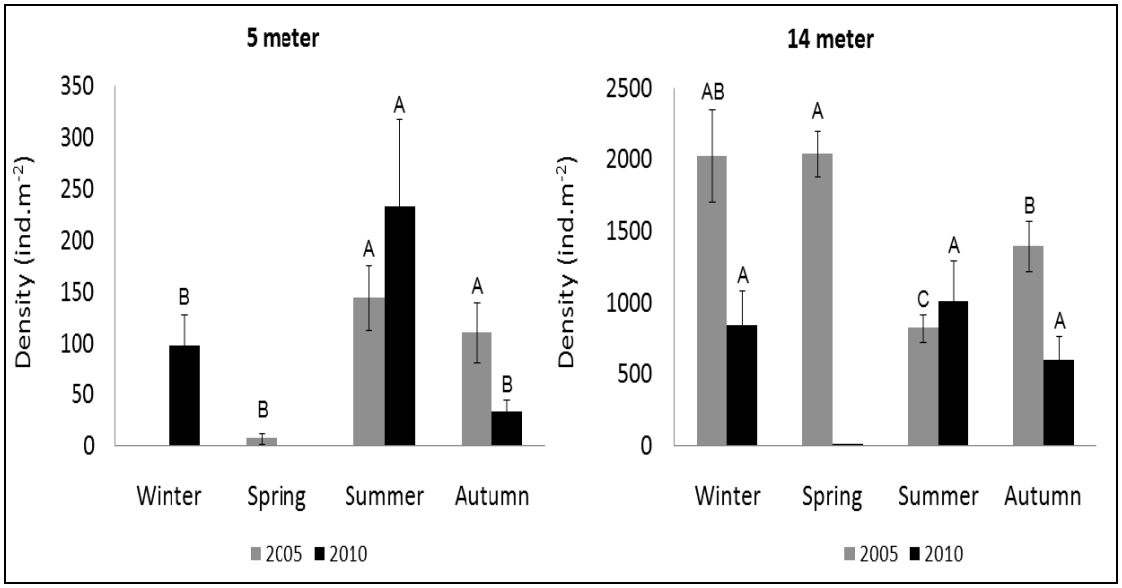

Figure 2: Density (mean ± SE) of *S. gynobranchiata* during the sampling periods. Upper case letters show seasonal variation.

In case of Spearman's rank correlation coefficient between density of *S. gynobranchiata* with sediment variables (Tab. 2), variable TOM showed a relationship with density.

Table 2: Spearman's rank correlation coefficient between density of *S. gynobranchiata* with sediment variables; *, P < 0.05, **, P < 0.01.

	Winter	Spring	Summer	Autumn
TOM 5 meters	0.632**	0.109	0.047	- 0.273
TOM 14 meters	- 0.457*	- 0.750**	- 0.040	- 0.454*
Sand 5 meters	0.462	0.472	0.065	0.067
Sand 14 meters	0.215	0.217	- 0.274	- 0.512*
Silt-clay 5 meters	0.330	0.287	- 0.095	0.066
Silt-clay 14 meters	0.156	- 0.131	0.162	0.397

DISCUSSION

Invasive species are considered a major global threat to the diversity and integrity of marine ecosystems (Norkko et al., 2011). It is often difficult to accurately assess the long-term effects of invaders because of the lack of data and the changing nature of ecosystems. However, existing historical information can be used to make a comparison with current conditions and generate hypotheses that can be tested experimentally (Crooks, 2001).

S. gynobranchiata has recently been observed in the south Caspian Sea (Taheri et al., 2009) and after discovery it became the dominant species of macrofauna in that area (Taheri and Yazdani Foshtomi, 2011). The present study shows that the density of *S. gynobranchiata* decreased between 2005-2010 with densities of 2,040 and 1,013 ind./m^2 in 2005 and 2010 respectively. In Izmir Bay (Alsancak Harbour) *S. gynobranchiata* was a dominating species with a maximum density reported at 60,480 ind./m^{-2} (Cinar et al., 2005, 2006). The maximum density recorded reached to 10,311.11 ind./m^{-2} at a 30 meters depth along the Noor Coast. Generally, the density and biomass of *S. gynobranchiata* increased as the water became deeper while the amount of total organic matter and percentage of sand decreased (Taheri et al., 2009). *S. gynobranchiata* was the dominant species with 84.95 percent of the total density of macrofauna (Taheri and Yazdani Foshtomi, 2011). In spring 2010 at the Gorgan Bay (in the south east of the Caspian Sea), *S. gynobranchiata* was 64.80 percent of the total density of Annelida which represents its maximum density observed 3,617 ind./m^{-2}.

Seasonal density variations did not show a regular trend in both years, but with increasing water depth the density of *S. gynobranchiata* increased. In 2005, there was a significant correlation between the densities of *S. gynobranchiata* with the percentage of TOM but in 2010 there was a significant correlation only in winter.

After the invasion of *M. leidyi* in the southern Caspian Sea, biodiversity of phytoplankton has changed (Roohi et al., 2010) and chlorophyll levels have increased (Kideys et al., 2008). Because phytoplanktons are the most important source of TOM in the south Caspian Sea (Lahijani, 2004), increases in chlorophyll could be the cause of the increasing percentage of TOM in 2010. In both 2005 and 2010, the percentage of TOM increased as the water got deeper. Because *S. gynobranchiata* is a deposit feeder (Cinar et al., 2005), higher densities of it found in deeper water may be related to the increased percentage of TOM (as a food). Taheri et al. (2009) showed that the density of *S. gynobranchiata* is positively correlated with the percentage of TOM. Higher densities of *S. shrubsolii* and *S. benedictii* have also been reported with an increase in TOM (Rossi and Lardiccii, 2002; Garcia-Arberas and Rallo, 2004). But the strangest thing is why the density of *S. gynobranchiata* did not increase in 2010 while the percentage of total organic matter increased?

The south Caspian Sea has a lot of different pollutants like heavy metals (Karbassi and Amirnezhad, 2004), microbial pollutants (Fereidouni et al., 2006), and rural and agricultural waste water. These contaminants continue to increase in this part of the world and certainly pollution can have a bad effect on macrofauna. In the Gorgan Bay, there was no significant correlation between the density of Annelid and several environmental conditions (Taheri et al., 2011), so it seems there are other factors controlling benthic fauna in the south Caspian Sea.

The backwash power of a rip current has an effect on surface sediment and transports fine sediment (MacMahan et al., 2005). Rip currents can also wash the meiofauna and macrofauna out to deeper areas (McLachlan and Hesp, 1984), which can be a reason for higher densities in deeper water. Furthermore, rip currents can wash away TOM and indirectly affect the availability of organic matter used as food for macrofauna. Hence, it could be said that the effect of the rip current on sediment, TOM and washing macrofauna and their larvae is another reason explaining increasing density with increasing depth.

CONCLUSIONS

Although the percentage of total organic matter as a food source has increased since 2005, 2010 results show the density of *S. gynobranchiata* has decreased slightly since 2005. So it seems that in the invasion phase the population of *S. gynobranchiata* has decreased to a balance condition. Besides this, it is suggested that the changing density of this species is controlled by other biotic/abiotic factors like intra/interspecific competitions and pollutants. More information about the macrofauna community and environmental variables are needed, however, to increase our understanding of the changing population of *S. gynobranchiata.*

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A SURVEY ON IONIC AND METABOLITE FACTORS OF BLOOD SERUM IN KUTUM (*RUTILUS FRISII KUTUM*)

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KEYWORDS: Kutum (*Rutilus frisii kutum*), plasma serum, ionic and non-ionic components.

ABSTRACT

In this study, ionic parameters and metabolite factors (cholesterol, total protein, and glucose) of serum and their interrelationships were detected in 48 specimens of kutum (*Rutilus frisii kutum*) captured during spawning migration. Blood sampling was conducted by cutting the caudal peduncle of each sample, and blood was collected into heparinized and sterile capillary glass tubes.

Results indicated that values of Na^{+}, Ca^{+2}, K^{+}, and Mg^{+2} revealed the highest to the lowest content in blood serum of kutum, respectively. Cholesterol concentration was higher than glucose and the latter was estimated more than total protein. Na^{+} was positively correlated with Mg^{+2} ($P < 0.01$), whereas it shows reversed correlations with glucose ($P < 0.01$) and pH ($P < 0.05$). The results deduced in the present trail, might improve reproductive and farming management of this valuable species.

ZUSAMMENFASSUNG: Untersuchungen zu ionischen und Stoffwechselfaktoren des Blutserums von Kutum-Plötze (*Rutilus frisii kutum*).

In dieser Studie werden die ionischen Parameter und Metabolismus Faktoren (Cholesterol, Gesamteiweißstoffe und Glukose) des Serums und ihre Wechselbeziehungen zueinander in 48 Exemplaren der Kutum-Plötze (*Rutilus frisii kutum*) untersucht, wobei die Individuen während der Laichmigration gefangen wurden. Aus dem abgeschnittenen Stammteil des Schwanzes wurden Blutproben entnommen und in sterilen, heparinisierten Kapillaren-Glasröhrchen gesammelt.

Die Ergebnisse zeigten jeweils von den höchsten zu den niedrigsten Werten Anteile von Na^{+}, Ca^{+2}, K^{+} und Mg^{+2} im Blutserum von Kutum. Die Konzentration von Cholesterol war höher als jene von Glukose und letztere wurde mit einem Wert von mehr als das Gesamtprotein geschätzt. Na^{+} war positiv korreliert mit Mg^{+2} ($P < 0.01$), während es eine umgekehrte Beziehung zu Glukose ($P < 0.01$) und pH ($P < 0.05$) zeigte. Die auf dem gegenwärtigwen Weg abgeleiteten Ergebnisse können das Reproduktions- und Züchtungsmanagement dieser wertvollen Art verbessern.

REZUMAT: Studiul influenței unor factori ionici și metabolici asupra serului sângelui la specia *Rutilus frisii kutum.*

În acest studiu, au fost urmăriți, la 48 de invidizi din specia *Rutilus frisii kutum*, capturați în timpul migrației pentru depunerea pontei, parametri ionici și factorii metabolici (colesterol, proteine totale și glucoza) din serul sanguin și relațiile dintre aceștia. Probele de sânge au fost luate prin tăierea pedunculului caudal de la fiecare individ, sângele a fost colectat în tubușoare de sticlă capilare, sterile și cu conținut de heparină.

Rezultatele arată că valorile Na^{+}, Ca^{+2}, K^{+} și Mg^{+2} variază în serul sanguin al speciei *Rutilus frisii kutum*. Concentrația de colesterol este mai mare decât cea de glucoză, iar aceasta din urmă a fost estimată ca fiind mai mare decât proteina totală. Na^{+} a fost corelat pozitiv cu Mg^{+2} ($P < 0,01$), în timp ce se identifică corelații inverse cu glucoza ($P < 0,01$) și cu pH-ul ($P < 0,05$). Rezultatele obținute ar putea îmbunătăți managementul reproductiv și de creștere a acestei specii.

INTRODUCTION

Kutum (*Rutilus frisii kutum* Kamenskii 1901) lives in the Caspian Sea. This species is a migratory anadromous fish spawning in rivers during March and April. It has a group synchronous single spawning behaviour (Sharyati, 1993), spawning on aquatic weeds, gravel, and sandy substrates in rivers and lagoons (Abdoli, 1999).

This fish is the most popular food fish in southern coastal region of the Caspian Sea in the north of Iran, where it is locally known as Mahisefid (meaning white fish) because of its shiny scales. It has a great economic importance for the Iranian fishing industry in the southern Caspian Sea with more than 900 km of coastline. There is a little information about blood characteristics in Kutum (*R. frisii kutum*). Such information would provide a better understanding of the life history and physiological mechanisms of this species, especially when they are released into the southern area of the Caspian Sea for restocking. Determination of these parameters also may be useful in assessing any changes in water quality, related to soil quality, and fish response as well (Bastami et al., 2010).

MATERIAL AND METHODS

Kutums (*R. frisii kutum*) were captured from the estuary of Tajan River in Sari inlets to the Caspian Sea during migration in 2010. The average weight and length of fish sampled were 977 ± 229 g and 49.62 ± 1.2 cm, respectively.

Blood sampling procedure

Blood sampling was conducted by cutting the caudal peduncle of each sample, and blood was collected into heparinized and sterile capillary glass tubes. For blood plasma assessment, tubes were centrifuged for five minutes at 3,000 rpm. Then, the tubes were broken, and the resultant blood plasma was emptied into sterile micro tubes for further analysis.

Blood and seminal biochemical parameters, including Mg^{2+}, Ca^{2+}, total protein, cholesterol, and glucose contents, were calculated by spectrophotometry with a WPA-S2000 spectrophotometer and standard kits (Pars Co.). K^{+} and Na^{+} were analyzed using JENWAY-PF P7 Electrolyte Analyzer. The pH of blood plasma was measured with a classical laboratory pH meter (Orion Model 410A pH meter).

Statistical analysis

Analysis of each parameter was replicated three times. Means of blood biochemical parameters were subjected to homogeneity of variance and one-way ANOVA using SPSS program (version 13). Pearson's coefficient was used for linear correlation (r) between variables at $P < 0.05$.

RESULTS AND DISCUSSION

According to the results presented in table number 1, the values of Na^{+}, Ca^{+2}, K^{+}, and Mg^{+2} showed the highest to the lowest content in blood plasma of kutum, respectively. Cholesterol content was higher than glucose and the latter was estimated more than total protein. As shown in table number 2, representing the relationships among studied factors in serum, Na^{+} was positively correlated with Mg^{+2} ($P < 0.01$), but there was reverse relationship between Na^{+} with glucose ($P < 0.01$) and pH ($P < 0.05$).

Table 1: Biochemical component (mean ± standard deviation) and range in blood plasma measured in broodstocks of kutum (n = 48).

Parameter	Mean ± standard deviation	Range
Na^{+} (mmol/l)	180.07 ± 21.46	151-210.2
K^{+} (mmol/l)	3.2 ± 2.41	1.14-7.79
Ca^{+2} (mmol/l)	3.6 ± 0.3	3-4.1
Mg^{+2} (mmol/l)	1.75 ± 0.6	0.9-3
Cholesterol (mg/l)	1882.18 ± 643.16	22.73-105.4
Total Protein (mg/l)	44.13 ± 18.72	19-105.4
Glucose (mg/l)	1266.67 ± 647.09	414.4-2857.8
pH	7.61 ± 0.4	6.89

Significant positive correlation ($P < 0.05$) is between calcium concentration and total protein content. Mg^{+} had a significant and positive relationship with the ratio of Na^{+} to K^{+} and Ca^{+2} to K^{+} ratio ($P < 0.05$) while it revealed a reversed correlation with pH ($P < 0.01$) and glucose ($P < 0.05$). Ca^{+2} concentration correlated positively with total protein ($P < 0.05$). The correlation between the ratio of Na^{+} to K^{+} and Ca^{+2} to K^{+} ratio was positive ($P < 0.01$).

Figure 1: The Caspian Sea and distribution of kutum (*Rutilus frisii kutum*).

The first connective tissues between fish and its surrounding environment operating in gas transportation, acid-alkaline balance, ion regulation, and ammonia excretion are the gills. Environmental stressors are of important factors confining fish condition under any rearing situation.

Fish migration from saltwater to freshwater (like studied kutum species here) makes changes in ionic and acid-alkaline balances which influences on physiology and growth. It was found that the values of Na^{+}, Ca^{+2}, K^{+}, and Mg^{+2} ions displayed the highest to the lowest content in blood plasma of kutum, respectively, which is in accordance with findings of Sattari (2002) (Tab. 1). Moreover, cholesterol content was higher than glucose and the latter was measured more than total protein which was previously evidenced by Luz et al. (2008). Thrall et al. (2004) estimated the natural content of calcium in fish species for 20 mg/dl. Majabi et al. (2001) found two effective variables of fish species and environment condition on sodium concentration and appraised it for approximately 150 m mol/l in most fishes. They also identified Na^{+} and Cl^{-} deficiency as a result of general infections and functional disorders in gills.

Table 2: Correlation between ionic and non-ionic factors of blood plasma in migrating broodstocks of kutum (n = 48); (T. p. - total protein, Ch. - cholesterol, Gl. - glucose).

	Na^{+}	K^{+}	Ca^{+2}	Mg^{+2}	Na^{+}/K^{+}	K^{+}/Ca^{+2}	T. p.	Ch.	Gl.
K^{+}	- 0.081								
Ca^{+2}	- 0.176	0.01							
Mg^{+2}	0.776[b]	- 0.272	0.15						
Na^{+}/K^{+}	0.424	- 0.635	- 0.085	0.544[a]					
K^{+}/Ca^{+2}	0.226	- 0.87[b]	0.042	0.554[a]	0.818				
T. p.	0.138	0.137	0.515[a]	- 0.109	- 0.23	- 0.081			
Ch.	0.05	0.066	0.078	0.085	- 0.035	0.092	0.366		
Gl.	- 0.698	- 0.045	0.258	- 0.591	- 0.285	- 0.082	0.412	0.055	
pH	- 0.629	- 0.158	- 0.26	- 0.753	- 0.327	- 0.384	- 0.149	- 0.258	0.226

a Shows significant difference ($P < 0.05$)
b Shows significant difference ($P < 0.01$)

Thrall et al. (2004) reported Na^{+} and K^{+} concentrations of 150 and three mmol/l, respectively, in freshwater fish which is in agreement with the present study. Wurts and Durborow (1992) deduced Ca^{+2} and Mg^{+2} ions as necessary factors in blood biological processes. Fish can directly access to Ca^{+2} and Mg^{+2} ions from water and food. So, Ca^{+2} acts as one of the most important ions in fish culture water. They also recommended a range of 25 to 100 mg/l for Ca^{+2} concentration and commented that high capacity of calcium is needed for culturing striped bass while rainbow trout can tolerate Ca^{+2} concentration of 10 mg/l when pH is adjusted upper than 6.5.

Ca^{+2} content of blood plasma in female broodstocks is considered as a desirable index to properly evaluate the time of sexual ripening in broodstocks, since its concentration gradually rise up during several months before reproductive season until a peak immediately one or two months before the beginning of reproductive season. Afterwards, during the reproductive season, its content rather decreases. This was attributed to the reproductive cycle and crucial importance of calcium during vitellogenesis stage. For example, its content was discovered to be 4.5 and 2.8 m mol/l before and after reproductive season, respectively, in blood plasma of Atlantic flatfish.

Concerning these points and coincidence of the present study with the period of maximum spawning of kutum (i.e. early spring), it might be concluded that calcium content in this trial (3.6 mmol/l) was determined after an increasing period in blood plasma of the female broodstocks followed by a decline period. There was a significant and positive correlation between calcium content and total protein. This might be attributed to two reasons. Firstly, gonad development with fluctuations in calcium level in blood plasma occurs simultaneously with fish growth and increasing in size and subsequently increased total protein.

Figure 2: Blood sampling from kutum (*Rutilus frisii kutum*) broodstock.

Direct relationship between these factors is explicable since the present experiment was conducted during maximum spawning period of kutum (increasing concentration of calcium in plasma).

Secondly, calcium contributes in protein metabolism and acts as a cofactor in relation to many metabolic and enzymatic reactions. With regard to the enzymatic apparatus of Na^{+-} K^{+} ATPas and the results presented in table number 2, the significant and reverse relationship between K and the ratio of Na^{+} to K^{+} is remarkable. This relation might be evident at first glimpse, but the functional concept of Na^{+-} K^{+} ATPase enzymatic apparatus could be perceived if attentively be noticed. The reversed relationship mentioned above, actually implied to the reversed path of K^{+} and Na^{+} ions in the aforesaid enzymatic apparatus. There was a significant correlation between Mg^{+2} and Na^{+} in this trail.

Davis et al. (2005) stated that the presence of Mg^{+2} in culture water aids to the loss of other salts (like Na^{+} and K^{+}) from fish body fluid (for instance blood) which is in agreement with the results indicated in this survey. Indeed, the significant and direct relationship between Mg^{+2} and the ratio of Na^{+} to K^{+} implies the significant correlation between Na^{+} and Mg^{+2}.

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RESEARCH ON WATER QUALITY USED IN THE MILK INDUSTRY IN SIBIU COUNTY (TRANSYLVANIA, ROMANIA)

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KEYWORDS: environment, dairy, wastewater, physico-chemical properties.

ABSTRACT

Dairy wastewater consists of transport water and raw materials washing, technology water, condensation water or cooling water from the washing and disinfecting rooms, manufacturing and packaging equipment cleaning and water from plumbing. These wastewaters are characterized by a high turnover of physico-chemical and microbiological properties due to their composition and origin variety. Because of the composition of protein, fat, and lactose, wastewater cannot be discharged to the sewerage system before their purification, because the mere disposal would pollute the environment. The main purpose of this research is to monitorize the quality of water in the milk processors industry, in order to ensure food security by framing it within the limits permitted by current rules.

ZUSAMMENFASSUNG: Untersuchungen zur Qualität des in der Milchindustrie verwendeten Wassers im Kreis Sibiu/Hermannstadt (Transilvanien, Rumänien).

Die Abwässer aus der Milchindustrie entstehen beim Transport, durch Waschen der verwendeten Rohstoffe, als Ergebnis technologischer Prozesse, als Kondens- und Kühlwasser, beim Spülen und der Desinfektion der Produktionsräume, beim Reinigen der Geräte und der Verpackungen sowie aus Rohrleitungen. Diese Abwässer zeichnen sich bedingt durch ihre Zusammensetzung und Herkunft durch eine hohe Fluktuation der physikalisch-chemischen und der mikrobiologischen Eigenschaften aus. Bedingt durch die Zusammensetzung der Proteine, der Fettstoffe und der Laktose können die Abwässer nicht vor einem Reinigunsprozess in die Abwasserrohre geleitet werden, da sie eine Belastung der Umwelt hervorrufen würden. Das Hauptziel der durchgeführten Untersuchungen war ein Monitoring der Wasserqualität in der Milchverarbeitungsindustrie zur Qualitätssicherung im Rahmen der durch die derzeitigen Vorschriften gegebenen Grenzen.

REZUMAT: Cercetări privind calitatea apei folosite în industria laptelui în judeţul Sibiu (Transilvania, România).

Apele reziduale din industria laptelui constau în ape de transport şi spălare a materiei prime, ape tehnologice, ape de condens sau de răcire, ape de la spălarea şi dezinfecţia sălilor de fabricaţie, a utilajelor şi ambalajelor, ape de la instalaţiile sanitare. Aceste ape reziduale se caracterizează printr-o mare fluctuaţie a proprietăţilor fizico-chimice şi microbiologice, datorită varietăţii provenienţei şi compoziţiei acestora. Datorită compoziţiei în proteine, lipide, lactoză, apele reziduale nu pot fi deversate la reţeaua de canalizare înainte să se realizeze epurarea lor, deoarece simpla deversare ar contribui la poluarea mediului înconjurător. Scopul principal al cercetărilor este monitorizarea calităţii apei din industria laptelui, în vederea asigurării securităţii alimentare a acesteia prin încadrarea în limitele conforme normelor.

INTRODUCTION

Food wastewater has the characteristics of large high concentration amounts of organic pollutants (Xie and Sun, 2002). One of the main issues is the amount of wastewater continuously produced in the food plants worldwide. Compared to other sectors, the food industry uses a much greater amount of water for each ton of product (Chmiel et al., 1996).

In the future, food and beverage industries will be influenced by the need to comply with EU legislation governing the discharge of industrial effluents (Corporation, 2011). Food industry standards and eco-sanitation concept specify and encourage that processed water intended for reuse - even for cleaning purposes - must be of drinking quality (Mavrov and Bélières, 2000; Elkin et al., 2008; Media, 2012; Curtean-Bănăduc and Bănăduc, 2012; Aquamedia, 2013; Corporation, 2011; Klemeš et al., 2008). Regulations for other applications, such as boiler make-up water or warm cleaning water, are even much more stringent (Media, 2012; Klemeš et al., 2008).

In a background of natural water resource availability and cost increase, wastewater treatment for water reuse can lower the overall water consumption and the global effluent volume of industrial plants (Vourch et al., 2008).

Many older factories were traditionally built near rivers and other natural sources of water, such as springs. Thus, the factory had a supply of water to assist its processing, and also to use as an outlet for the wastewater from the site (Walker, 2008).

Water is used as an ingredient, an initial and intermediate cleaning source, an efficient transportation conveyor of raw materials, and the principal agent used in sanitising plant machinery and areas (Media, 2012). Dairy wastewater is distinguished by the high BOD_5 and COD contents, high levels of dissolved or suspended solids including fats, oils and grease, nutrients such as ammonia or minerals and phosphates and therefore requires proper attention before disposal (Sarkar et al., 2006). Milk industry wastewater contains high concentrations of COD, BOD_5 and TKN of up to 11,000, 5,900 and 720 mg/l, respectively (Viraraghavan et al., 1994; Sirianuntapiboon et al., 2005). Dairy companies have been using condensate from the evaporation of milk for feeding boilers and for lower grade use after simple treatment with chlorine dioxide (Elkin et al., 2008; Klemeš et al., 2008).

Environmental considerations are receiving an increased priority upon political, social, and economic agendas, especially when related to agriculture (Capper et al., 2009). Disposal of improper treated wastewater often poses risks to the environment (Wu et al., 2005). Using advanced technology to mitigate risk by refined wastewater treatment is a key issue in meeting legislative guidelines, e.g. EU Water Framework Directive (Wu et al., 2005).

Environmental management was regarded as having a function operationally linked and often health and safety at work, while environmental and safety activities include making necessary costs in the business, recognizing that firms implement an environmental management system, have strategic function and help define the entire business strategy, product design, financial and information systems design (Banu and Vizireanu, 1999).

The main purpose of this research is monitoring water quality in the milk processors industry, in order to ensure food security by framing it within the limits permitted by current rules. In order to fulfil this purpose there have been made physico-chemical analyse on wastewater from milk industry units, to ensure optimal quality for their reintegration into the natural circuit.

MATERIAL AND METHODS

Research location

In order to achieve the established goals and objectives, research was conducted at two dairy processing units. To monitor the quality of untreated wastewater samples were collected from the discharge point for wastewater pre-treatment station (for food units that do not have effluent treatment plants - C1) and from the discharge point of the own wastewater treatment stations of food units denoted.

In order to study water quality in the dairy industry, during the 2013-2014 period, wastewater samples were collected (before pre-treatment), from some work control points.

The physico-chemical analysis of water was to determine the organoleptic and physical properties and chemical composition. Water samples were collected in bottles provided with ground glass stoppers.

The main measurements that were made:

- Nitrites were determined by the molecular absorption spectrometric method STAS 12754-89;
- Nitrates were determined by the STAS 12999-91;
- Water hardness was determined by complex metric titration of calcium and magnesium by the method STAS 3026-76;
- pH of water by ISO 10523:2009;
- BOD_5 was obtained by determination of oxygen dissolved in water after harvest and after five days by method EN 25814:1999;
- CCO-Cr - Determination of chemical oxygen consumption by method ISO 6060:1996;
- Total suspension was determined by filtration on glass fiber filters by method EN 872:2005;
- Wastewater pH by method ISO 10523:2009;
- Chlorides were analyzed by titration with silver nitrate using chromate as indicator (Mohr method) by method ISO 9297:2001;
- Total nitrogen was determined by method EN 25663:2000;
- Total phosphorus - spectrometric method with Ammonium molybdate ISO 6878:2005.

RESULTS AND DISCUSSION

After withdrawing the samples from the checkpoints of the monitored units, physico-chemical analyses were conducted to determine whether values of water quality indicators are consistent with the maximum limits governed by the regulations in force. The results obtained after realizing all measurements are presented in table 1.

Knowing the value of biochemical oxygen demand in five days (CBO_5) is extremely important in assessing wastewater pollution, expressing the amount of biodegradable organic substances contained in that water.

Also determining the chemical oxygen demand (CCO_{Cr}) is extremely important in assessing wastewater pollution, expressing the amount of organic substances in the water subjected to this analysis.

The results obtained show that the pollution degree of the water used is insignificant and therefore this water can be used to collect milk without any influence on the characteristics.

All results obtained show that parameters are compliant to the current legislation in the field.

Table 1: Monitoring control from the discharge point for wastewater to the pre-treatment stations.

Sample point	Date / Year	15 January		15 March		15 May		15 July		Normal values
		C1	C2	C1	C2	C1	C2	C1	C2	
NO^{3-} (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	25.00
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
NO^{2-} (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	2.00
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Cl_2 (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	0.50
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
pH	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	6.5-8.5
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
CBO_5 (mg O_2/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	20
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
CCO_{Cr} (mg O_2/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	500
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Susp. solids (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	35
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Total N (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	10
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	
Total P (mg/l)	2013	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	5
	2014	11.52	23.12	19.14	23.36	10.65	13.78	20.02	21.34	

CONCLUSIONS

Comparative analyses of potable water used in monitored processing units revealed that, although not exceeding the maximum values allowed by current standards, the highest concentrations of nitrites and nitrates as well as the higher water hardness values, are presented at the power units supplied with water from its own source, compared to power units supplied with water from the central source.

Results confirm that the water used to receive raw milk materials has no influence on the milk composition and all the parameters analysed are compliant to the standards imposed by existing legislation.

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ZINGEL ZINGEL (LINNAEUS, 1766) ON SITE MANAGEMENT DECISIONS SUPPORT SYSTEM - STUDY CASE

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KEYWORDS: *Zingel zingel*, Natura 2000 SCI, Transylvania, Romania, pressures, threats, community interest fish species habitat necessities, management elements.

ABSTRACT

The ADONIS:CE was utilised here, in the biology/ecology domain, to produce a framework management model of *Zingel zingel* fish species based on this species' identified needs, regarding: the habitat, the indicators which reveal the favourable conservation status and the proper measures, and the identified pressures and threats on this fish species.

If these suggested management elements will not be implemented in ROSCI0132, the presence of the *Zingel zingel* species will be endangered in the next one or two decades.

Such management systems, based on: the site, the habitats and on numerous species should be implemented in the conservative interest Natura 2000 case of ROSCI0132.

RÉSUMÉ: Système support pour le processus décisionnel dans la gestion d'un site - étude du cas de *Zingel zingel* (Linnaeus, 1766).

ADONIS:CE a été employé dans le domaine de la biologie/écologie afin de produire un management modèle cadre de l'espèce de poisson *Zingel zingel* ayant comme point de départ les besoins identifiés pour cette espèce en ce qui concerne l'habitat, les indicateurs révélant le statut de conservation favorable ainsi que les mesures appropriées, les pressions identifiées et les menaces pesant sur cette espèce.

Si les éléments de gestion suggérés n'étaient pas implémentés dans le ROSCI0132, la présence de l'espèce *Zingel zingel* serait mise en danger dans les prochains dix ou vingt ans.

Ainsi, des systèmes de gestion basées sur la bonne connaissance du site, des habitats et des espèces devront être implémentés dans le cas du ROSCI0132 pour d'autres espèces de poissons d'intérêt communautaire au titre de Natura 2000.

REZUMAT: Sistem suport pentru luarea deciziilor de management in situ pentru conservarea speciei *Zingel zingel* (Linnaeus, 1766) - studiu de caz.

ADONIS:CE a fost utilizat aici în domeniul biologie/ecologie pentru a realiza un model de management cadru pentru specia de pește *Zingel zingel*, la baza elaborării modelului au stat necesitățile pentru habitat ale speciei, indicatori care relevă starea de conservare favorabilă și măsurile potrivite, presiunile și amenințările identificate asupra acestei specii de pește.

Dacă aceste elemente de management sugerate nu vor fi implementate în ROSCI0132, prezența speciei *Zingel zingel* va fi periclitată în următorii 10-20 ani.

Astfel de sisteme de management, pentru un sit, pentru habitate și pentru o specie, trebuie realizate și pentru alte specii de interes conservativ Natura 2000 în cazul ROSCI0132.

INTRODUCTION

The European Union states should create the needed conditions for the protection of all the Habitats Directive (Annex 2) species and habitats in order to preserve or better increase their conservation status (*, 1992). The Natura 2000 sites designated for the Romanian national territory, including those selected for fish species' protection, were selected for their importance in relation with their conservative value. The acceptance of these sites, at the biogeographical seminars for Romania, was based on special selected criteria, as follows: well conserved, healthy and stable fish populations, representative habitats, good geographical location, and low anthropogenic impact. Based on the Natura 2000 European process, there are important ways the EU states' nature protection should improve: institution capacity building; protected natural areas' surface increasing; raising the citizens' awareness, optimum management plans, and implementation for protected areas, (Bănăduc, 2001, 2007, 2008, 2010, 2011; Bănăduc et al., 2012; Curtean-Bănăduc and Bănăduc, 2008).

A Community interest species is *Zingel zingel* (Linnaeus, 1766). This fish is a demersal freshwater species, is more active at night, and lives in relatively fast-flowing, deep and big lotic systems complete with sand, pebbles and clay riverbeds. The reproduction period is March-April; the roes are laid down on gravel or rocks. Its food consists of aquatic insects, crustaceans, roes and small fish, (Bănărescu, 1964; Bănărescu and Bănăduc, 2007).

In the Romanian territory, the distribution range of *Zingel zingel* is more restricted and fragmented than in the past century (Bănărescu, 1964), due to the impact of human activities, impacts which differ quantitatively and qualitatively from one watershed/watershed sector to another, and from one nature protected area to another (Oțel, 2007).

The fish fauna structure, where the *Zingel zingel* species was found, in ROSCI0132 (Natura 2000 site Oltul Mijlociu - Cibin - Hârtibaciu) reveals very few individuals as a direct effect of heavy anthropogenic impacts. The distribution area of the fish populations and their abundance differs in this Natura 2000 site reflecting the related quality decrease results of the Olt River watershed lotic habitat (Bănăduc, 1999, 2000, 2001, 2005; Curtean-Bănăduc et al., 2007; Curtean-Bănăduc and Bănăduc 2001, 2004a, b; Curtean et al., 1999).

In the worldwide swerve in which the rivers become more and more evident as a precious natural resource, the anthropic impacts on it will change its accessibility in quantitative and qualitative terms (Curtean-Bănăduc and Bănăduc, 2012). If this swerve will continue, no general management tools will be enough in protecting areas, because diverse habitat elements should be assessed; after that particular management, elements have to be adapted and suggested for the local and/or regional habitats' peculiar conditions.

The process modelling can be applied in acquiring a "broad picture" of discrete systems and/or actions of a domain. The modelling processes are used in understanding management steps. The modelling tools are software products which are used to make business organization models, as well as highlight information regarding said models. Three functions are highlighted: corroborate an existing situation, examine the results of potential modifications, and propose plans to modify the actual situation in a better direction. Ways to make diverse diagrams which include proper management elements are offered (Hall and Harmon, 2005). The main goals of this study are: to show the state of *Zingel zingel* populations in the ROSCI0132; to highlight the human impact pressures and threats; to advise management elements for the increase of this fish species' conservation status supported by a management model made for the specific habitat requirements of this species; based on specific habitat indicators as a decisional backup system for management decisions and strategies.

MATERIAL AND METHODS

The ROSCI0132 protected area (45.682778 latitude, 24.324444 longitude, 2,826.10 ha surface, between 314 and 568 a.s.l. m) is situated in the administrative units of Sibiu, Braşov and Vâlcea counties (Romania), in the Continental and Alpine European biogeographic regions. This Natura 2000 site was proposed and accepted including for ten fish species, species which belong to the Annex 2 of the Habitats Directive (92/43/EEC), (*Zingel zingel* Natura 2000 code 1159, *Zingel streber*, *Gobio kessleri*, *Pelecus cultratus*, *Barbus meridionalis*, *Cobitis taenia*, *Sabanejewia aurata*, *Rhodeus amarus*, *Aspius aspius* and *Gobio uranoscopus*). (*)

The river sectors of the researched zone where *Zingel zingel* were sampled are shown in figure number 1.

The fish individuals were sampled with fishing nets in 2010-2013. The sampled individuals were identified in the field and released back in their habitats.

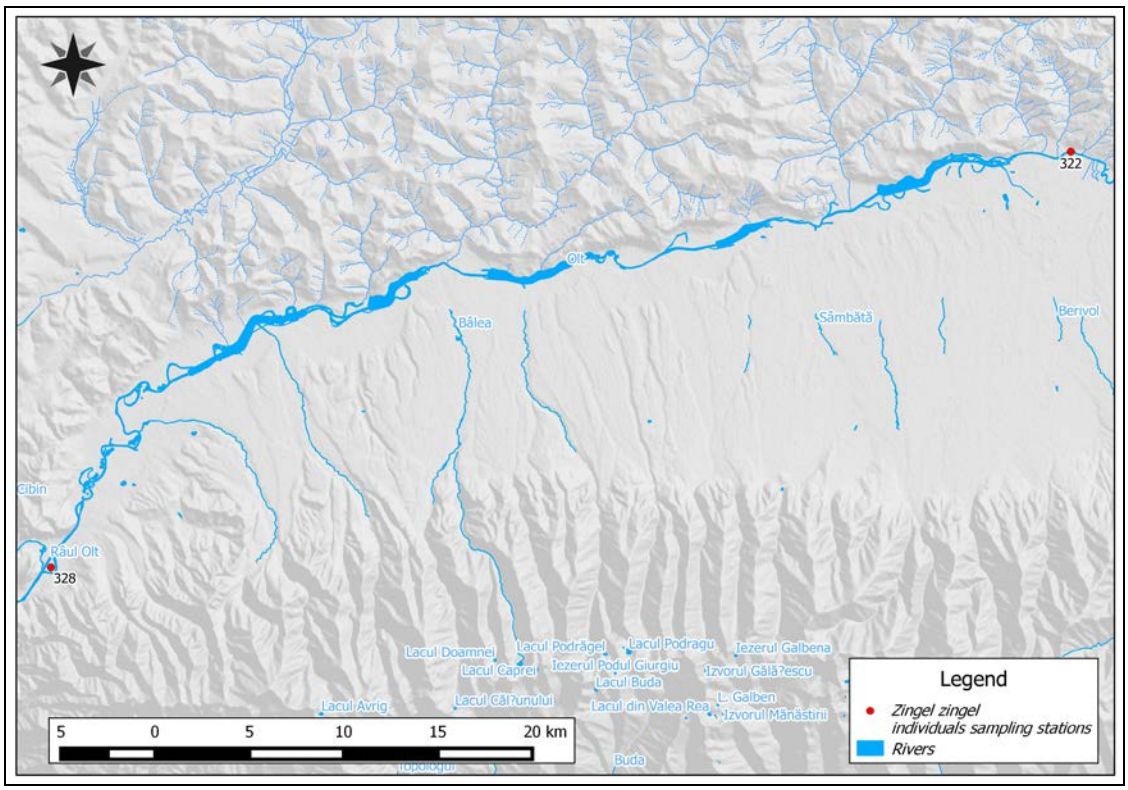

Figure 1: *Zingel zingel* individuals sampling stations in Olt River, 322 and 328. (Geographic Information System support Mr. Pătrulescu A.).

Zingel zingel populations were under assessment in this research period and their ecological status was evaluated in relation to the local human threats and pressures on this fish species' habitats and populations.

The ecological status of the fish population was evaluated based on the following criteria: equilibrated distribution of fish individuals on age classes, size area distribution, population size and a high/low number of individuals of this fish species in the local fish communities.

The *Zingel zingel* species' particular habitat requirements, pressures and threats, were ascertained based on their presence or absence, interdependence between them, and the fish populations' ecological status in the researched zone.

To identify the proper management elements needed in order to assure the fish species' survival in the studied area, and in order to reveal the needed process, the authors used a specific management model. Therefore the authors used ADONIS:CE, created by Business Object Consulting. ADONIS: Community Edition, which is actually a free tool given by the BOC Group which should be useful as a good entry point to Business Process Management and as a proper modality to become familiarized with ADONIS. ADONIS:CE is a rich feature, stand-alone version of ADONIS with some limitations in comparison with its commercial edition. Business Process Model and Notation (BPMN) is a standardized modelling language which is appropriate for the illustration of processes. Based on uniform notation, the processes can be clear, fast, and intuitively modelled (**).

RESULTS AND DISCUSSION

Zingel zingel populations ecological state evaluation

The ecological state of *Zingel zingel* populations in the Olt River sampling sectors 322 and 328 (Fig. 1) is very low in conformity with: unbalanced distribution of individuals on age classes, population sizes, and a very low percentage of fish individuals of the species of interest in the structure of the local fish fauna. In the Olt River, the habitats of the studied species in the sampling sectors are in very low ecological condition, in respect of *Zingel zingel* ecological requirements.

Human pressures and threats

During this specific study, the following threats and pressures on *Zingel zingel* species populations were identified: pressures - destruction/major modification of natural habitats of this fish species, lotic habitats destruction or fragmentation along the rivers due to major hydrotechnical works (dams and lakes) and pollution; threats - water pollution, poaching, river regularization and mineral substrata overexploitation. The presence of all these human pressures and threats, and their negative effects on the ichthyofauna are well known in the middle Olt River sectors (Bănăduc, 1999), but nothing was changed as of yet to mitigate these effects.

Specific requirements

Zingel zingel adults generally need relatively big river sectors with fairly deep and fast flowing water which contains sectors with sand, pebbles and/or clay. In the reproduction period, the adults need big or medium river sectors with relatively deep and fast water flowing sectors, complete with riverbeds of pebbles and vegetal debris. The water should not be polluted and with low organic loads. (Bănărescu and Bănăduc, 2007)

Specific habitat indicators

Based on the *Zingel zingel* species' presence and abundance in the researched sectors, the following habitat indicators were suggested: surfaces in the minor riverbed with a depth of the water over one m (66%); plant debris percentage on the riverbed (15%); fast flowing water surface percentage (66%); and percentage of the substrate covered with pebbles (66%).

Management measures

In the natural riverbeds' morphodynamics preservation/reconstruction, it is strongly recommended that new dams/hydrotechnical constructions be forbidden; this modifies the lotic regime of the water in lentic regime and also the substratum characteristics.

A complex functional fish leader system should be created to diminish the negative impact of the large and numerous dams and lakes.

The riverbed mineral exploitation, and respectively the total evacuation of the pebbles substrata, should not be allowed in order for the preservation of this species' habitat to be possible. The riverbed mineral exploitation should be forbidden especially in the river sectors with medium and/or fast flowing sectors, relatively deep water and stoney substrata. These exploitations should not be allowed at distances under five km from each other, or in the sectors between two stagnant or semistagnant water sectors.

In the reproduction period (March-April) fishing should be banned, as well as any activity which can influence the natural rate of sedimentation of suspensions in the river.

Poaching in the study area is very frequent, and a phenomenon which should be stopped.

The riverine vegetation corridors (herbaceous, shrubs and ligneous) should be protected on stripes of a minimum 25-100 m in length on both sides; assuring the vegetal debris needs in the trophic and reproduction processes of this species.

The illegal waste deposits should not be allowed in proximity of the water courses.

An integrated monitoring system for ichthyofauna should be created, adapted and implemented.

Site adjusted management model

The process for the on-site model management is actually based on activities (squares - please see below) and decisions (triangles - please see below) (Figs. 3, 4 and 5a-d).

The main objects used to create the management model for *Zingel zingel* in the ROSCI0132 area with ADONIS:CE tool are shown below (from Hall and Harmon, 2005 - Version 1.1, November, 2005, http://mhc-net.com/whitepapers_presentations/2005 Process Trends (040306).pdf):

A process represents a range of steps in which information is processed or transformed for different models. A process is possible to be modelled based on activities, decisions, subprocesses, documents attached to different activities, and notes.

The activity is the smallest part of a process and comprises the realised tasks along the process. In the modelling process, there are activities that rely on decisions. The decisions are a significant part of the process due to the fact that for each decision, a certain probability for accomplishing the following activities can be selected, (used in analysis and simulation). To every existent decision, a condition of probability can be assigned. For this, variables are defined (paths can be followed in accordance to the assignment of variables - defined in the transition conditions) as are generators (induce values to variables to which they are in connection with). The generator is directly associated by connectors with decisions and variables.

Model structuring in subprocesses is helpful for improving process organization and judgment. The subprocess works as a structured process; it is suggested to be applied, predominantly when the model is highly elaborate, and with their support, the user "comes along" straight to the process from the topmost to the lowmost level.

In this paper we attempted to model habitat ecological requirements of the species *Zingel zingel* and the conditions that ensure favorable conservation status. As one can see in the following figure (Fig. 2 - Hierarchy models), the basic process is *Zingel zingel* species. The subprocesses showed in the figure are part of the basic model. They can be viewed by a simple click, both using the Explorer window and also from the starting model.

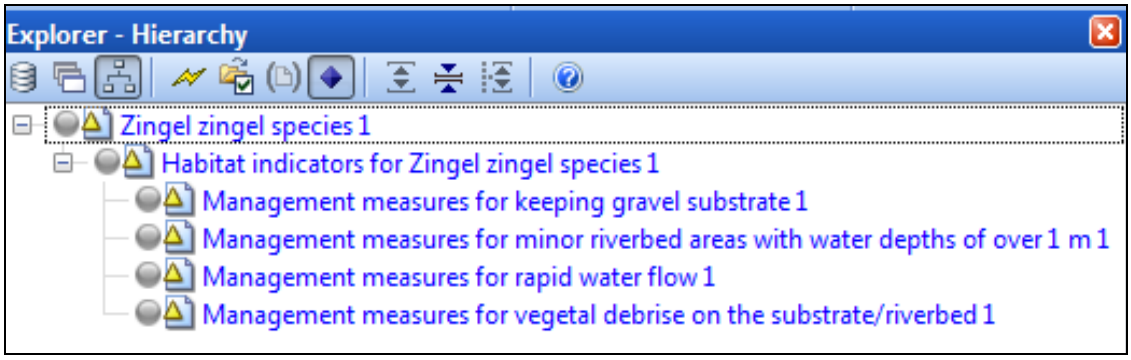

Figure 2: Hierarchy of process modeled.

The initial "process" is called *Zingel zingel* species (Fig. 3) and contains two "activities" (*Habitat specific requirements* and *Current pressures and threats*), a subprocess called *Habitat indicators for Zingel zingel species* and a decision that ensures favorable conservation status. During the measurements and observations made in the field, it was noted that ensuring favorable conservation status indicators is likely to succeed only 30% of the time (e.g. Decision: if Conservation_state = 0.3, we follow the branch "Yes" of the decision, if Conservation_state = 0.7 we follow the branch "No" of the specific decision).

The next figure (Fig. 4) is the subprocess called from the starting model, named *Habitat indicators for Zingel zingel species.*

This process is modelled only by decision (represented by indicators are taken into account), subprocesses (Figs. 5a-d) presenting management measures and two activities (*Field Observations* and *Implementation of an integrated monitoring system*).

Considering that we took into account four indicators, we call the four subprocesses to ensure important management measures to be taken if the indicators do not provide favorable conservation status. After calling each subprocess, the last activity is reached, namely *Implementation of an integrated monitoring system*, and then the process ends.

For each decision, we assigned a variable (e.g. *Water_depths*, *Gravel_substrate*) and a generator (type discrete, e.g. "Yes" branch = 0.66, "No" branch = 0.34 for Water_depths) which - based on measurements taken - can determine the condition probability that the indicator exists in favorable conservation status.

If you follow all these outlined management measures, and if the integrated monitoring system is carried out by specialized personnel, it will ensure the conservation of the endangered *Zingel zingel* species.

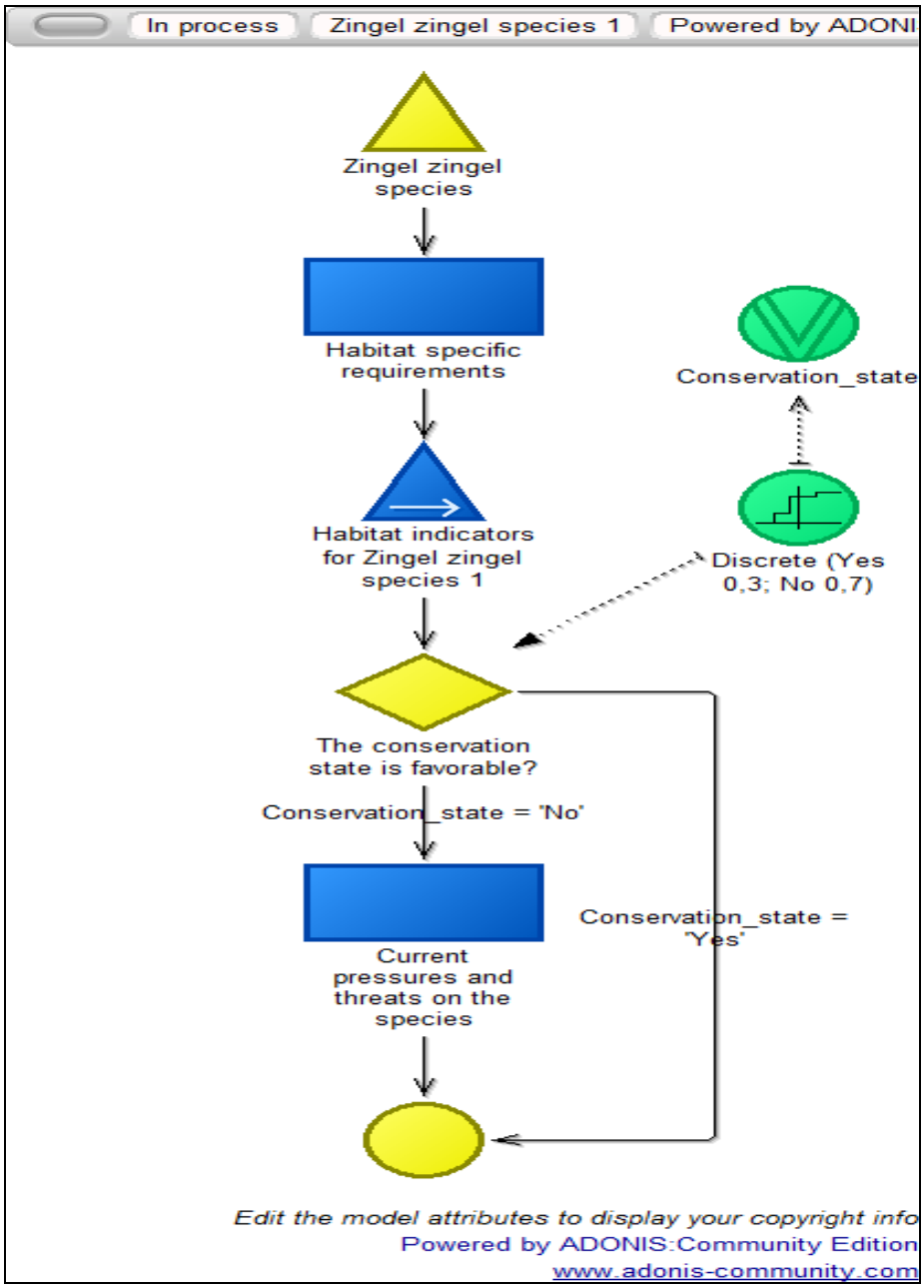

Figure 3: Process model *Zingel zingel* species.

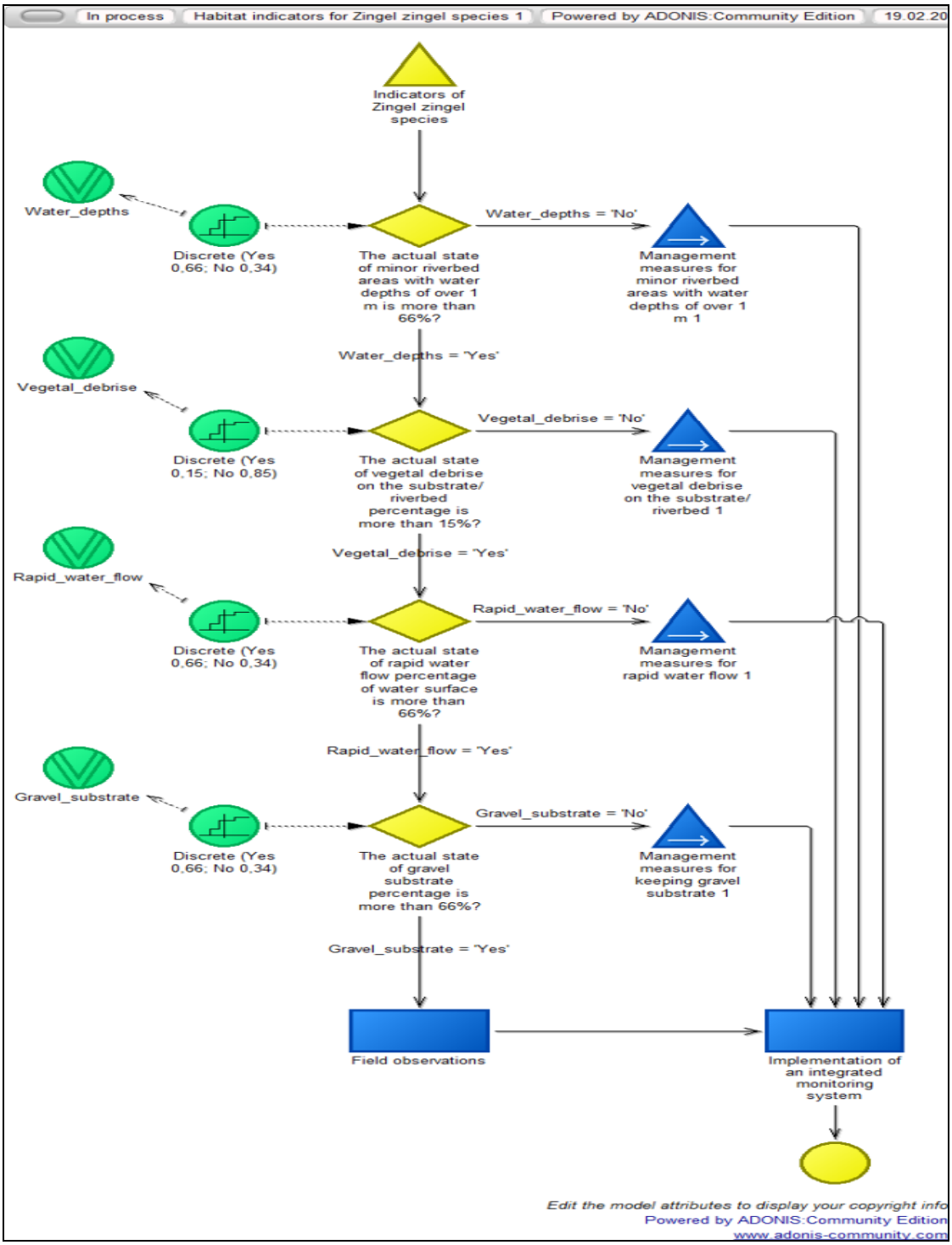

Figure 4: Habitat indicators for *Zingel zingel* species model process.

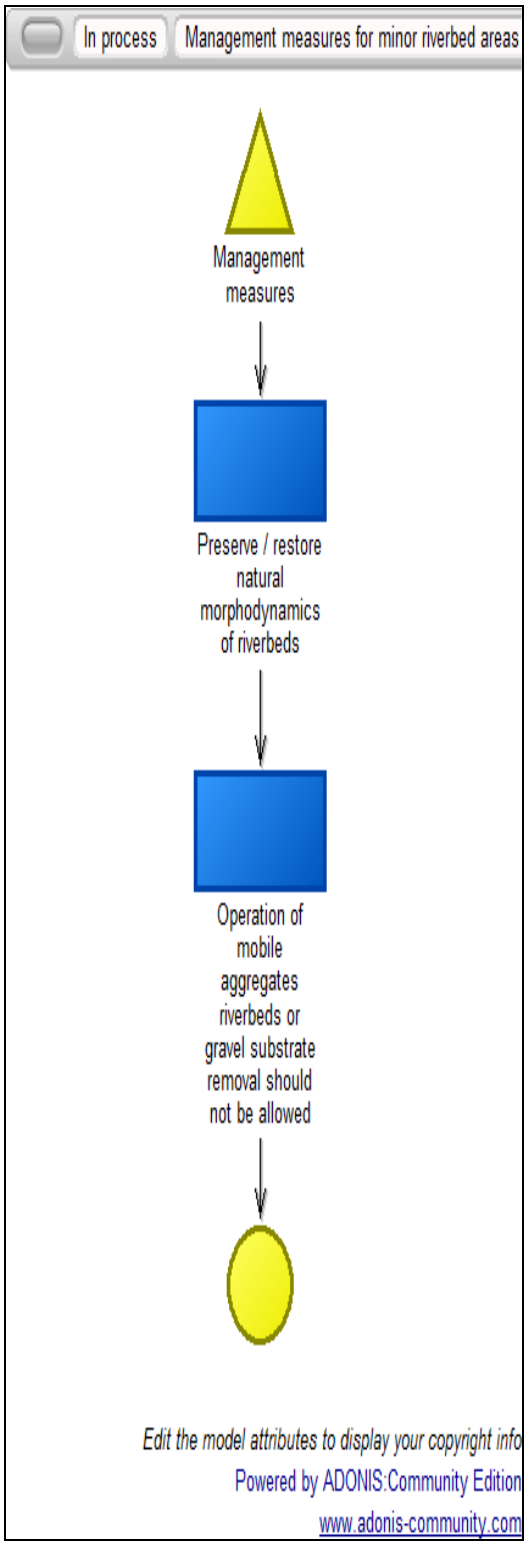

Figure 5a: Measures for the first indicator.

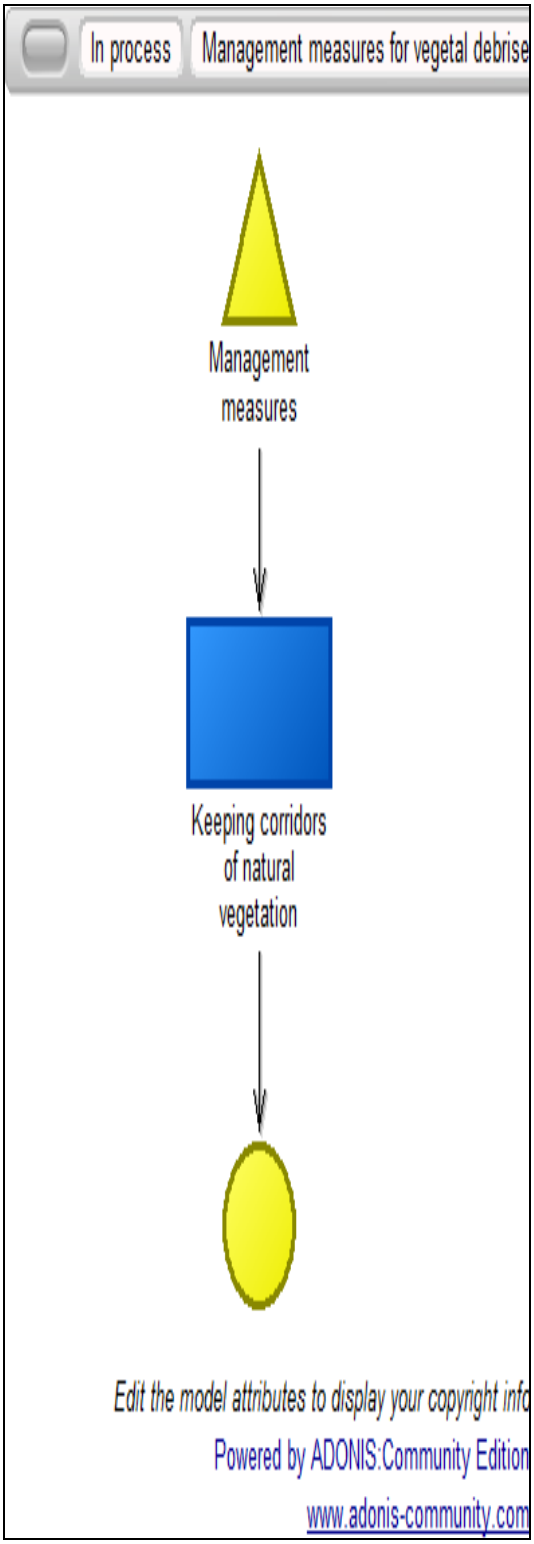

Figure 5b: Measures for the second indicator.

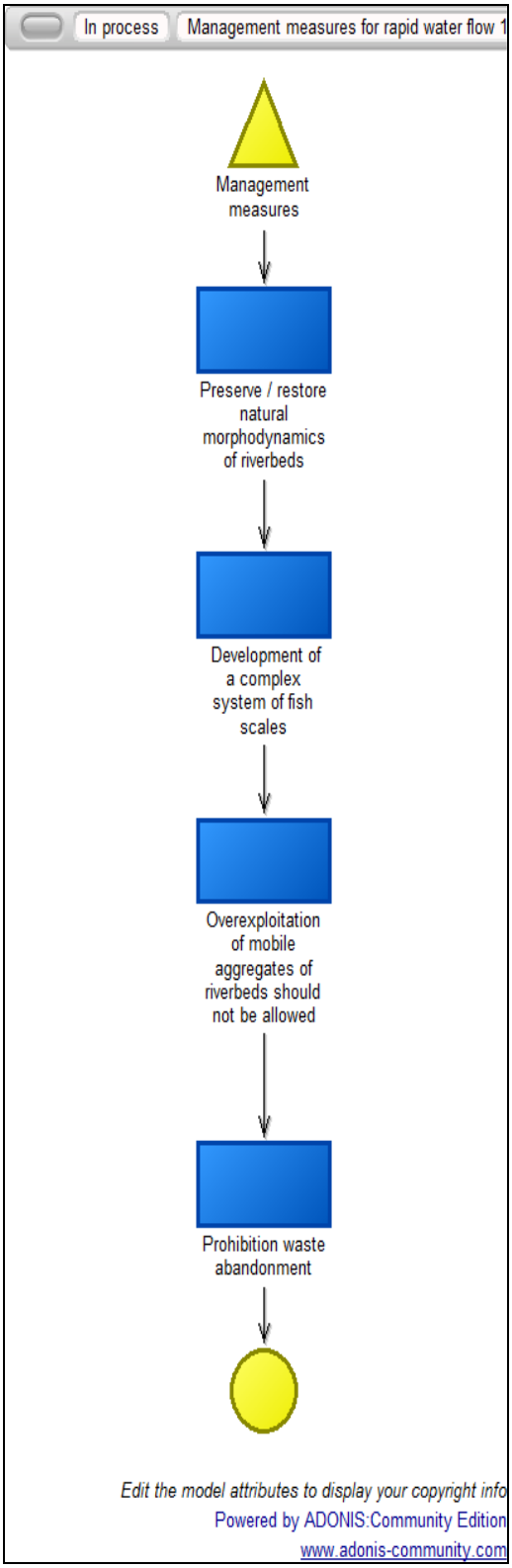

Figure 5c: Measures for the third indicator.

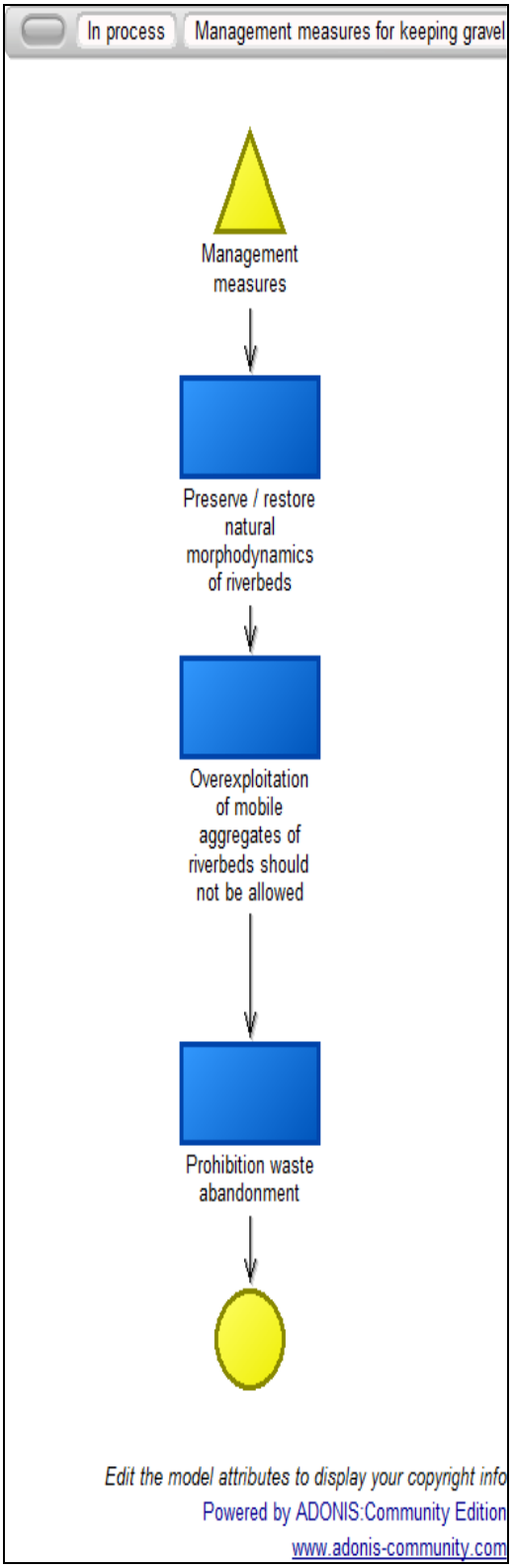

Figure 5d: Measures for the fourth indicator.

CONCLUSIONS

The principal threats to the *Zingel zingel* species ecological status in the Natura 2000 site ROSCI0132 are: river regulation and mineral substratum overexploitation, water pollution and poaching. The highlighted pressures on this fish species' populations of conservative interest are: destruction/major modification of natural habitats, lotic habitats' destruction or fragmentation along the rivers due to major hydrotechnical works (dams and lakes), and pollution. A significant impact on *Zingel zingel* species is the absence of functional fish leaders for dams and lakes which drastically fragmented the lotic habitats continuum. The riverbed mineral overexploitation with the uncovering of hard massive rocks substrate should be banned, thinking about the mobile mineral substrata needed for this species. In the reproduction period of this species, fishing should be restricted as well as all human activities which can increase the sedimentation rate of the suspensions. The poaching phenomenon should be stopped. The Olt River should be managed with the purpose of keeping a good water chemical quality. The riverine vegetation (herbaceous, shrubs and ligneous) should not be harmed in a minimum of 100 m on both sides of the river banks in sectors as long as possible.

Seasonal integrated monitoring is needed, including water quality monitoring.

In this research, the authors "realized" a framework of *Zingel zingel* species. The ADONIS:CE was used here in the biology/ecology domain, creating a model of *Zingel zingel* species that presents all the needs for the habitat, the indicators that offer a favorable conservation status - the adequate measures, and the species' pressures/threats. If all these management requirements will not be put in to practice, the presence of this species will be jeopardized in the next one or two decades. On this site, the habitats and species management model for *Zingel zingel*, should be integrated in a management model for ichthyofauna, which is why such management systems should be implemented for other fish species of community conservative interest in the case of ROSCI0132.

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PROVIDING LONGITUDINAL CONNECTION IN CASE OF CROSS SLUICING ON WATER BODIES IN BANAT HYDROGRAPHIC AREA

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KEYWORDS: hydromorphological alterations, impact, longitudinal connection.

ABSTRACT

On Banat Hydrographic Area level, there are a series of works which put hydrological pressures on bodies of water: accumulations, damming, water diversions, regulations, shore protection, etc. These works were created in order to ensure water demand, defend against floods, regulate discharges, and combat humidity excess. Speaking justly, they have an important socioeconomic role. Among the negative effects of longitudinal connection interruption of water bodies we can mention, the risk of not achieving the positive ecological potential of water bodies in accordance with the Water Framework Directive, the reduction of the aquatic biodiversity, the reduction or even extinction of certain aquatic species and the alteration of the flow process. Because the negative effects of the hydromorphological alterations, especially those due to the interruption of the longitudinal connection, have a significant impact on the aquatic biodiversity. At Banat Hydrographic Area level, a series of measures, have been identified for the rehabilitation of the affected water courses: the removal of the hydrotechnical constructions from the water body if they have lost their functional features, building of passages for the migration of the ichthyofauna, reconnecting of the affluents and the disconnected arms as well as other measures intended to bring things back to their natural state. The implementation of these measures is made according to the importance and the extent of their positive impact as opposed to the negative effect that might occur as a consequence of their application. Analyzing the measures aforementioned and taking into consideration the characteristics of the hydromorphological pressures on water bodies in Banat Hydrographic Area, a number of measures regarding control are supplied in this paper.

RESUMEN: Conectividad longitudinal mediante exclusas en cuerpos de agua de la Cuenca Hidrográfica de Banat.

En cuanto a la Cuenca Hidrográfica de Banat, existe cantidad de infraestructuras que presentan presión hidrológica sobre los cuerpos de agua: estructuras de acumulación, embalses, desviaciones de agua, reguladores, protecciones costeras, etc. Estos trabajos fueron creados con el fin de asegurar la demanda de agua, defensa contra inundaciones, regulación de las descargas, combate contra el exceso de humedad, y por ello han tenido un papel socioeconómico relevante. Entre los efectos negativos que ha tenido la interrupción de la conectividad entre los cuerpos de agua, se puede mencionar el riesgo de comprometer el potencial ecológico de los cuerpos de agua en los términos que se definen en la Directiva antes mencionada, la reducción de la biodiversidad acuática, la disminución e incluso la extinción de ciertas especies acuáticas y la alteración del flujo de agua. En virtud de los efectos que tienen las alteraciones hidrogeomorfológicas, especialmente aquellas que interrumpen la conexión

longitudinal, la biodiversidad acuática se ha visto negativamente impactada en la Cuenca Hidrográfica de Banat. A este respecto se han identificado una serie de medidas tendientes a la rehabilitación de los cursos de agua más afectados, como la remoción de construcciones hidrotécnicas de los cuerpos de agua si estas han perdido sus rasgos funcionales básicos, construcción de pasajes migratorios para la ictiofauna, reconexión de afluentes y de tributarios inconexos, así como también otras medidas cuya finalidad sea restablecer las condiciones alteradas a su estado original. La implementación de estas medidas se hace de acuerdo a la importancia y la extensión de los impactos positivos esperados en balance a los impactos negativos que pudieran suceder tras su aplicación. El análisis de estas acciones y la consideración de las características de las presiones hidrogeomorfológicas sobre los cuerpos de agua en la Cuenca Hidrográfica de Banat que se presentan en este trabajo, han sido consideradas como adecuadas.

REZUMAT: Asigurarea conectivităţii longitudinale în cazul barărilor transversale pe corpurile de apă din spaţiul hidrografic Banat.

La nivelul Spaţiului Hidrografic Banat se găsesc o serie de lucrări care exercită presiuni hidromorfologice asupra corpurilor de apă: acumulări, îndiguiri, derivaţii, regularizări, apărări de maluri, etc. Aceste lucrări au fost create pentru asigurarea cerinţei de apă, apărare împotriva inundaţiilor, regularizarea debitelor, combaterea excesului de umiditate şi au un rol socio-economic important.

Dintre efectele negative ale întreruperii conectivităţii longitudinale a cursurilor de apă amintim: riscul de a nu atinge starea/potenţialul ecologic bun al corpurilor de apă conform Directivei Cadru a Apei, reducerea biodiversităţii acvatice, reducerea efectivelor sau chiar dispariţia unor specii acvatice, modificarea regimului curgerii.

Deoarece efectele negative datorate alterărilor hidromorfologice, în special celor datorate întreruperii conectivităţii longitudinale, au un impact semnificativ asupra biodiversităţii acvatice, la nivelul Spaţiului Hidrografic Banat s-au identificat o serie de măsuri de reabilitare a cursurilor de apă afectate: eliminarea de pe corpul de apă respectiv a construcţiilor hidrotehnice dacă acestea şi-au pierdut funcţionalitatea, executarea de pasaje pentru migrarea ihtiofaunei, reconectarea afluenţilor şi a braţelor deconectate, alte măsuri, prin care se revine la starea naturală. Aplicarea acestor măsuri se face în funcţie de importanţa şi mărimea impactului pozitiv în comparaţie cu efectul negativ, care ar putea să apară ca o consecinţă a aplicării lor. Analizând măsurile prezentate anterior şi luând în considerare caracteristicile presiunilor hidromorfologice ale corpurilor de apă din SH Banat s-au considerat pertinente o serie de măsuri care sunt prezentate în lucrarea de faţă.

INTRODUCTION

The Water Framework Directive 2000/60/EC represent the document through which the European Union establishes a community framework for the protection and management of water. It was adopted by the European Parliament on 23 October 2000 and its main objective is maintaining both surface and underground water bodies in “good condition” until 2015.

The Management Plan of the Hydrographic Area represents the instrument through which the Water Framework Directive is implemented and has as purpose the balanced management of water resources as well as the protection of the aquatic ecosystems.

The target area of this scientific paper is under a significant historical human impact influence (Burghelea et al., 2013) one more reason for such a study.

The risk of failure in achieving the environmental objectives

According to the 5th article in the Framework Directive which stipulates that "Each Member State must mention the impact of human activities on the condition of surface and underground waters", it is necessary to perform an assessment of the anthropic pressures and their impact on the level of water bodies, which may lead to identifying those water bodies which fail to achieve the objectives of the Framework.

The identified risk categories at the level of surface and underground water bodies are: organic substances pollution, nutrient pollution, dangerous substances pollution, hydromorphological alterations.

Hydromorphological pressures on water bodies

Water bodies are considered strongly modified when the normal environmental condition cannot be achieved because of the impact of the physical modifications of the hydromorphological characteristics of surface waters.

Hydromorphological alterations represent one of the most important pressures with impact on water resources and they are the consequence of different types of constructions on waters or closely dependent of water bodies. This type of pressure influences the hydromorphological characteristics specific to surface waters and produces a negative impact on the condition of aquatic ecosystems. These constructions consist mainly of dams, flood stops and crossings and they interrupt the longitudinal connection of rivers, exercising negative effect pressures on the hydrological condition, on the sediment transportation and on biota migration. Other types of works which are made along the river, such as dammings, regulations and consolidation of shores, interrupt the lateral connections of the water bodies.

Thus, the impact of hydromorphological alterations on the condition of water bodies can be seen in the change of migratory fish species, the decline of natural reproduction of fish populations, the reduction of biodiversity and species abundance as well as the alteration of populations' composition. The hydromorphological pressures to which also other types of pressures are added, act collaboratively and therefore multiply the consequences.

General presentation of the Banat Hydrographic Area

The Banat Hydrographic Area is composed of six main hydrographic basins as well as the hydrographic basins of Danube's left affluents, between Nerei and Cernei basins. The length of the hydrographic network is about 6,245 km to which there are added 145 km, the length of the Danube bordering the Banat HA. There are also 389 rivers whose basin-surface is larger than 10 km^2.

The hydrographic basins of category I in the Banat HA are: Aranca, Bega, Timiş, Caraş, Nera, Cerna and Danube.

At the level of the Banat Hydrographic Area, different types of land features can be found: the highest altitude is in the south-west part (Godeanu Mountains, maximum altitude of 2,229 m) and the lowest one towards the north-west part (Banatului Plane, minimum altitude of 77 m in the border area).

In the Banat HA, the lakes has a surface biger than 0.5 km^2 are nine and all of them are dam lakes. They are mainly found in Timiş, Bega, Caraş and Cerna basins, and have been built in order to provide water for consumption, industrial purposes, energy purposes and defense against floods.

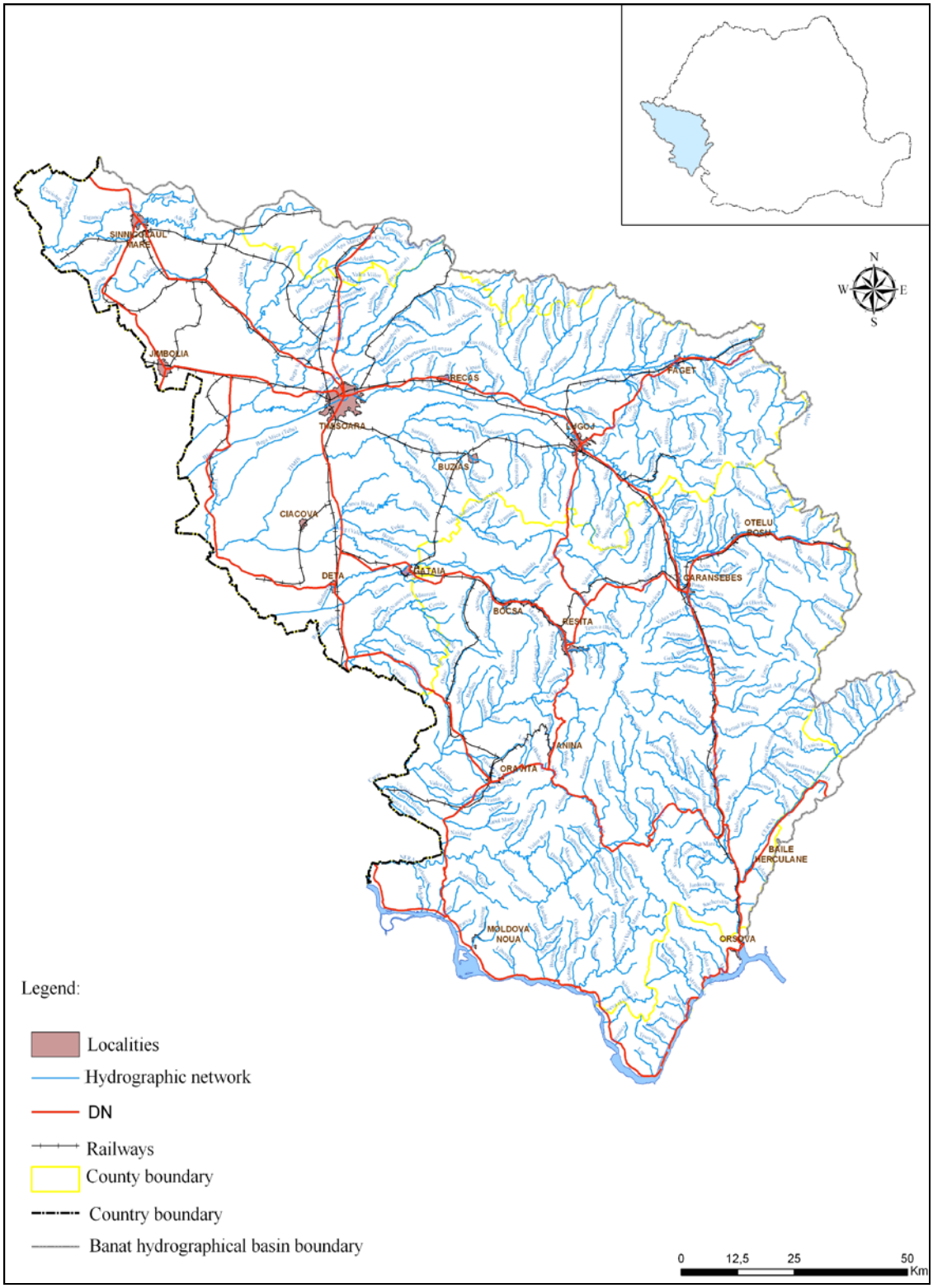

Figure 1: Banat Hydrographic Area.

Hydromorphological pressures at the level of Banat HA

At the level of the Banat Hydrographic Area there are different work categories which exercise hydromorphological pressures on water bodies. These are: accumulations, dammings, water diversions, regulations, shore protection, etc.

These works have been made for various purposes. The most notable is to ensure the demand for drinkable and industrial water. Others include energy use, flood defense, flow regulation, and fighting humidity excess, etc., all these being of social-economic importance.

The barrier lakes within the Banat Hydrographic Area represent a hydromorphological pressure because they interrupt the longitudinal connection of the flow. The existing barriers are as follows: Murani, Poiana Mărului, Gozna, Iovan's Valley, Herculane, Surduc, Secul, Trei Ape, and Rusca.

Regarding regulations and dammings, these are found in an area of 64 stream sections, having a total length of 699 km. There are 126 dammings of 1,049 km in length, out of which only 17 can be considered significant hydromorphological pressures, of 435.3 km in total length, and which are responsible for the interruption of the lateral connection of water bodies.

There are eight derivations and their purpose is to supplement the flows in sections, with a necessary water higher than the natural potential of the river. These derivations can cause both hydrological and environmental unbalances.

The passable canals are represented by a single passable route, the Bega Canal. Navigation on Bega canal determines a series of significant hydromorphological pressures on this ecosystem.

The significant water disposals in Banat HA produce quantitatively important hydromorphological alterations.

All these hydromorphological alterations contribute to the interruption of: longitudinal connection of watercourses, caused by hydrotechnical works such as dams, crossings, barriers; lateral connection of watercourses, caused by dammings, riverbed regulation works, shore consolidations.

The study of ichthyofauna migration in Banat Hydrographic Area

The EFI+ research project was made in order to acquire new knowledge and develop and improve new methods of biological assessment based on ichthyofauna. These are all necessary to meet the demands of the Water Framework Directive and applicable, as new methods, to all EU member states as well as to the pending ones.

According to the EFI+ list of medium distance migratory fish, in Banat HA we find the following migratory species: *Abramis brama* (bream), *Abramis sapa* (Danube bream), *Aspius aspius* (rapacious carp), *Barbus barbus* (barbell), *Chondrostoma nasus* (broad snout), *Lota lota* (burbot), and *Vimba vimba* (codling).

As a result of analyses carried out between 2005-2012, in Banat HA there was registered the presence of migratory species in 42 water bodies corresponding to the six hydrographic basins, as well as at the level of the sector in the Danube's hydrographic basin, as follows: Timiș Hydrographic Basin: 14 water bodies, Bega Hydrographic Basin: nine water bodies, Caraș Hydrographic Basin: seven water bodies, Nera Hydrographic Basin: five water bodies, Cerna Hydrographic Basin: four water bodies, Danube Hydrographic Basin: two water bodies; Aranca Hydrographic Basin: one water body.

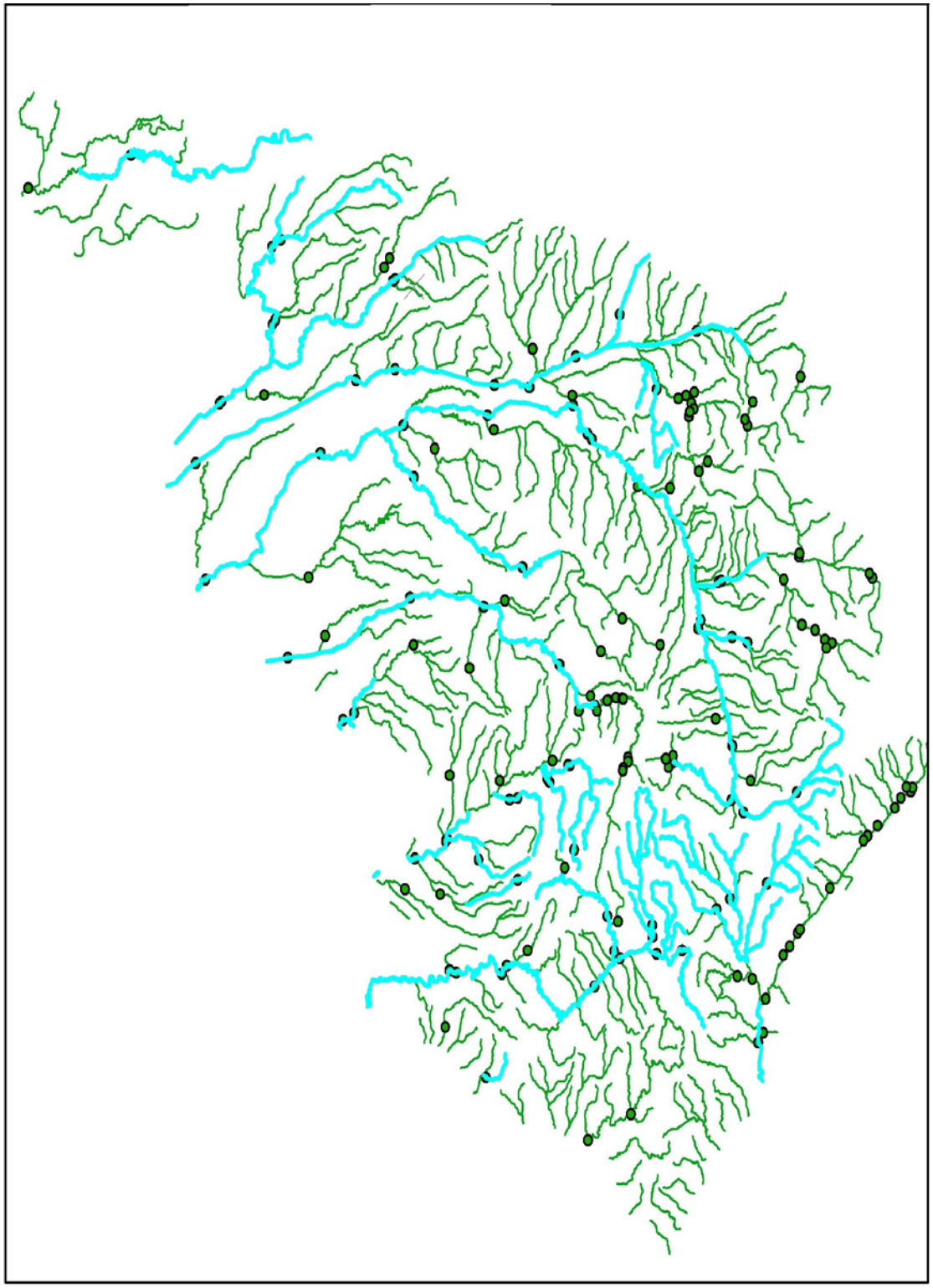

Figure 2: Fish migration, according to assays made between 2005-2012.

Measures to rehabilitate the longitudinal connection of rivers in the Banat HA

Following the target of a good water condition and good potential of water bodies, the Water Framework Directive sets the basis of a new strategy in managing waters, a strategy which takes into consideration new elements, inlcuding the rehabilitation of water resources. The research performed showed that the interruption of the longitudinal and lateral connection of watercourses leads, in time, to the reduction of the aquatic environment biodiversity. The negative effects of longitudinal connection interruption of watercourses because of cross barriers on water bodies are: the risk of not achieving the good environmental condition/good environmental potential; the reduction as well as the modification of natural reproduction of fish populations; the alteration of the flowing process.

Establishing the longitudinal connection of the watercourse is necessary, taking into consideration its effects on the aquatic biodiversity; in order to attain this, one could chose one of the following measures: the removal of the existing hydrotechnical constructions on the watercourse if these have lost their function; the building of passes for the migration of the ichthyofauna (bypass canals, incline-decline systems, fish elevators) if in those waters there are migratory fish species and if the existing obstacles have more than 30 cm in height for cyprinids and 50 cm for salmonids; the reconnection of affluents and of disconnected arms - natural or built; other measures aiming mainly at re-establishing the natural condition.

After identifying the rehabilitation measures for the water bodies in the Banat Hydrographic Area, their implementation is made according to each type of morphological alteration existing in that water body. Considering the importance and size of the positive impact that these measures have is of great concern. This is done by comparison to the negative effects that could appear as a result of these measures.

Analysing the presented measures and taking into consideration the characteristics of the hydromorphological pressures on water bodies in the Banat HA, the following have been considered to ensure longitudinal connection: the creation of a bypass on Bega watercourse, at Balint Watermill - periodically functional and where there is a four meters high dam.

This measure is most suited on the left bank and its implementation eases the access of migratory ichthyofauna on medium distances.

- the closing down of the crossing at Chizătău Watermill, on Bega River, as it is unfunctional for its purpose, having free flow;
- the removal of the cross barrier at Petroşnița Watermill, on Timiș River;
- the creation of a bypass, starting with a pipe through the dam, on Bega watercourse at the Topolovăț Hydrotechic Knot which is fully used (hydroenergetically, irrigations and defense against floods);
- the building of fish ladder on Bega at UHE Timișoara;
- the removal of the cross barrier at Sadova Veche Watermill on Timiș watercourse;
- the creation of a gap of 0.5 m in the crossing or a fish ladder on Bistra River at CHE Glimboca;
- the creation of a bypass on Caraș River at Vrani Watermill - functional;
- the relieving and partial cleaning of Timiș River waterbed at MHC Constantin Daicoviciu as it is unfunctional because the crossing and the feed canal are destroyed 75%;
- the building of a fish passage on Timiș River at Coştei Hydrotechnic Knot;
- the building of a fish ladder on both banks on Timiș River aligned against the crossings in Cotul Mic.

Figure 3: Balint Watermill sector.

Figure 4: Hydrotechnic Knot in Coştei.

Figure 5: Crossing in Cotul Mic.

CONCLUSIONS

The identification of rehabilitation measures of the longitudinal connection for water bodies within Banat Hydrographic Area was performed individually for each type of hydromorphological alteration found at the level of the hydrographic space. The river water bodies were analyzed and the existence of migratory fish species and those whose migration is hindered by the cross sluicings present on water were taken into consideration. Also, the specific characteristics of the area, including specific features of the body of water and its uses were not discarded. The measures to be taken were agreed upon as a result of the correlations of the field data with the ones in the databases.

The most important effects of ensuring longitudinal connection of water bodies are the following: the improvement of their condition/of their environmental potential, the reestablishment of the aquatic habitats that have been affected, the increase in abundance of aquatic species especially of the ichthyofauna, etc.

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CREATING A SYSTEM FOR UPSTREAM - DOWNSTREAM FISH MIGRATION OVER THE FIRST AND THE SECOND DISCHARGE SILLS DOWNSTREAM OF MĂNĂŞTUR DAM ON THE SOMEŞUL MIC RIVER (CLUJ NAPOCA, TRANSYLVANIA, ROMANIA)

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KEYWORDS: lotic ecosystem, fish migration, Someșul Mic River, connectivity.

ABSTRACT

The paper presents a case study that proposes a technical solution to facilitate fish migration upstream the discharge sills located on Someşul Mic River, near the Mănăştur Dam from the Cluj Napoca Town. The proposed solution provides building of a system to facilitate fish migration, placed on the left bank of Someşul Mic River, meant to restore the longitudinal connectivity of Someşul Mic River in front of the Mănăştur Dam discharge sills and to facilitate the access of the migratory fish species to upstream breeding habitats. The proposed migration system is based on using traction of winches and the gravitational fall of water and will lead to the restoration of the longitudinal connection of the Someşul Mic River near the weir selected as case study, and will reconnect a habitat with a length of around one km, that will contribute to insuring of optimal conditions for developing migratory fish species present in the area.

RESUMEN: Creación de un sistema bidireccional para facilitar la migración de peces en el primero y segundo alféizar de descarga de la presa Mănăștur, en el río Someșul Mic (Cluj Napoca, Transilvania, Rumania).

En este artículo se propone una solución técnica para facilitar la migración de peces hacia el alféizar de descarga en el río Someşul Mic, cerca de la presa Mănăştur, en el poblado de Cluj Napoca. La solución consiste construir un sistema en el lado izquierdo del río Someşul Mic, frente al alféizar de descarga de la presa Mănăştur, con el fin de facilitar el acceso de peces migratorios a sus hábitats reproductivos, río arriba. Este sistema se vale tanto de la tracción de malacates como de la caída del agua por gravedad, y permitirá restaurar la conectividad longitudinal del río Someşul Mic a la altura de la presa; este sistema, asimismo, volverá a conectar un hábitat de aproximadamente un km de largo, que contribuirá a asegurar que se den las condiciones óptimas para el desarrollo de los peces migratorios presentes en el área.

REZUMAT: Crearea unui sistem pentru migrarea peștilor amonte - aval de cele două praguri deversoare (primul și al doilea) situate aval de barajul Mănăștur de pe râul Someșul Mic (Cluj Napoca, Transilvania, România).

În această lucrare este prezentată o soluţie tehnică propusă pentru facilitarea migrării ihtiofaunei peste ambele praguri de fund de lângă Barajul Mănăştur, amplasat pe Someşul Mic, la Cluj Napoca. Soluţia presupune realizarea unui sistem de migrare lângă malul stâng al râului Someșul Mic şi va avea ca scop refacerea conectivităţii longitudinale a râului Someşul Mic, în dreptul pragurilor de fund de lângă Barajul Mănăştur şi facilitarea accesului speciilor de peşti migratori din zona de studiu către habitatele de reproducere din amonte. Realizarea sistemului de migrare propus, bazat pe folosirea tracțiunii troliilor și a căderii gravitaţionale a apei, va asigura reconectarea unui habitat cu o lungime de aproximativ un km şi va contribui la crearea unor condiţii optime pentru dezvoltarea speciilor de peşti prezente în zonă.

INTRODUCTION

The subject of this article represents a European theme of great topicality and interest regarding the restoration of the water courses affected by the hydromorphological pressures created by the presence of transversal works which lead to the interruption of longitudinal connectivity of rivers, stopping the fish migration and modifying the flow regime. Restoring the longitudinal connectivity of the river will contribute to ensure protection of protected fish species. All fish species present in the study area are part of the Someşul Mic River (Fig. 1) freshwater ecosystem situated in Transylvania, an area that face significant watershed management risks. Someșul Mic River is channelled and covered by concrete and has not meandered in the village of Cluj, a fact which has a negative impacts on the dynamics of the watercourse.

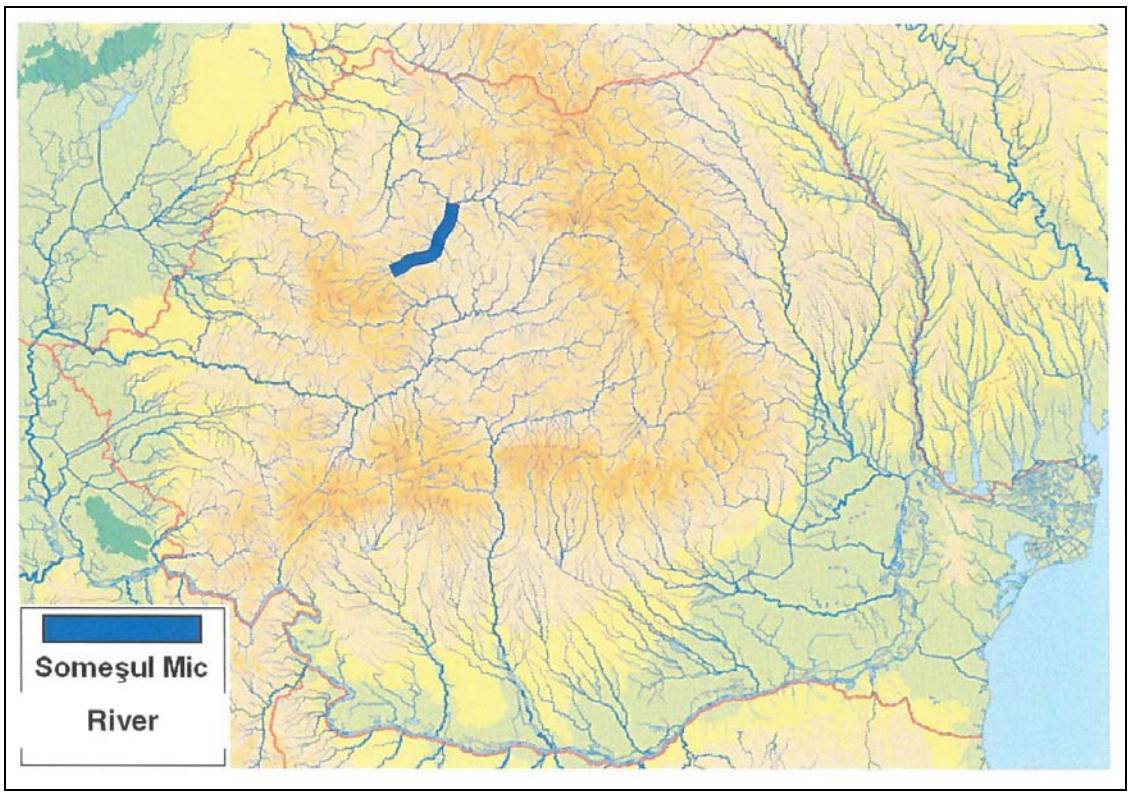

Figure 1: Someșul Mic River localization in the north-western part of Romania.

There are many hydrotechnical facilities along the Someşul Mic River, a river in north-western Romania (Cluj County), including discharge sills (Fig. 2). In the city of Cluj Napoca there are sills near: “U” Cluj Stadium, Opera, and Astoria buildings, etc. These discharge sills seriously affect the connectivity of the Someşul Mic River, strongly reducing its biodiversity and ecological valence, implicitly. The need for longitudinal connectivity of watercourses represents an essential condition for the Water Framework Directive approved by the European community and, therefore, it should be applied to all streams containing migratory species. This article represent a part of a complex study regarding the restoration of longitudinal connectivity of Someşul Mic River accomplished in a framework of a more large Programme of Measures for restoring longitudinal and lateral connectivity of Someşul Mic River.

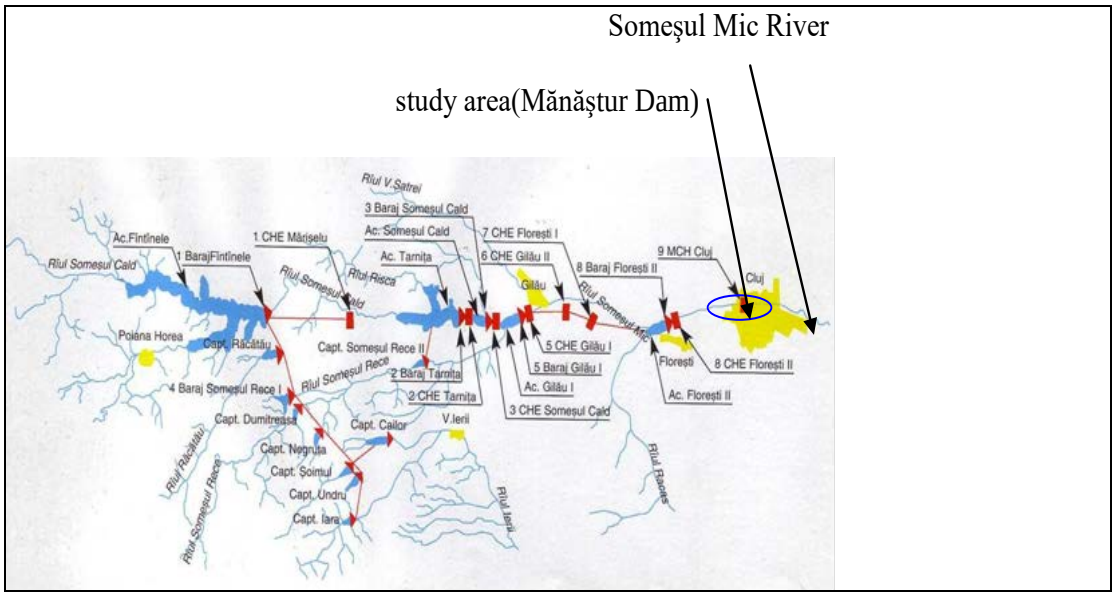

Figure 2: Hydrotechnical constructions on the Someşul Mic River (www.hidroconstructia.com).

The subject of this case study proposes an ecotechnical solution consisting of the frontal connectivity in the city of Cluj Napoca. The solution proposed for fish fauna migration upstream - downstream of the spillway sills situated at the City Hall of Cluj Napoca is practical, it can be developed without expensive technology and does not affect the discharge sills structure and associated construction. This solution for ichthyofauna migration upstream-downstream from the dams involves average costs and can be applied anywhere in the world.

RESULTS AND DISCUSSION

Fish passage is an important design consideration for dams around the world, and many dams are now being retrofitted to facilitate upstream movement of ichthyofauna over these structures. The success of fish passage systems is variable, suggesting a need for continued work designing and testing new systems. Although the impacts of dams on geomorphology and thermal regimes remain, fish passage systems can provide some relief for migratory fish species in cases where dam removal is not an option.

The systems presented here are intended for situations like the first and second discharge sills downstream of Mănăştur dam on the Someşul Mic River in Cluj Napoca, Romania (Fig. 1). The water speed downstream of Mănăştur dam is about one m/s and the water flow about 5.5 m^3/s. River slope is 0.5 percent (%). The present fish species include nase (*Chondrostoma nasus*) which is protected by the Bern Convention as well as barbel (*Barbus meridionalis*) which is protected by the Habitats Directive.

In order for fish to move past the first discharge sill (Fig. 4) a circular concrete basin provided with an opening should be constructed downstream of the discharge sill (Fig. 3). The opening through which fish must go should be placed downstream, its axis forming an angle of 40° from the x-coordinate and 60° from the ordinate (Fig. 4). In this case the distance between the circular basin and the discharge sill is four meters.

Figure 3: The first discharge sill downstream of Mănăştur dam.

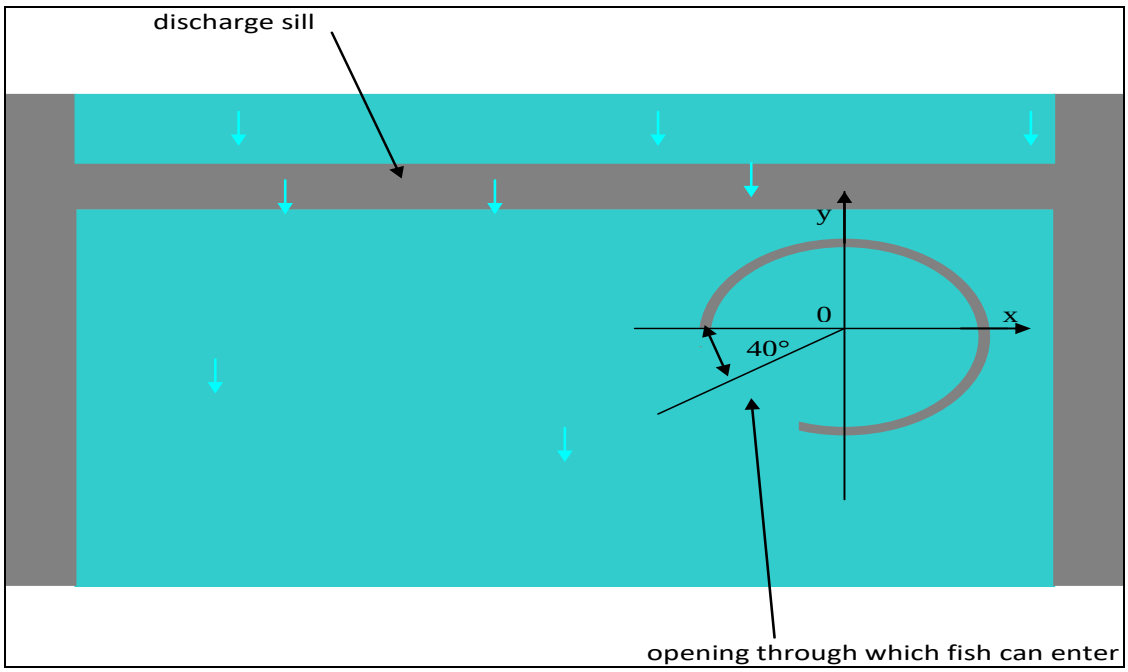

Figure 4: Positioning the circular concrete basin and opening through which fish can enter basin - indicative scheme.

Fish must be directed towards the circular concrete basin entrance using generators of electric fields with low amperage for blocking or redirecting fish, positioned downstream of the discharge sill (Fig. 4). In this case study more generators positioned parallel to the right bank and downstream of the circular concrete basin are required, and other generators will be positioned parallel to the left bank right next to the circular concrete basin. Also, some highly resistant woven plastic fences will be used for redirecting. This plastic fence (parallel to the left bank) is fixed to the riverbed by the means of metal dowels and, at the top it is connected to buoys. The other woven plastic fence forms an angle of about 30°C in relation to the discharge sill and it is also fixed to the bed by the means of metal dowels and connected to buoys (Fig. 4). The plastic fence is placed during upstream migration season and removed at other times to reduce fouling with leaves or other debris. Redirection system of fish is common and useful for many species not only existing in Someșul Mic River.

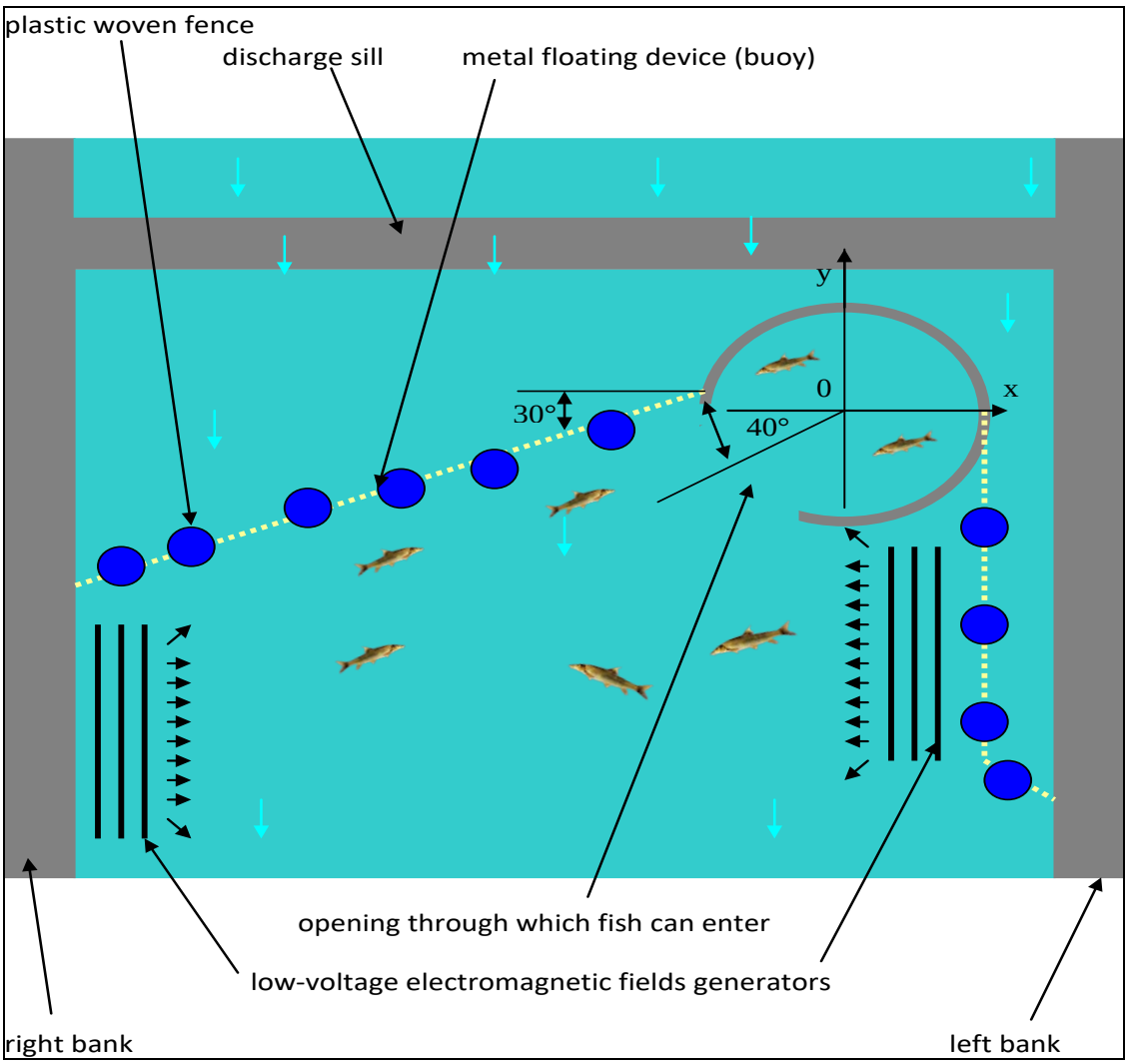

Figure 5: Positioning both the plastic fence and low-voltage electromagnetic fields generators - indicative scheme.

Eight spacers are fixed to the circular concrete basin and other four stainless steel bars are fixed to these spacers.

Two metal clamps are fixed for each metal bar and some resistant plastic disc is fixed to all clamps (Fig. 5) fixed on an inclined plane (Fig. 6).

Each necklace slides on the bar it is set. Spacers are one cm long and two cm thick each of them.

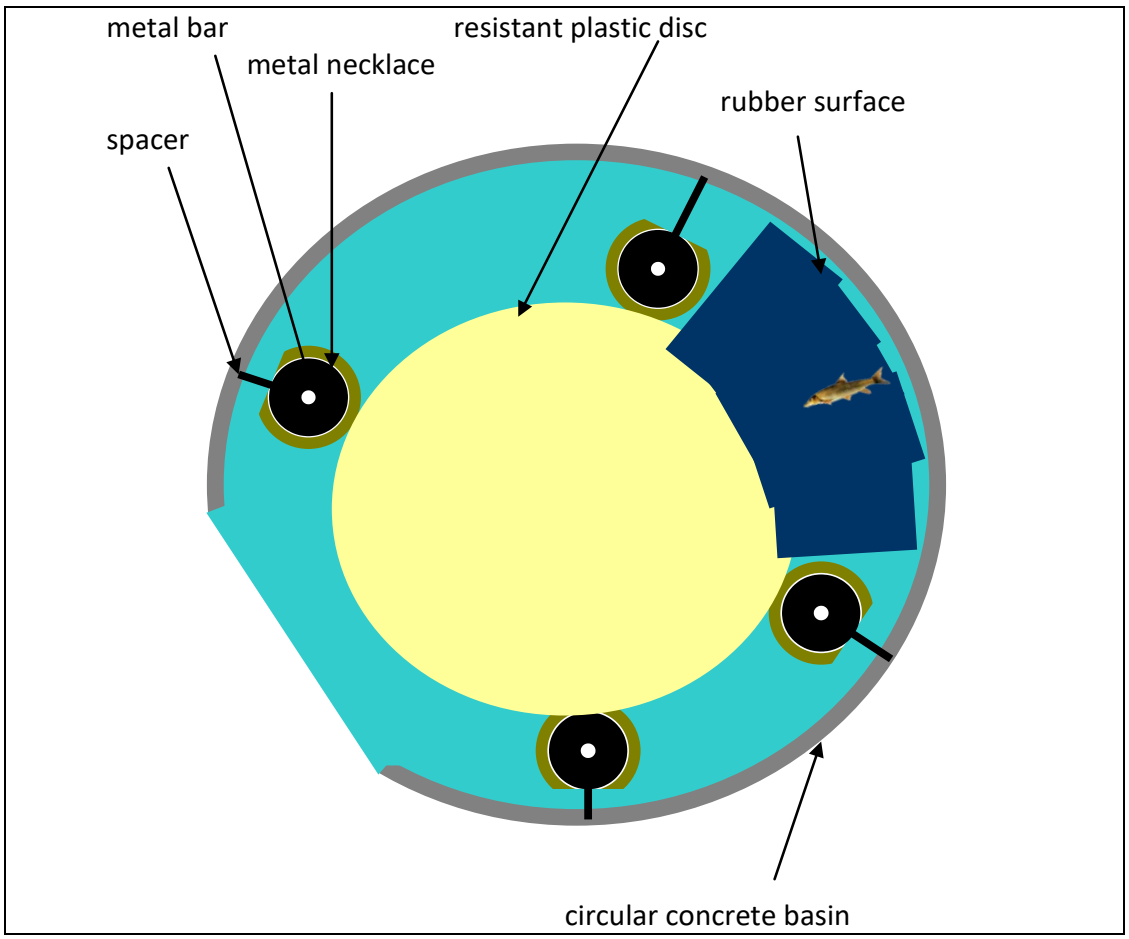

Figure 6: Fixing the resistant plastic disc to the concrete circular basin - indicative scheme.

Spacers are one cm long and two cm thick each. The calculations are made according to the biomass to be transported. The plastic disc thickness is five cm. The thickness of the bars on which the two cm-thick metal necklaces are fixed is three cm. From all these it follows that the plastic resistant disc diameter is 3.939 m. Between the necklace and metal bar there is a space of about a quarter of a millimetre which allows the necklace to slide on the bar. Within the remaining space between the concrete circular basin and plastic resistant disc, some rubber surface will be fixed to prevent the ichthyofauna from falling through the free space between the durable plastic disc and circular basin when the disc rises vertically (Fig. 6). One centimeter away from the basin is enough for rubber membrane that holds water needed to transport fish safely.

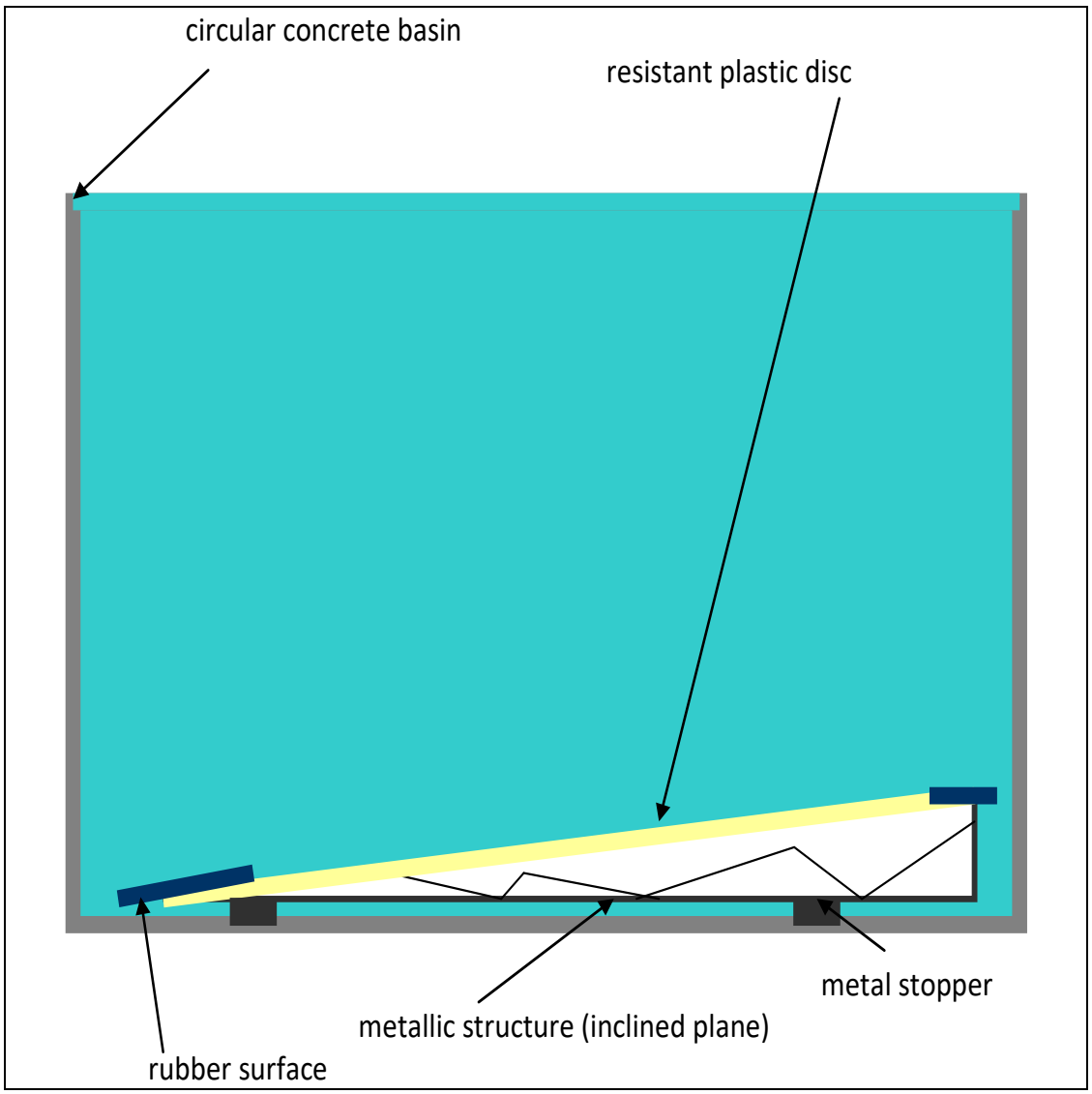

Figure 7: Fixing the resistant plastic disc metal inclined plane basin - indicative scheme.

Lifting and lowering the resistant plastic disk and the metal structure on which it is fixed is performed by using a pulley fixed to a concrete pillar (Fig. 7).

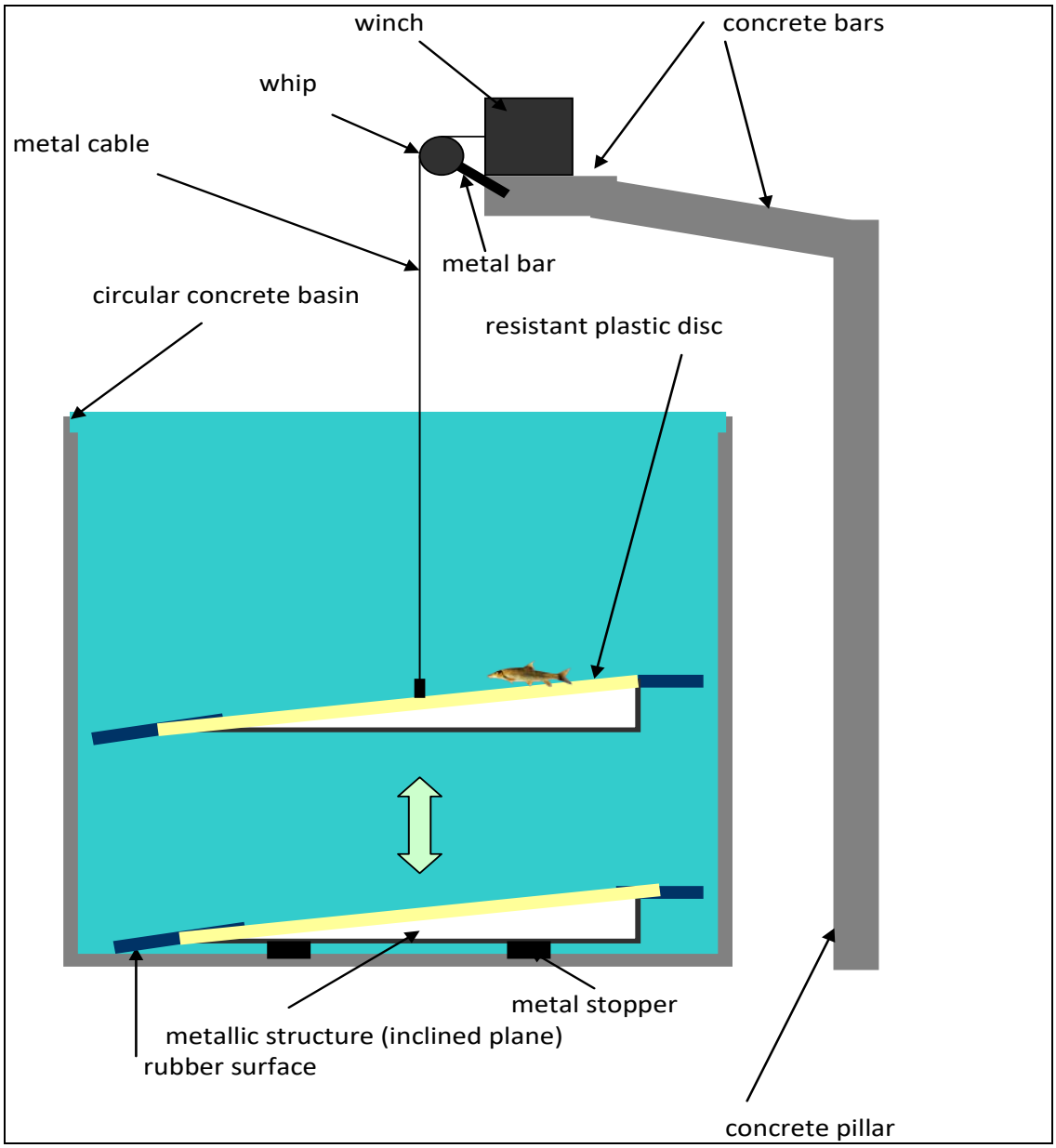

Figure 8: Positioning the winch on the concrete bar (downstream solution) basin - indicative scheme.

When the metal structure reaches its peak, all fish slip on the resistant plastic disc into a plastic tube fixed right above the discharge sill (Fig. 8).

Fish cannot dart out of the structure (outside the basin) because lifting will be done quickly and the resistant plastic will rise above the door thereby blocking the exit.

Another important issue is that the rubber membrane between the pool and inclined plane will protect the fish. Some water will remain on the resistant plastic disc until it reaches maximum so that fish can go easily down the channel over the discharge sill.

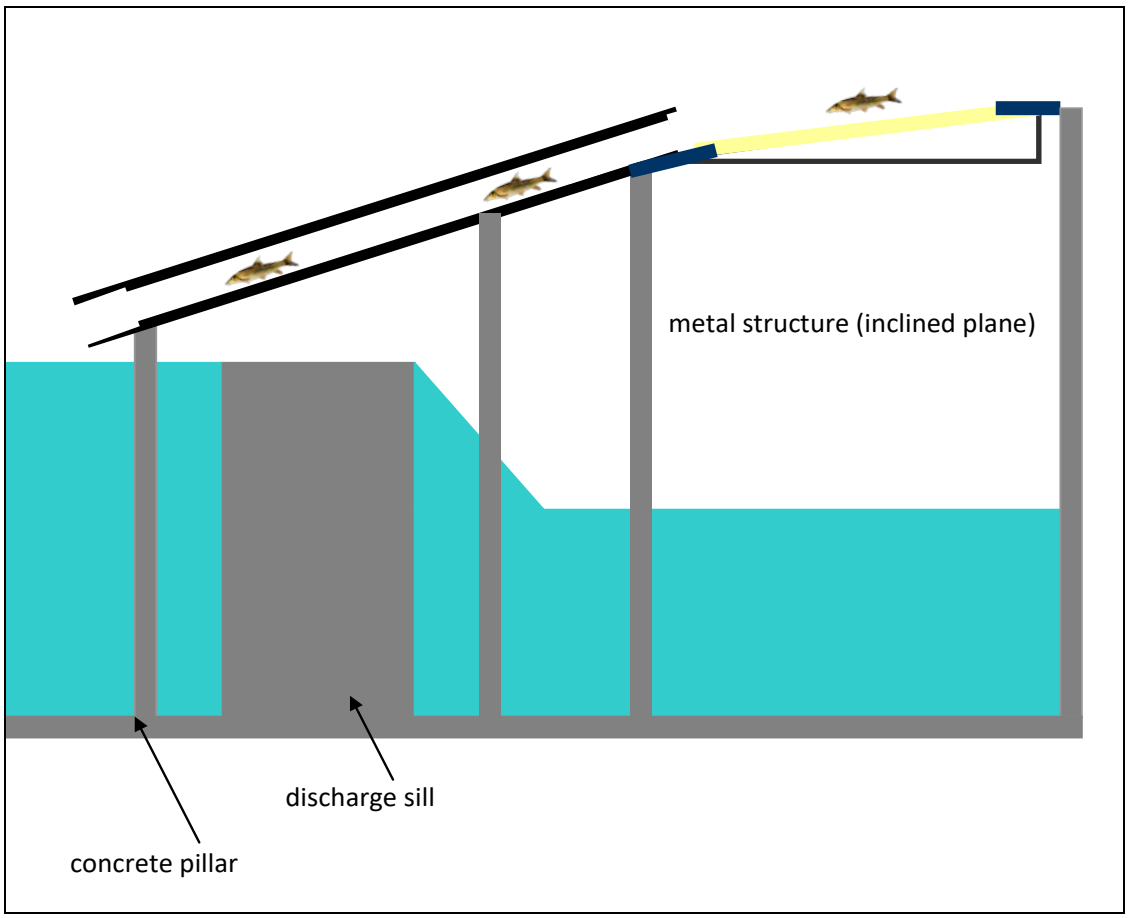

Figure 9: Fixing the plastic canal above the discharge sill, metal structure (inclined plane) basin - indicative scheme.

When the metal comes back to its initial position it presses on a spring door that, when at the maximum position, completely blocks water from entering the circular concrete basin (Fig. 9).

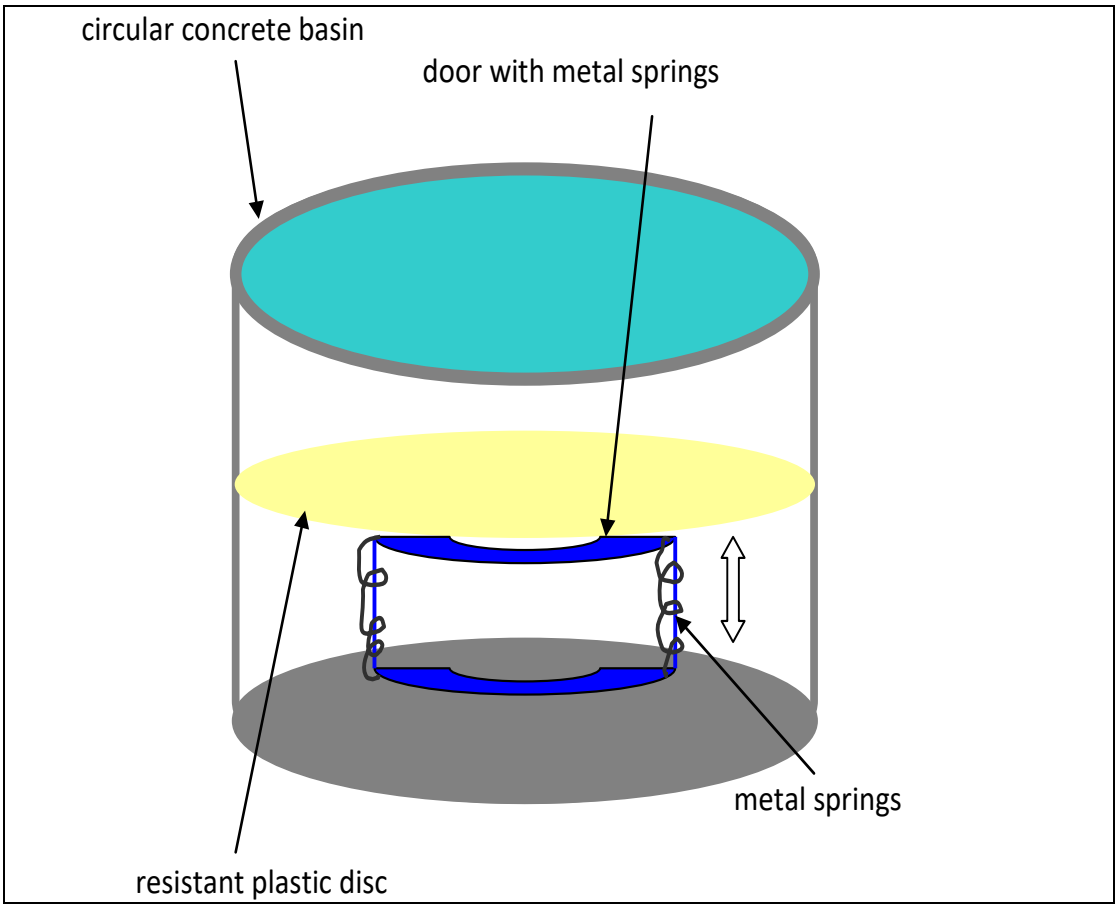

Figure 10: Positioning the fish entrance door of the circular concrete basin - indicative scheme.

The resistant plastic disc remains in the maximum position for approximately 15 seconds, and then returns to its original position by the means of the pulley. The maximum height reached by the resistant plastic disc is 35 cm and 40 cm respectively, lower than the crest of the circular concrete basin, which does not allow fish to jump out of the pool. Thus all ichthyofauna on the plastic disc reaches upstream of the discharge sill. The efficiency of the system is complete and can operate day and night for many species of fish, salmonids included. Protection of fish is total, as there is no risk of fish injury as in case of the old fish ladders provided with concrete slots.

Inside the basin there are some sensors for ichthyofauna triggering up and down the plastic resistant disc. The spring door closes completely before resistant plastic disk reaches the maximum position, not allowing the fish to enter the basin. All components are stainless steel and the energy consumption (sources include: national network, solar energy, or batteries) is rather reasonable.

In order to obtain an upstream - downstream solution, the same sizes circular concrete basin will be built. The redirecting system is symmetrical to the first one and following the same principle (Fig. 10).

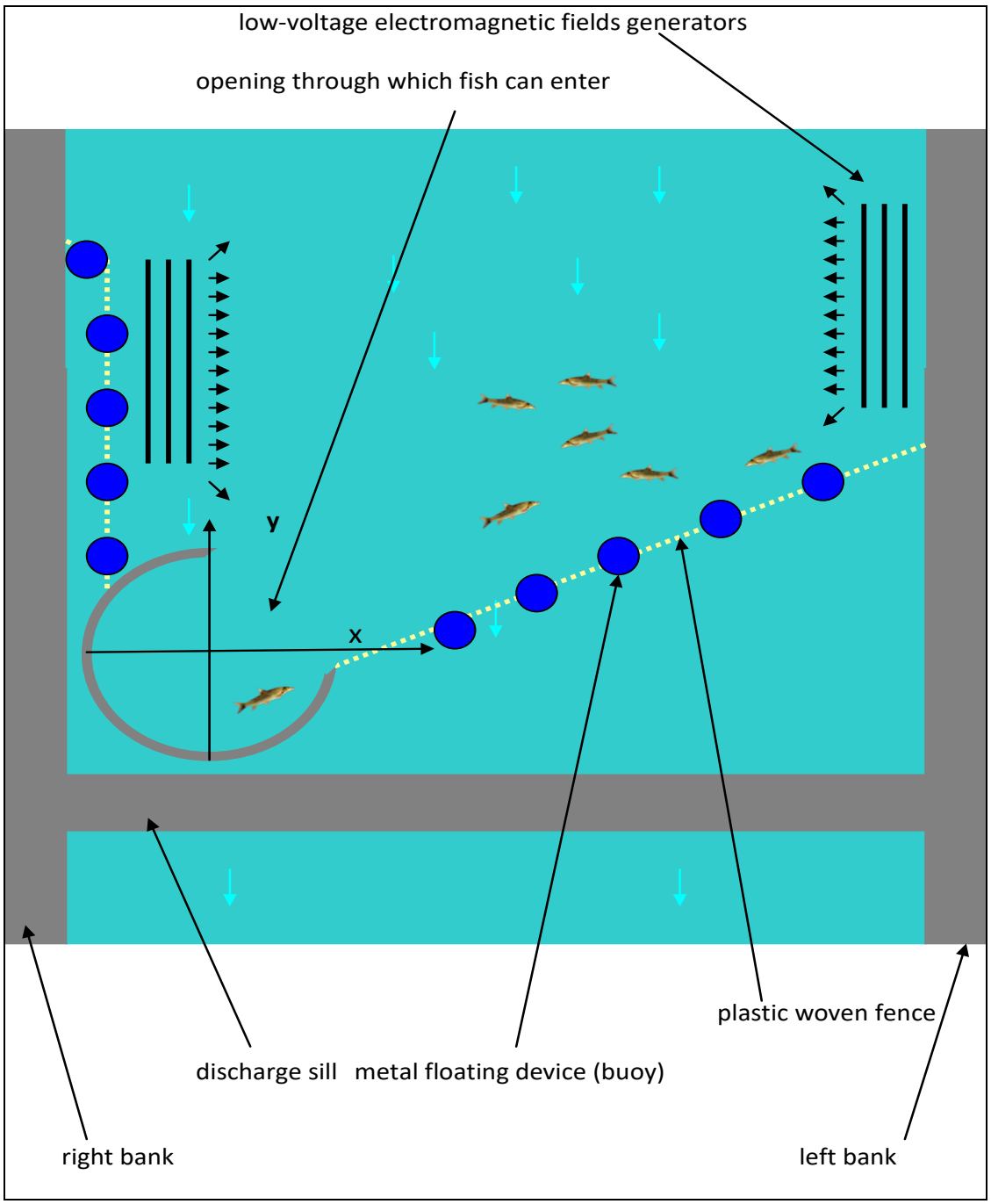

Figure 11: Positioning the circular concrete basin upstream of the discharge sill basin - indicative scheme.

The same system with durable plastic disc is to be used except that the disc is mushroom-shaped. The disc running is to be performed by the means of an electric pulley fixed to the concrete bars (Fig. 11). Resistant plastic disc will be fixed to the circular concrete basin by using the same system as the in the case of the disc on the inclined plane. In this case we do not have any metal structure.

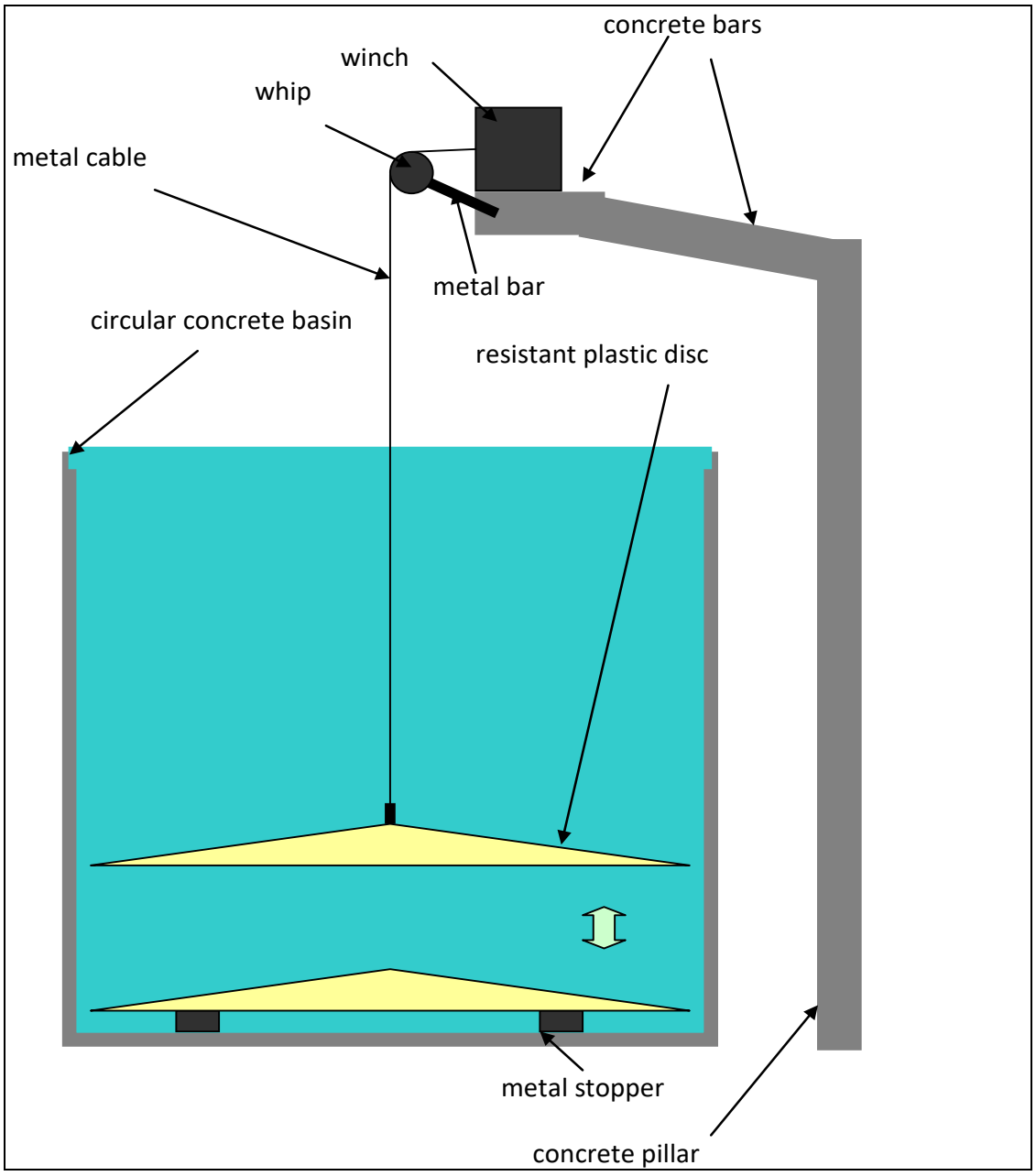

Figure 12: Positioning the winch on the concrete bar (downstream solution) basin - indicative scheme.

The distance between the mushroom-shaped disc and the circular concrete basin is one cm, enough for water to drain until the mushroom-shaped disc reaches the maximum height. When reaching the edge of the crest, on the outside surface of the circular concrete basin, a circular metal canal is set to undertake the ichthyofauna jumping over the basin (Figs. 12 and 13).

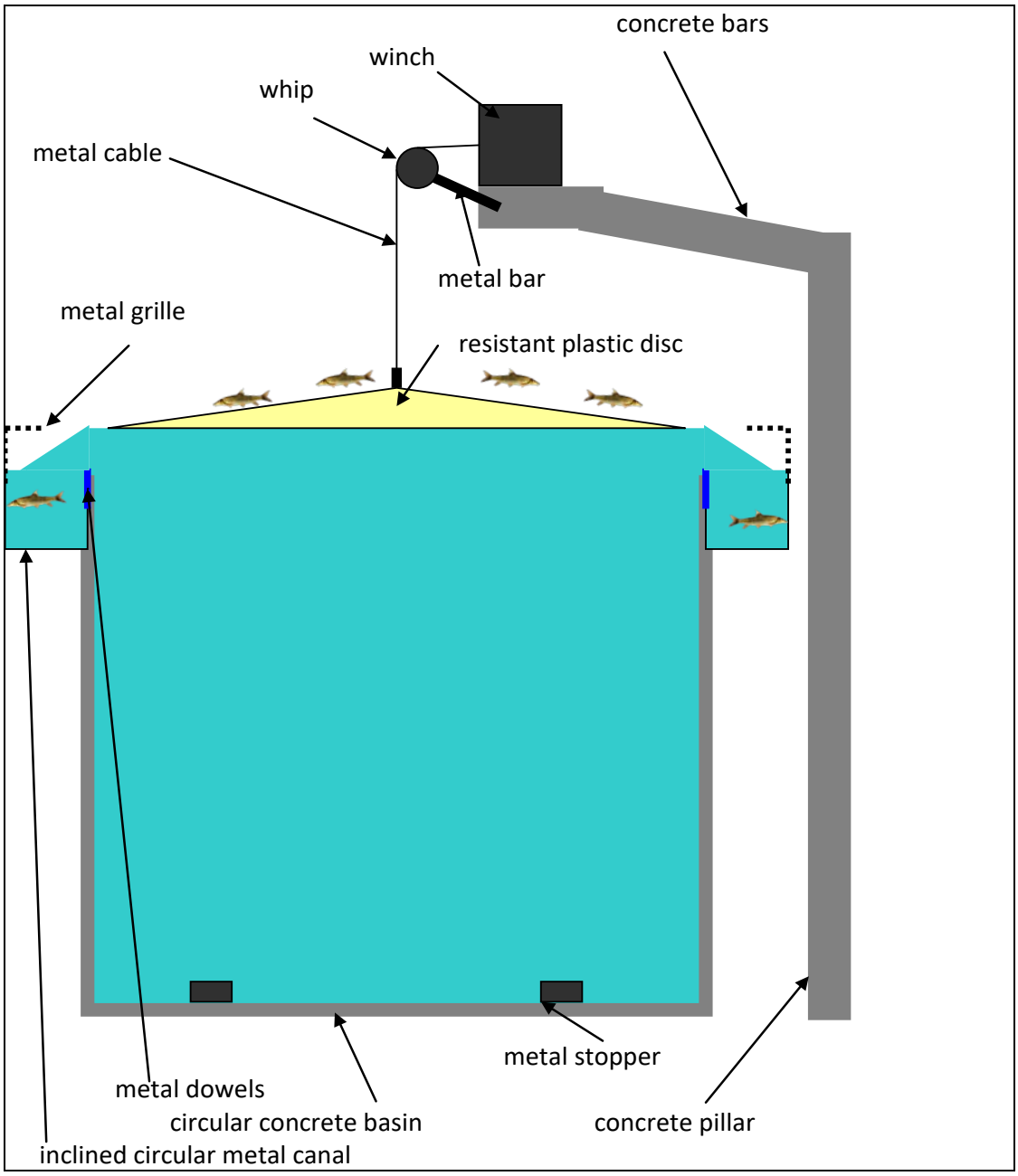

Figure 13: Positioning the circular metal canal basin - indicative scheme.

The circular canal is covered with metal lattice in the top in order to prevent the fish from jumping into the river and be captured at the same time. All ichthyofauna is undertaken by this inclined canal and passed above the discharge sill in total safety (Fig. 13 - inclined metal canal, circular concrete basin).

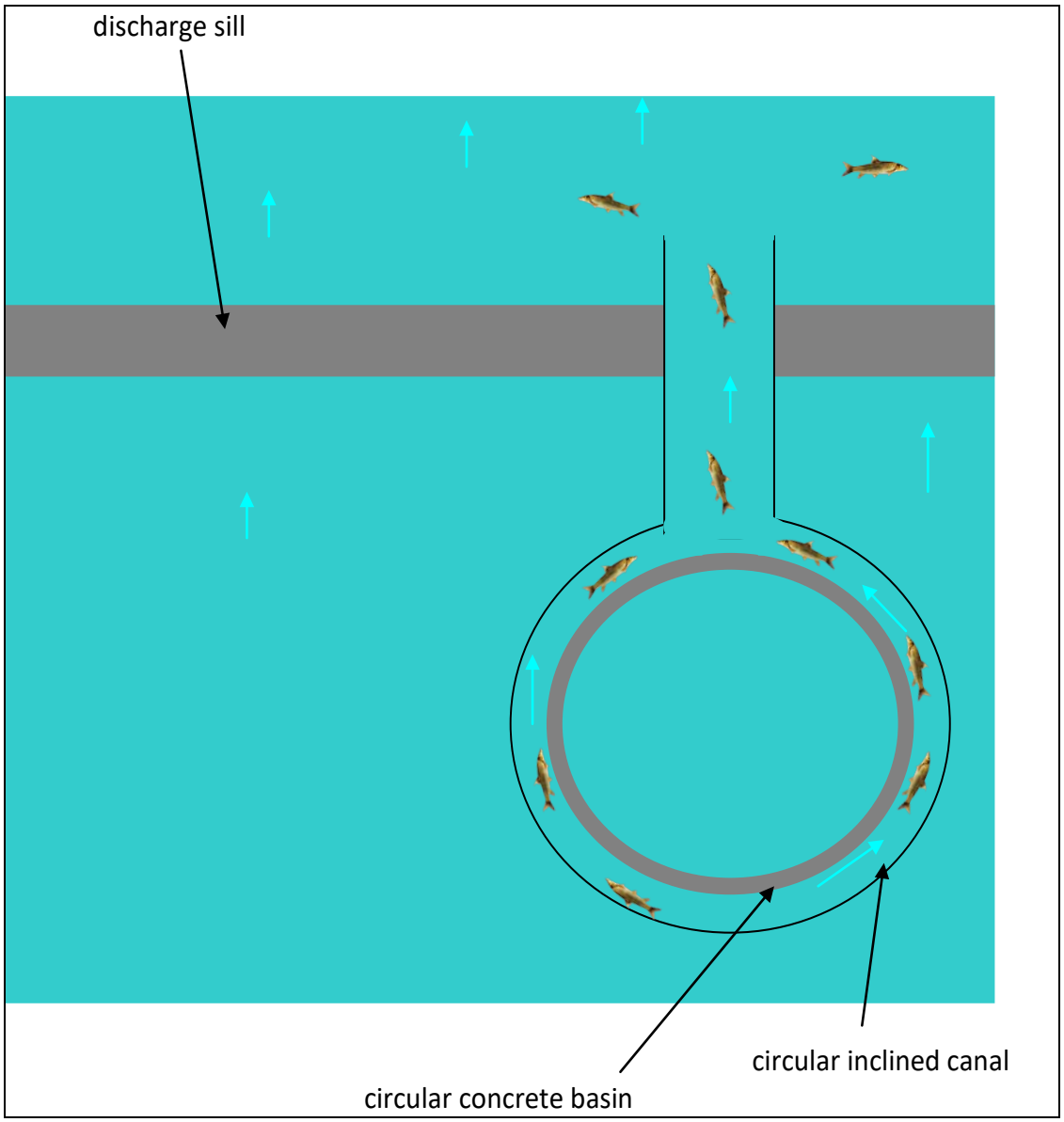

Figure 14: Positioning the circular metal canal on the circular concrete basin - indicative scheme.

This solution supports over-three-meter dams where fish do not migrate downstream as they sometimes do over some small discharge sills. This solution employs average costs.

In order for fish to climb over the second discharge sill (Fig. 14), an escalator is to be built downstream of the discharge sill and equipped with rubber steps and parapets with variable geometry (Fig. 15).

Figure 15: The second discharge sill located near Mănăştur dam.

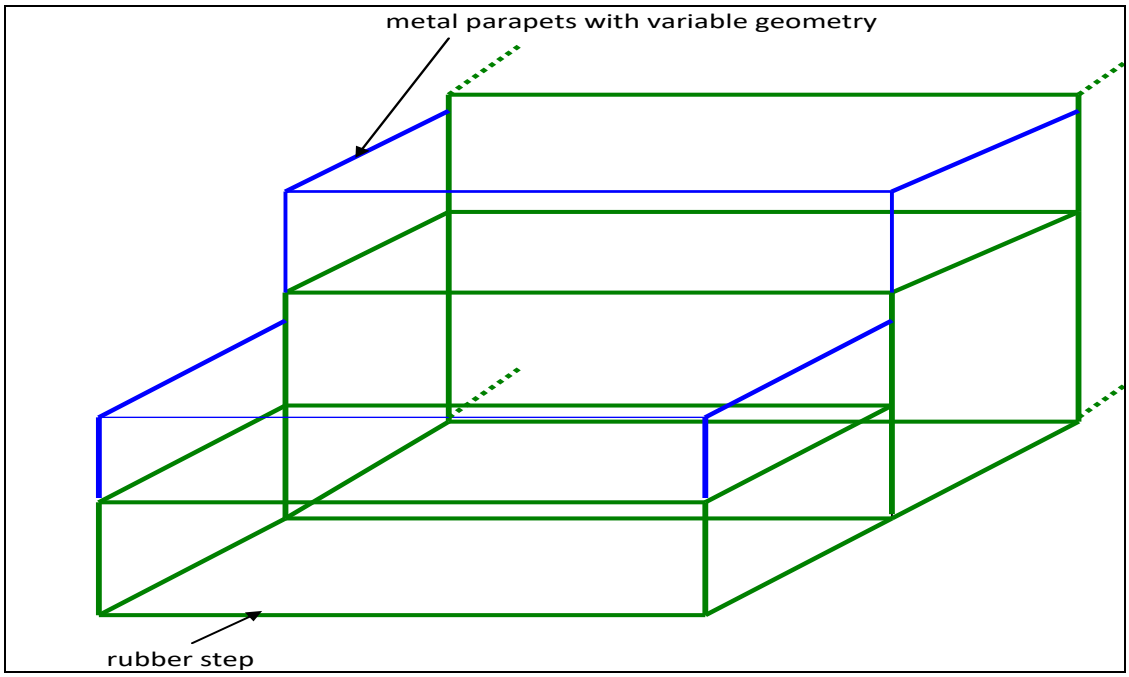

Figure 16: Escalator rubber steps and parapets with variable geometry basin - indicative scheme.

As a solution, instead of the circular concrete basin, a rectangular parallelepiped concrete basin will be built. For fish redirecting, there will be used the same system as for the previous solutions (Fig. 16).

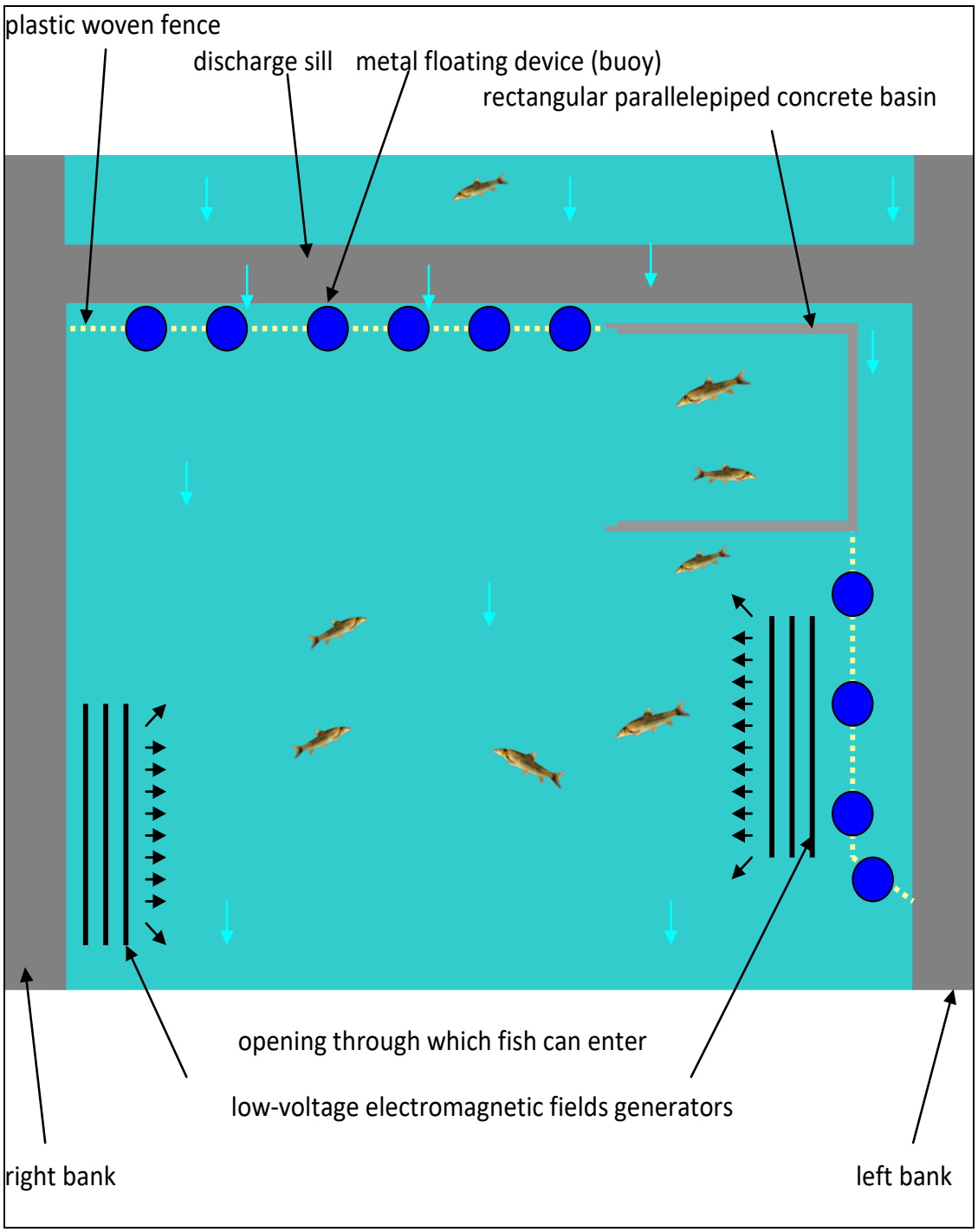

Figure 17: Positioning the rectangular parallelepiped concrete basin.

The lower horizontal side of the escalator will be under water inside the rectangular basin and its upper horizontal side will be higher than the discharge sill. The steps will transfer the entire fish fauna towards a rectangular canal and therefore directly into the water body upstream of the discharge sill (Figs. 17 and 18).

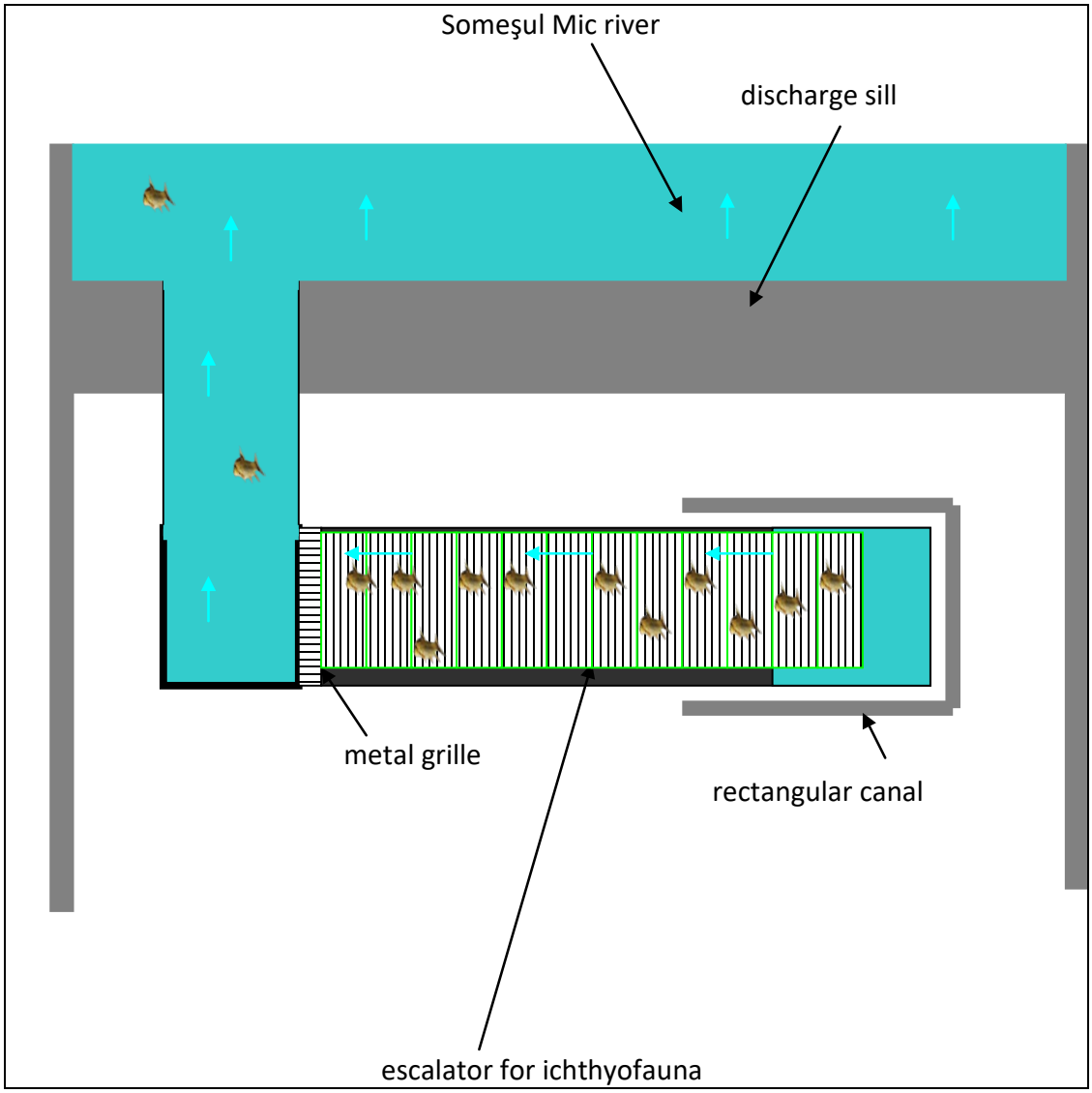

Figure 18: Positioning the escalator (horizontal plane)
- indicative scheme.

There is some two cm-metal lattice between the rectangular canal and the escalator. This escalator is lifting the ichthyofauna depending on the discharge sill height. The system is totally waterproof; costs are average but the utility is maximal.

These designs are presented as experimental systems for further testing.

In particular, we suggest testing the systems with fishes of the size and species that are found native to the area.

Fish vary in characteristics such as attraction to fishway structures, swimming velocity, and jumping ability.

It may be, for example, that the escalator design is utilized by small benthic species that would otherwise be unable to migrate over the sill.

Although the design is intended to benefit ichthyofauna, it may also serve to inoculate upstream areas with macroinvertebrate fauna, particularly those that lack an aerial dispersal stage.

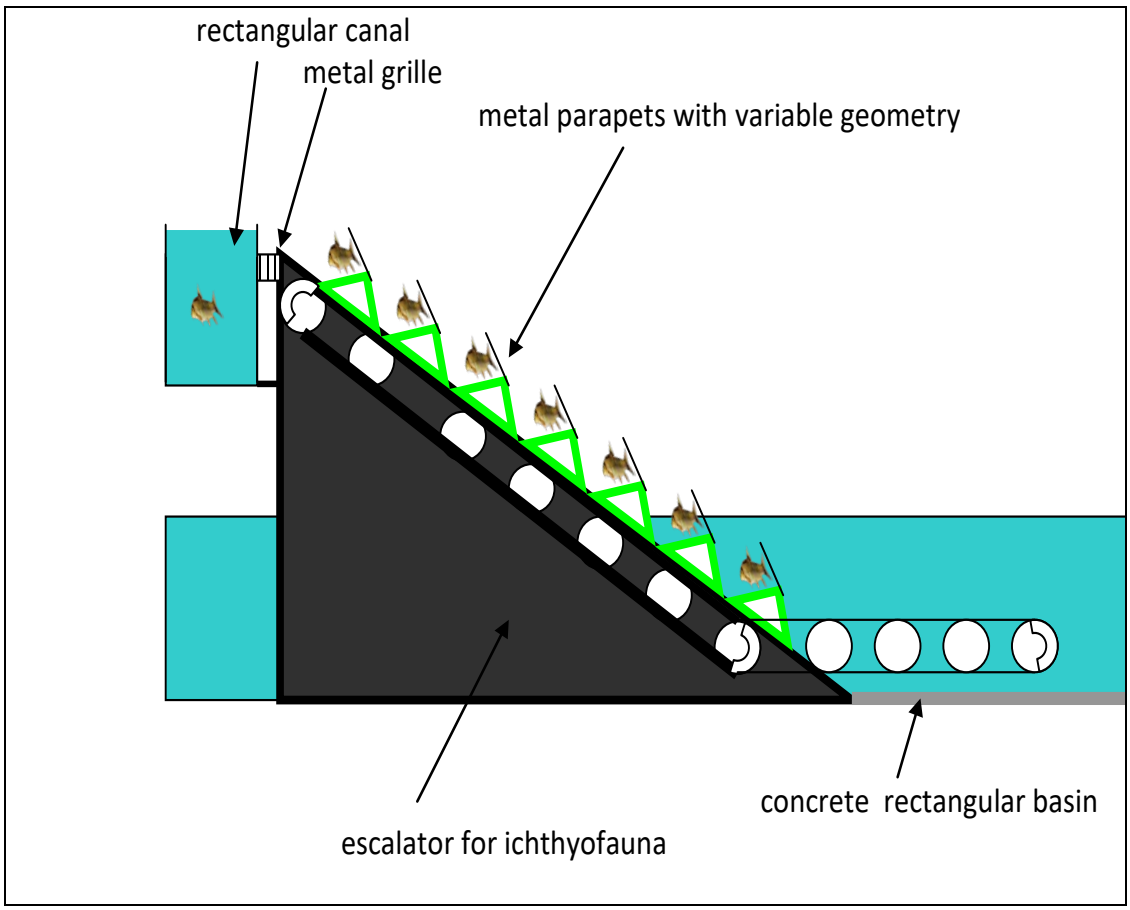

Figure 19: Positioning the escalator (inclined plane)
- indicative scheme.

This article represent a new scientific concept, a new technology for fish passage that helps a lot the fish in their migration over the discharge sills. This article represents only a design solution for building a fish passage but the results and discussions will be during construction and especially after completion.

CONCLUSIONS

This system of fish migration upstream - downstream of the discharge sills provides longitudinal connectivity of the Someșul Mic River representing an important issue in the local lotic ecosystem restoration. All system components are classic and can be made in any country that has industry.

In addition, there is no need for a hydraulics laboratory because no velocities are calculated, relying instead on gravity.

This innovative system can also be tested with salmonids.

Because there are ichthyofauna sensors the system can work alone without human intervention.

Many fish can pass over the dam, including juvenile and older because there is no need to swim against the current of the river.

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NEW PARADIGM OF CO-MANAGEMENT OF MPAS IN INDONESIA, LESSONS LEARNED FROM COREMAP

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ABSTRACT

Establishment and Co-management of Marine Protected Areas (MPAs) which are conducted by Coral Reef Rehabilitation and Management Project (COREMAP) Phase II represents a new paradigm from the top-down approach, that being the bottom-up community-based approach. The process of establishing MPAs initiated by village level has legalized by village regulations on enacting of no-take zones (NTZs). There are five steps and an 18 months period of establishment and management of NTZs. The networks of village level MPAs also is functioning as no-take area of District MPA that is managed by the District Government. With a new paradigm, collaborative management of MPAs is exemplified by COREMAP Phase II through the sharing of responsibility between central and local government as well as community, providing an unique typical feature in the management of conservation areas in Indonesia.

ZUSAMMENFASSUNG: Eine neue Herangehensweise im Co-Management Mariner Schutzgebiete (MPA) in Indonesien, Erkenntnisse aus dem Projekt zur Renaturierung von Korallenriffen.

Etablierung und Co-Management in Marinen Schutzgebieten (Marine Protected Areas/ MPAs), die im Rahmen der zweiten Phase des Korallenriff Renaturierungs- und Managementprojektes (COREMAP) angewendet wurden, stellen eine neue Herangehensweise dar, die nicht von der oberen, sondern von der unteren Ebene, den Kommunen, ausgeht. Der auf Gemeindeebene initiierte Prozess der Etablierung eines Managements von Marinen Schutzgebieten, hat durch einen kommunalen Beschluss die Einrichtung von eingriffsfreien Zonen (NTZ- no-take zones) rechtskräftig gemacht. Für Einrichtung und Management dieser Zonen gibt es einen fünf Stufenplan über einen Zeitraum von 18 Monaten. Das Netzwerk der Marinen Schutzgebiete (MPA) auf kommunaler Ebene, funktioniert ebenfalls in Form eingriffsfreier Mariner Schutzgebiete, deren Management beim Distrikt Gouvernement liegt. Mit einem neuen Paradigma wird das kollaborative Management von Marinen Schutzgebieten (MPAs) durch die Phase II des Korallenriff Renaturierungs- und Management Projekts /COREMAP beispielhaft durch die geteilte Verantwortlichkeit zwischen zentraler und lokaler Regierung sowie den Kommunen dargestellt und liefert ein einmaliges, typisches Merkmal im Management von Schutzgebieten in Indonesien.

REZUMAT: O nouă abordare în co-managementul Ariilor Marine Protejate din Indonezia, noi cunoştinţe din Proiectul de Reabilitare şi Management al Recifelor coraliere (COREMAP).

Implementarea şi co-managementul Ariilor Marine Protejate (Marine Protected Areas/MPAs), care au fost aplicate în cadrul fazei a II-a a Proiectului de Reabilitare şi Management al Recifelor Coraliere (COREMAP) prezintă o nouă abordare, care nu porneşte de la nivelul superior, ci de la cel inferior, al comunelor. Procesul de implementare a unui management al Ariilor Marine Protejate, iniţiat la nivel comunal, a legiferat printr-o decizie comunală, organizarea de Zone Fără Intervenţii (NTZ no-take zones). Pentru organizarea şi managementul acestor zone, există un plan de realizare în cinci etape pe o perioadă de 18 luni. Reţeaua Zonelor Marine Protejate (MPA) la nivel comunal funcţionează de asemenea, sub formă de zone marine fără intervenţie, responsabilitatea managementului lor fiind la nivelul guvernului districtual. Managementul colaborativ ale Zonelor Marine Protejate se exemplifică prin Faza a II-a a Proiectului de Reabilitare şi Management al Recifelor Coraliere, cu o nouă paradigmă reprezentată prin responsabilitatea împărţită între guvernul central, cel local şi prin comune, furnizând un indicator unic şi tipic în managementul de arii protejate din Indonezia.

INTRODUCTION

Indonesia is the world's largest archipelagic nation, with 17,480 islands, 95,181 km coastline, 3.1 km^2 territorial waters, and 2.7 km^2 of Exclusive Economic Zone. The coastal zone is a highly productive ecosystem that serves as an important base for the country's economic growth. Over 55% of the national fishery harvest comes from capture fisheries in coastal areas. Some of the richest areas of biodiversity are found in the coastal zone of the country, and include coral reefs, mangrove swamps, sea grass beds, lagoons, and estuaries. Indonesia's coastal zone is home to 2,500 species of mollusks, 2,000 species of crustaceans, six species of sea turtles, 30 of marine mammals, over 2,000 of fish, and extensive coral reefs.

As a part of Coral Triangle area, Indonesia has diverse and extensive coral reef with its 70 genera and 500 species of hard corals covering 32,935 km^2 or about 16.5% of the global area of coral reefs. It is considered as the second largest coral reef in the world after Great Barrier Reef in Australia. This coral reef provides a lot of benefits, including coastal protection from storm waves, food sources and habitats of biota, genetic materials for drugs, coral and sand beaches and diving areas for millions of tourists.

Although coral reefs are recognized as one of the most productive ecosystems in the world, they are very susceptible to both natural and human impacts. Coral reefs are declining in many areas due to steadily increasing threats from direct human pressures and indirect effects of global climate change. Human pressures or anthropogenic stress is much more dangerous for coral reefs because it is not only permanent but has also the tendency to increase within a period of time (Sorokin, 1993). Human stressors or anthropogenic stress in South East Asia region has the highest rate compared with other regions such as Micronesia, Polynesia, GBR Australia, Hawaii, Red Sea, East Pacific, and West Atlantic (Sorokin, 1993).

In Indonesian coral reefs in particular, there are six categories of negative anthropogenic impact that may be commonly encountered (Nontji, 2002): (1) siltation as an effect from land clearing and deforestation which resulted in land erosion and runoff; (2) pollution in the river coming from industrial waste, urban development, and agricultural waste; (3) coral and sand mining for building material; (4) dredging, filling, and coastal construction activities causing negative impact by covering the reefs with sediment; (5) destructive fishing such as blasting and use of cyanide which have been widely practiced even in remote islands or National Parks; (6) extensive development of marine tourism without proper management.

Series monitoring data showed that there was significant improvement in the condition of coral reef between 1998 and 2007. In 2007, only 6.4% of the coral reef of Indonesia was in excellent condition, while the rest 24.3% was good, 29.2% was poor, and 40.1% was damaged. In addition, in 2007 excellent coral reef has decreased to 5.5%, good 25.1%, poor 37.3%, and damaged 32.1% (Lipi, 2007).

RESULTS AND DISCUSSION

Marine Protected Area, Indonesia context

In response to the coastal and marine resources degradation, Government of Indonesia collaborates with other institutions safeguarding coral reef and its associate ecosystems through establishing Marine Protected Area (MPA), as it is believed as the best tool to manage fisheries resources in sustainable fashion. MPA is defined as a water area, which is protected and managed through zoning system, to achieve sustainable management of fish resources and its environment. In fact Indonesia has long experiences in conserving natural resources, marine resources protection program entering new paradigm since Law 31/2004 and Law 45/2009 on fisheries formalized and Government Regulation (PP) No. 60/2007 on Fisheries Resources Conservation signed. Before these policies were enacted, perspective to the conservation program was mostly focused on protection and preservation. These programs lead to conflict among communities and also of the community against government policies.

Based on the new policies, approach in the planning and management of MPA shifted from centralized to the decentralised approach in line with local autonomy. Government encouraged local government in the provincial, district and village levels to develop and manage their own MPAs. Focus of conservation program now is not only to protect marine biodiversity rather than the multipurpose MPA while empowering local community. Shifting paradigm of the conservation program in Indonesia could be revealed based on table 1.

Table 1: Shifting paradigm on MPA planning and management in Indonesia.

Aspect	Past		Present		Note(s)
	Central	Local	Central	Local	
Initiative	V	X	V	V	
Management	V	X	V	V	Open to develop co-management
Evaluation	V	X	V	V	
Biodiversity protection	YES		Yes		
Sustainable fisheries	Limited		Yes		
Sustainable tourism	Limited		Yes		
Community empowerment	Limited		Yes		
Policies	Mix terrestrial and marine		Integrated coastal and marine		MPA using own policies

According to the Law 31/2004 and Law 45/2009 and PP no. 60/2007, MPAs in Indonesia are divided into four categories namely marine national park, marine tourism park, fisheries reserve, and marine nature reserve. In addition, there are also coastal and small island parks, and coastal and small island reserves as other conservation areas category cited in the Law 27/2007 on Coastal Zone and Small Island Management.

Marine national park is the only conservation area initiated and managed by national policy, while the others could be initiated and managed by national, local government or collaboration among them. In addition, refer to the IUCN category marine national park is correspond to the category II, marine tourism park fits with category V, and marine nature reserve and fisheries reserve are matches with category IV of IUCN. Objectives, management, and main focus of each MPA category are described in table 2.

Table 2: Category of MPA in Indonesia.

Name	Objective	Management	Main focus	IUCN
Marine National Park	Science, research, education, sustainable fisheries, tourism, recreation	National	1. Biodiversity 2. Tourism 3. Fisheries	II
Marine Tourism Pak	Tourism and recreation	National/local	1. Tourism 2. Biodiversity	V
Marine Nature Reserve	To protect fisheries biodiversity and its ecosystems	National/local	Fish diversity and its ecosystem	IV
Fisheries Reserve	To protect certain species	National/local	Protection of certain species	IV

Furthermore, regarding the zoning system, all the MPA should have core zone at least 2% of total area. Zoning of the MPA consists of core zone, sustainable fisheries zone, utilization zone, and other zone. Core zone is designed to focus on biodiversity protection, while other zones are to support sustainable activities such as fisheries and or marine ecotourism. Regulations related to each zone are presented in table 3.

Table 3: Activities at each zone of MPA.

Activity/Zone	Core	Sust. fisheries	Use	Other
Research and monitoring	yes	yes	yes	yes
Education	yes	yes	yes	no
Fisheries, selected gears	no	yes	no	no
Mariculture	no	yes	no	no
Marine eco-tourism	no	yes	yes	no
Basic infrastructures development	no	yes	yes	yes

COREMAP II

Coral reef Rehabilitation and Management Project (COREMAP) is a long term commitment of the Government of Indonesia to better manage coral reef ecosystems. Started through COREMAP phase I during 1999-2003 as initiation step, COREMAP phase II as acceleration step is designed to establish a management system for coral reef resources in priority areas. It has been implemented since 2004 under Ministry of Marine Affair and Fisheries. COREMAP II aims to protect, rehabilitate, and achieve sustainable use of the Indonesian coral reefs and their associated ecosystems which, in turn, enhance the welfare of the coastal communities. Main objectives of the program are to: 1) strengthen institutional capacity to manage coral reef resources at the national and local levels; 2) preserve and rehabilitate coral reef resources by empowering community groups to actively involvement in every step of management cycle; 3) increase public awareness and knowledge of local community on the sustainable management of coral reefs.

The COREMAP II is implemented through Ministry of Marine Affairs and Fisheries and funded by the Asian Development Bank for the western part of Indonesia and by the World Bank for eastern part of Indonesia. The program covers eight provinces and 15 districts: 1) North Sumatera Province (districts of Nias, South Nias, and Central Tapanuli); 2) West Sumatera (Mentawai); 3) Riau Islands (Batam, Bintan, and Natuna); 4) South Sulawesi (Pangkep and Selayar); 5) Southeast Sulawesi (Buton and Wakatobi); 6) East Nusa Tenggara (Sikka), 7) Papua (Biak); and 8) West Papua (Raja Ampat). There are three component programs implemented which are institutional strengthening, community based and collaborative management, and public awareness and education.

In terms of institutional strengthening, COREMAP II had developed a policy and a national strategy at national and local levels, development of human resources, project management, program coordination, and legal assistance. Community-based management focused on community empowerment, community-based coral reef management, local MPA management, supports the Marine National Park development, alternative livelihoods development, and local infrastructures. In addition, component of public awareness and education supported public awareness campaign, dissemination of information and education, sea partnership, and program support of communication.

A few project out comes to date include a contribution of about 25% to the National MPAs as targeted 10 million ha by 2010 and 20 million ha by 2020, supporting the new paradigm of MPA's establishment in Indonesia as a bottom-up process. This has resulted in significant changes of perspective and awareness of the local community, which share budget and responsibilities for the success of the project activities.

Community-based and Co-Management Approach

Community-based and co-management component provides significant input to the success of the project. Local communities are encouraged to participate in the project activities since the beginning. Community facilitator and village motivator worked together with community in developing village-based MPA, well-known as marine sanctuary or Daerah Perlindungan Laut (DPL) and formalized through village regulation. In addition to the establishment of DPL, head of the village also assigned village leaders as DPL management board, who take responsibility to manage the DPL based on DPL management plan.

There are five steps in establishing the community-based marine sanctuary, starting with socialization until signation of the village ordinance. The first step is the introduction and the socialization of the need and importance conservation program, the gathering of baseline information and delivering the key information of the village which could be carried out in one-six months. After that, it is needed about two-four months to improve the community capacity through community meetings, trainings, information sharing, and cross visits, then conducting public consultations three-six months, drafting village regulation and the approval about three-six months. Finally, after approval of the village regulation, DPL management board will implement the management of DPL which needs additional six-18 months.

In order to scale up these village MPAs to the district level, project management unit and project implementing unit (PIU) assisted by district consultants (WB) and regional advisers (ADB) conduct program synchronizations. District-based MPA, in parallel, will accommodate the villages MPAs as core zones or utilization zones. In the national level, national coordinator unit (WB) or project management office (PMO) assisted by consultants support local government to have MPAs enactment through minister decree. This scaling up processes could be drawn as in figure 1.

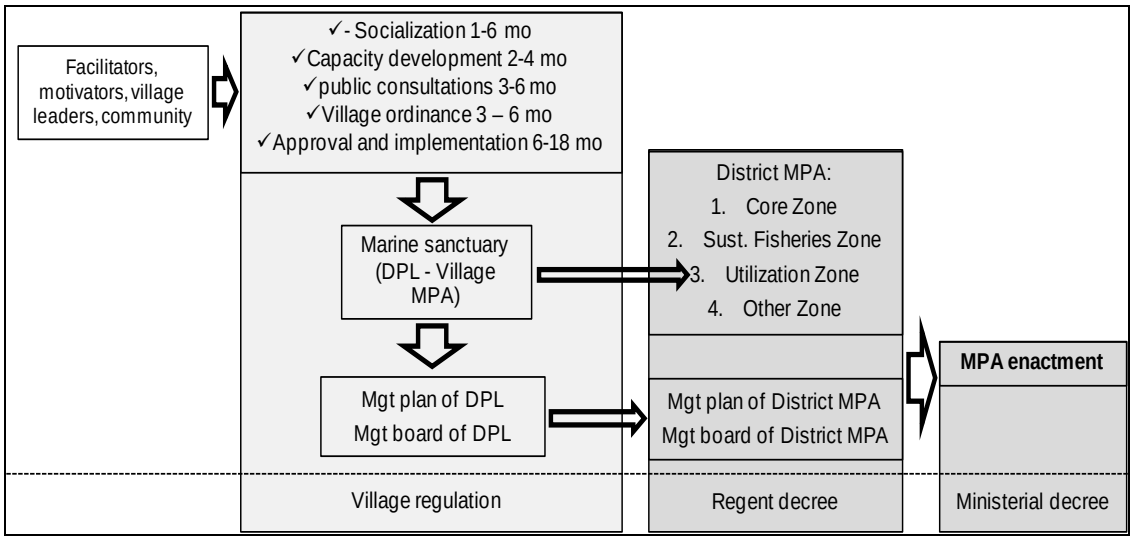

Figure 1: Scaling up village MPA and co-management process.

Challenges and lessons learned

Indonesia has a long experience in the development of community-based and co-management of the conservation areas executed by government, non-government organizations, international projects, and events by local community groups. However, through COREMAP II some challenges could be emphasized:

- difficulties in reaching agreements among communities due to different perception levels of conservation concepts and issues;
- long time needed for various meetings at different levels from grass-roots and the need for facilitation from the national/provincial level;
- lack of understanding of marine conservation issues by the local government and community leaders;
- sectoral interest in government officers makes it difficult for program integration and project coordination.

The lessons learnt from the implementation of COREMAP II are:

1. creating the public trust in community-engagement is important as early as the beginning of the program in order for the community to be well informed about the program objectives and become interested to participate in all program activities, this can shorten the duration of the MPA's establishment process;
2. generating self-enthusiasm through institutional strengthening in communities is essential in order to manage the marine conservation area autonomously even after the end of the project;
3. positioning the role of communities as a partner in all activities and to obtain their viewpoints which need to be integrated in program management;
4. local wisdoms on management of marine resources which already exist in communities are important to be appreciated and strengthened through village regulations.

CONCLUSIONS

COREMAP program in Indonesia is a unique program because of wide geographic coverage, nationally coordinated but decentralized in implementations, multi-stakeholder inclusion, direct quantifiable fisheries benefit, and sound financial management. The process required the institutional strengthening of communities as well as local governments so that MPAs can be managed sustainably.

COREMAP I and II helped build a strong basis for policies and regulations to manage national coral reef programs, in the form of Strategic Plan and Government Regulation (national and local levels). The program has significantly contributed to sustainable management and utilization of coral reefs, strengthening community awareness and income generation. Besides, COREMAP provided significant benefit in increasing public awareness and reduced rate of coral reefs degradation.

The COREMAP's contributions in the establishment of MPAs are significant for MPAs' national objectives.

The new paradigm, in line with the emerging perspective on marine issues, has strengthened the local wisdom and values of marine resource utilization, as well as increased the sense of belonging in the management of marine resources in a sustainable manner at local community level (grass-roots) and local/regional governments. Collaborative management of MPAs exemplified by COREMAP through the shared responsibility between central and local government, provides a unique perspective, typical for the management of conservation areas in Indonesia. The final objectives of the management targeted by MPAs are sustainable fisheries and community prosperities.

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BAYESIAN UPDATE FOR DESCRIPTIVE STATISTICS IN FISHERIES SCIENCE

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KEYWORDS: Bayes Theory, descriptive statistics, *Upeneus pori*, Iskenderun Bay.

ABSTRACT

In the present paper we have examined Bayesian update for descriptive statistics for a sample of 730 Por's Goatfish (*Upeneus pori*) (Ben-Tuvia and Golani, 1989), collected from Iskenderun Bay, in the northeast Mediterranean Sea. The computational approach uses the Markov Chain Monte Carlo simulation to draw samples from the posterior distributions of model parameters implementing the simulation in OpenBUGS software. We assigned the results of previous studies as a prior distribution. The posterior distribution for mean length and variance were found to be 11.1 cm and 0.003, while for weight, they were 15.7 g and 0.026. The 95% confidence limits of length and weight were 10.99-11.21 and 15.42-16.05 respectively. The key aspect of this research is that when previous studies are included in the estimation, this significantly reduces the variance and uncertainty, leading to a more sufficient and reliable estimation.

RÉSUMÉ: Mise à jour bayesienne pour le descriptif des sciences appliquées à la pêche.

Dans le présent article nous avons examine les derniers aspects de la statistique descriptive bayesienne pour un échantillon de 730 individus de l'espèce *Upeneus pori* (Ben-Tuvia and Golani, 1989) de la baie de Iskenderun, au nord-est de la Méditerranée. La simulation Monte Carlo Markov Chain a été utilisée pour ploter les distributions postérieures des paramètres qui ont été implémentés en suite dans le logiciel OpenBUGS. Les enregistrements passes ont été assignés en tant que distributions antérieures. Les distributions postérieures de la moyenne et de la variance pour la longueur ont été de 11,1 cm et 0,003, et respectivement de: 15,7 et 0,026, pour le poids. L'intervalle de confiance de 95% pour la longueur a été de 10,99-11,21 et de 15,42-16,05, respectivement, pour le poids. Un résultat-clé a été le fait que l'utilisation des études précédentes pour les estimations baisse la variance et l'incertitude. Ceci rend à son tour l'estimation suffisante et plus fiable.

REZUMAT: Aplicații ale metodei bayesiene la statistica descriptivă în pescuitul științific.

În acest articol examinăm ultimele noutăți ale metodei bayesiene pentru statistica descriptivă aplicată la un eșantion de 730 pești din specia *Upeneus pori* (Ben-Tuvia and Golani, 1989) din Golful Iskenderun în nord-estul Mediteranei. S-a utilizat simularea Monte Carlo Markov Chain pentru a extrage eșantioane din distribuțiile posterioare ale parametrilor modelului, apoi a fost implementată în programul OpenBUGS. Distribuția anterioară a fost cea a înregistrărilor precedente. Distribuțiile posterioare pentru media și pentru varianța lungimii au fost 11,1 cm și 0,003, respectiv 15,7 și 0,026 pentru greutate. Intervalul de confidență de 95% este 10.99-11.21 pentru lungime, respectiv 15.42-16.05 pentru greutate. Una din concluziile studiului a fost că includerea în estimare a studiilor precedente reduce semnificativ varianța și incertitudinea, ducând la o estimare suficientă și mai fiabilă.

INTRODUCTION

The Bayesian inference and decision making has experienced a fast growth over the last thirty years in fisheries modeling. The reason for this is that inference supplies an alternative path to analyze data that is likely to be more conducive to fisheries sciences difficulties than frequentist methods. Fisheries scientists bring together and analyze data with the aim of enhancing nature management. Hence, the analysis of data should arrive to results that are easy to understand and useful for fisheries management decisions (Ellison, 1996; Wade, 2000; Kinas and Andrade, 2007). Generally, fisheries scientists analyze their data in a classical statistical way that tests hypothesis. However, these ways may not explore what the data could possibly tell us about populations. For this reason, Bayesian inference provides an alternate way to analyze data that redresses many of the problems in the frequentist way of calculating descriptive statistics, and most importantly, allows the integration of uncertainty.

Bayesian inferences have similarities to likelihood based methods. However, in practice, they differ from likelihood by weighting the likelihood values by the prior probabilities to acquire posterior probabilities. The methods update estimates by combining the prior probabilities. This is the key difference between the frequentist way and Bayesian methods. The other difference is asking; "What is the probability in observing that for the given data the various hypotheses are true?". Bayesian asks this question in a different way. Bayesian methods are interested in the probability of the hypotheses being true given the observed data (Wade, 2000; McCarthy, 2007). Therefore Bayesian methods have two main advantages for fisheries scientists. The first one is that Bayesian inferences are easy to present and automatically include the uncertainty of the estimate and probability statements, better representing the state of a population The second one is that Bayesian theory allows unknown parameters to be included, which allows taking into account the relative consequences of making wrong decisions and the uncertainty from the significant state (Wade, 2000; Mantyniemi, 2006).

In fisheries sciences, calculation of descriptive statistics is most important. If researchers use the Bayesian way to make decisions about fish catchability size of a fish species, they might take into account prior knowledge. However, this cannot be possible in a frequentist way. Therefore, because of the Bayesian way for determining the descriptiveness of a fish species gives more details about the species, Bayesian inferences are more suitable than frequentist methods.

METHODS

What is Bayes Theory?

Bayes theory calculates probability of the value of a parameter given the observed data. The data is what is known, the value of the parameter is what is unknown, and Bayesian therefore focus on what the data tell about the parameter (Lindley, 1972; Wade, 2000; Kinas and Andrade, 2007; McCarthy, 2007). Prior distributions are combined with the information obtained from sample data and update to posterior distributions. The problem of this process is called Bayes Theorem stated by Thomas Bayes in 1764 (Lindley, 1972; DeGroot, 1989; Box and Tiao, 1992; Congdon, 2003; Lee, 2004; McCarthy, 2007; Link and Barker, 2010; Savchuk and Tsokos, 2011). The theorem which is given as follows:

$$P(\theta|y) = \frac{P(\theta)P(y|\theta)}{\int P(\theta)P(y|\theta)d\theta} \quad (1)$$

Consequently, equation (1) is often expressed as:

$$P(\theta|y) \propto P(\theta)P(y|\theta) \quad (2)$$

The symbol $\propto$ being read as "is proportional to". This also means that, for example when the data and prior have normal distributions, the posterior distribution also has a normal distribution. Here $P(\theta)$ denotes the prior of model parameters and the term $P(y|\theta)$ denotes the probability of data given the parameters.

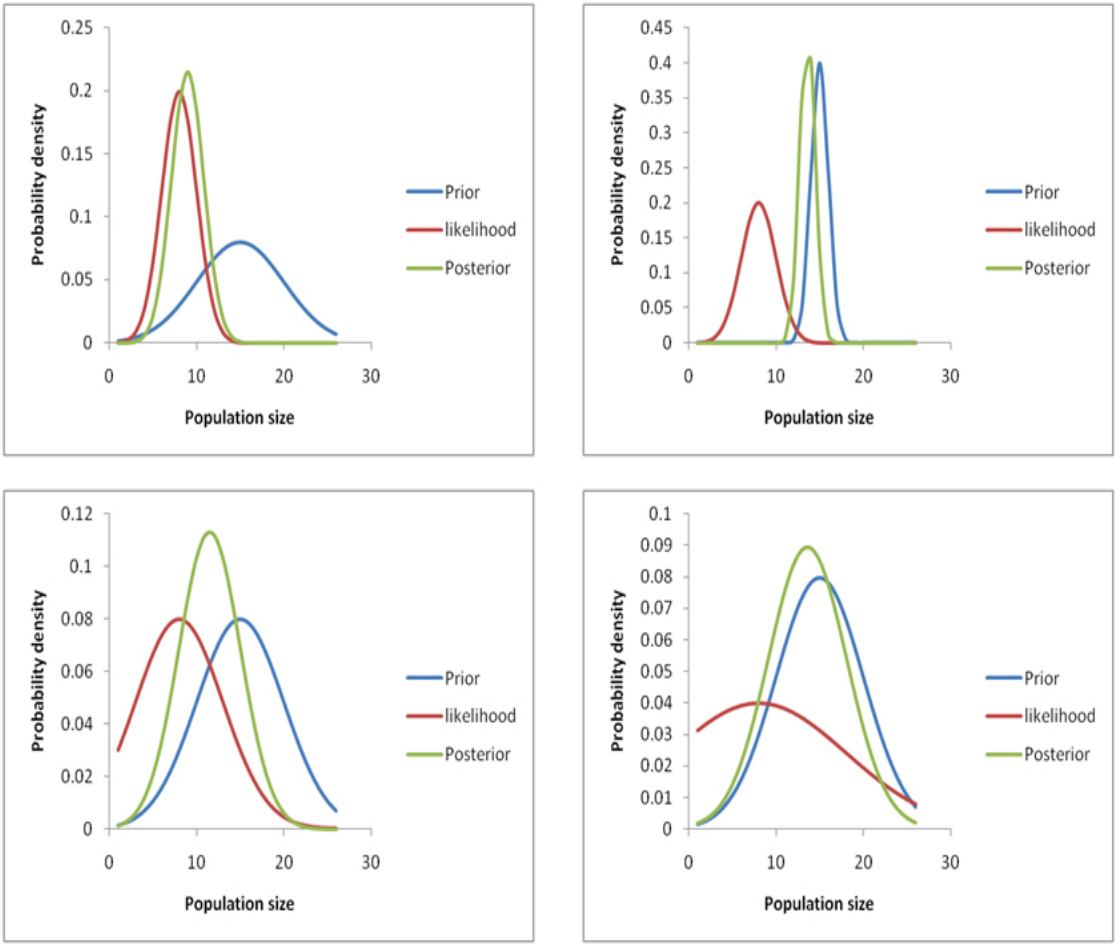

Figure 1: Effect of prior knowledge on posterior distribution (http://mantyniemi.avaruus.net).

The main idea of Bayesian inference is set at nothing for some by the essential of specifying priors for unknown parameters. The fragrance of subjectivity, connected to chosen priors is the biggest limitation of the widespread use of Bayesian inference by researchers today. Occasionally, Bayesian inference is desirable, because the prior distribution may have an effect on inference (Wade, 2000; Gelman et al., 2003; McCarhty, 2007; Millar, 2002). Prior knowledge of a parameter, for example, fish length, whether from previous knowledge or informed discretion, might be quantified in terms of a probability distribution. Additionally, we should take into account prior knowledge, which affects the posterior distribution (Fig. 1).

Presence of prior information does not remove the potential argument connected to the specification of a prior distribution. There are likely to be challengeable suppositions made concerning the comprehension and exclusion of the existing information, and in its transformation from prior into a prior distribution (Millar, 2002).

Bayesian Update for Descriptive Statistics

In this study we focus on descriptive statistics of a normal model. In the easiest case, where the data and prior both have normal distributions, Bayesian methods supply an analytical solution for the posterior. The posterior depends on the sample size, mean, and variance of the data (Gelman et al., 2003). Given σ^2, we just have normal data with a normal prior, so the posterior is normal. According to Gelman et al., (2003) and Box and Tiao (1992), analytical solution for the posterior distribution is that:

$$\vartheta_i = \frac{\frac{\theta_{0i}}{\varphi_{0i}} + \bar{x}\frac{n}{S^2}}{\frac{1}{\varphi_{0i}} + \frac{n}{S^2}} \qquad \varphi_i = \frac{\varphi_{0i}\frac{S^2}{n}}{\frac{S^2}{n} + \varphi_{0i}},\ i = 1,2 \tag{3}$$

where *n* is the size of sample, θ_{0i} is the mean of prior, φ_{0i} is the variance of prior, $\bar{x}$ is the mean of sample, S^2 is the variance of sample, ϑ_i is the mean of posterior and, φ_i is the variance of the posterior. For his study subscript *i* indicates length (= 1) and weight (= 2).

These two formulas provide useful perception into Bayesian inference. The mean of the posterior is a weighted average of the means of the prior and data. The weights are the precision of the prior ($1/\varphi_{0i}$) and the data (n/S^2). The effect of the data and prior on the posterior mean depend on which is more informative (Fig. 1). Therefore there is an approximate 95% chance that the mean of posterior plus or minus 1.96 times the standard deviation of the posterior.

Model entire OpenBUGS program is that:

```
model{
ϑ_i ~ dnorm(θ_0i, φ_0i)
stdev < −sd(y[])
prec < − 1/(stdec ∗ stdev)
for(i in 1:n){
y[i] ~ dnorm(ϑ_i, prec)
}
}
```

RESULTS AND DISCUSSION

The Bayesian method described above is applied to a real sample of 730 Por's Goatfish (*Upeneus pori*) observations. A summary of this data is provided in figure 2. The computational approach uses the Markov Chain Monte Carlo simulation (Gilks et al., 1995) to draw samples from the posterior distributions of model parameters by implementing the simulation in OpenBUGS software (Spiegelhalter et al., 2012).

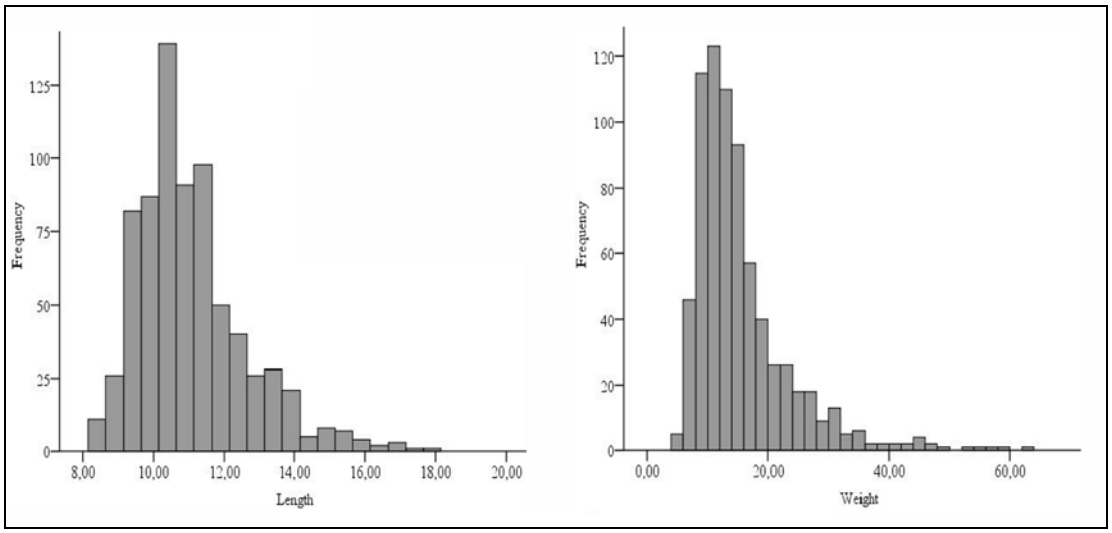

Figure 2: Summary of *Upeneus pori* sample.

Figure 2 shows histograms for total length and total weight. The total length is distributed between eight and 18 cm for the studied species. Most length spans are between nine and 12 cm. The total weight is distributed between five and 70 g. Most weight spans are between 10 and 20 g. Figure 2 shows that the empirical distribution for the lengths of the most spanned subjects (between nine and 12 cm) and for the weights of the most spanned subjects (between 10 and 20 g) are symmetric with light tails.

We assign the following prior distribution for the mean length and weight used in normal model and this information comes from various previous studies as indicated in table 1. These priors are informative, effectively saying that we have information about the model parameters.

Priors are $\vartheta_1 \sim N(11.843, 1.714)$ and $\vartheta_2 \sim N(15.815, 27.321)$.

Previous studies shown in table 1, were conducted in the same area with samples used in this study. Here we incorporate the above prior distribution for means, consistent with our belief that the point spread is approximately the mean of the length and weight, but with nonzero variance, indicating some degree of uncertainty. The marginal posterior distribution of the mean and the variance of length and weight, calculated from equation (3), displayed in table 2.

Table 2 also shows that 95% (two-side) credible mean intervals.

The observed average length and weight of the samples were 11.09 cm and 15.53 g. The posterior distribution for the mean and the variance of length is 11.1 cm and 0.003, for weight is 15.7 g and 0.0259. The 95% credible interval of length is (10.99-11.21), for weight is (15.42-16.05) and the most probable fish length is about 11.1 cm and weight is about 15.7 g (Tab. 2). The posterior distribution for the mean weight and length is also informative compared to their priors (Fig. 3).

Table 1: Previous studies which are used for prior knowledge.

Title of study	Autor(s)	Mean		N
		Length	Weight	
Growth and reproduction of Por's Goatfish (*Upeneus pori*) (Ben-Tuvia and Golani, 1989) in Iskenderun Bay, the Eastern Mediterranean	İşmen A.	13.68	-	616
Weight-length relationships for 20 Lessepsian fish species caught by bottom trawl on the coast of Iskenderun Bay (NE Mediterranean Sea, Turkey)	Ergüden et al.	11.98	18.78	210
Distribution of trace elements in the tissues of *Upeneus pori* and *Upeneus mollucensis* from the Eastern Coast of Mediterranean, Iskenderun Bay, Turkey	Dural M., Bickici E.	12.68	22.79	20
Age, growth and mortality of *Upeneus pori* (Ben-Tuvia and Golani, 1989) off the Karatas Coasts of Iskenderun Bay	Çiçek E., Avsar D.	9.83	9.74	247
Length-weight relationships for 31 teleost fishes caught by bottom trawl net in the Babadillimani Bight (NE Mediterranean, Turkey)	Çiçek et al.	10.49	11.95	1225
Evaluation of the demersal fish assemblages of the Northeastern Levant Sea	Ok M.	12.4	-	9271

Table 2: Result of Bayesian analysis.

Parameter	Mean	Std. Deviation	Monte Carlo Error	25%	Median	97.5%	Chain	
							Start	Sample
ϑ_1	11.1	0.057	0.00017	10.99	11.1	11.21	10000	100001
ϑ_2	15.7	0.161	0.00049	15.42	15.7	16.05	10000	100001

The posterior marginal probability density graphics are shown in figure 3. As we can expect, both figure 3 and table 2, show us that the median and the mean of both parameters is the same.

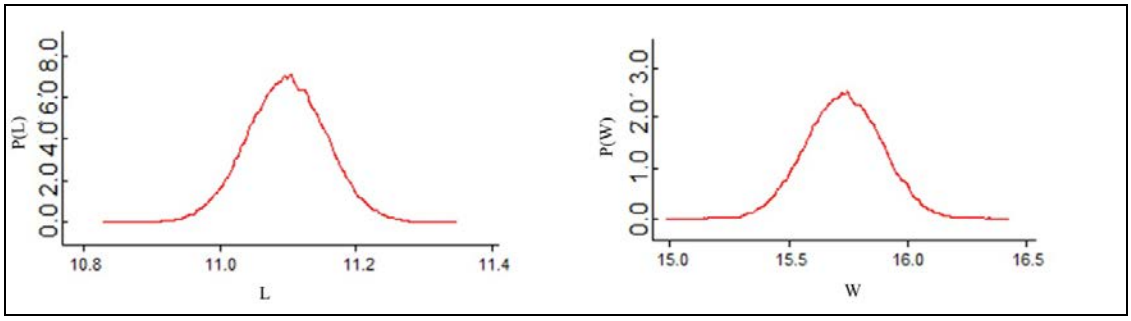

Figure 3: Probability density graph of posterior means.

CONCLUSIONS

The Bayesian model for the estimation of population was developed by Box and Tiao (1992), Gelman et al. (2003), Lee (2012) and McCarthy (2007). Here, we have taken a step further towards fisheries data. Moreover, this paper attempts to answer a simple question: "Giving my past experience and samples obtained, what should I think about the population mean and variance?" For this idea, that is based on to use the probability concept as a measure of belief, the Bayesian method, is suitable to answer this kind of question. If we compare our posterior results to distribution of length and weight sample, in this study, we should understand how to answer the question (Figs. 2 and 3). On the one hand, the frequentist methods cannot provide a quantitative answer to this question. It is well known that the frequentist approach deals only with the conditional distribution of given observations that the parameter values were known. On the other hand, according to Lee (2004), direct comparison between the result of Bayesian and Frequentist analysis is pointless. Despite the similar values, they are answers to different questions. Descriptive statistics is the most important topic in statistics. In this paper, we examined Bayesian update for descriptive statistics of a random sample with the idea explained above. Of course, our study is not suggesting a new method, however, we tried to show how to calculate descriptive statistics in a Bayesian way.

ACKNOWLEDGEMENTS

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BIODEGRADATION OF 4-CHLOROBIPHENYL BY *PSEUDOMONAS SYNXANTHA*

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KEYWORDS: 4-Chlorobiphenyl, microorganisms, biodegradation, soil.

ABSTRACT

The stabilization and disposal of polychlorinated biphenyls (PCBs) from soil environment and wetland areas is of great concern for health and safety. Wetland remediation with microorganisms is an approach for treating PCBs. A bacterial strain was isolated from hydrocarbon contaminated soil of Ropar, Punjab, able to degrade PCBs under aerobic conditions. The percentage of degradation with 100 mM/ml of 4-chlorobiphenyl was up to 90%. Degradation was monitored by mass spectrometry, high performance liquid chromatography and spectrophotometrically, showing that 4-chlorobiphenyl was degraded almost completely. The bacterial strain was identified as *Pseudomonas synxantha* by 16sRNA sequencing method. This is the first report of 4-chlorobiphenyl degradation by *Pseudomonas synxantha*.

RÉSUMÉ: La biodégradation du 4-chlorodiphényle par *Pseudomonas synxantha***.**

La stabilisation et l'élimination des diphényles polychlorés (PCB) sont une des préoccupations majeures concernant la protection des sols et des zones humides pour des raisons de sureté et de santé. La restauration des zones humides à l'aide des microorganismes est une approche récente dans le traitement de la pollution aux PCB. À Ropar, Punjab, dans des sols contaminés aux hydrocarbures, une souche bactérienne capable de dégrader le PCB dans des conditions aérobies a été identifiée. Le pourcentage de dégradation du 4-chlorodiphényle pour une concentration de 100 mM/ml a atteint 90%. La dégradation a été étudiée par spectroscopie de masse, par chromatographie liquide de haute performance et par spectrophotométrie. Les résultats de ces techniques ont montré une dégradation quasi complète du 4-chlore diphényle. Par le séquençage de l'ARN 16S, la souche bactérienne a été identifiée comme étant *Pseudomonas synxantha*. Il s'agit de la première mention de la dégradation du 4-chlorodiphényle par *Pseudomonas synxantha*.

REZUMAT: Biodegradarea 4-clorobifenilului de către *Pseudomonas synxantha*.

Stabilizarea și eliminarea bifenililor policloruraţi (PCB) este una din preocupările majore cu privire la protecția mediului pedologic și a zonelor umede din motive de siguranță și sănătate. Reabilitarea zonelor umede cu ajutorul microorganismelor este o abordare recentă în tratarea poluării cu PCB. O tulpină bacteriană capabilă să degradeze PCB în condiții aerobe a fost izolată din solul contaminat cu hidrocarburi din Ropar, Punjab. Procentul de degradare al 4-clorobifenilului la 100 mM/ml a fost de până la 90%. Degradarea a fost monitorizată prin spectroscopie de masă, cromatografie lichidă de înaltă performanță și spectrofotometrie și s-a demonstrat că 4-clorobifenilul a fost degradat aproape complet. Prin metoda secvențierii 16sARN tulpina bacteriană a fost identificată ca fiind *Pseudomonas synxantha*. Acesta este prima mențiune a degradării 4-clorobifenilului de către *Pseudomonas synxantha*.

INTRODUCTION

The stabilization and disposal of polychlorinated biphenyls (PCBs) from soil and wetland areas is very important for health and safety. Wetland improvement with microorganisms is a way to deal with PCBs. Polychlorinated Biphenyls (PCBs) are often encountered as contaminants of soil environments and wetlands areas, usually originating from electrical transformer leaks or improper disposal of wastes containing PCBs. PCBs have been used as dielectric fluids in capacitors, flame retardants, transformers, ink solvents and plasticizers. PCBs have been sold under trade names such as Clophen (Bayer, Germany), Aroclor (Monsanto, USA, Canada and UK), Phenoclor (Prodelec, France and Spain), Kanechlor (Kanegafuchi, Japan) and Sovol and Sovtol (Orgsteklo, Orgsintez, former Soviet Union). More than 1.7 million tons of PCBs were produced globally, and a substantial amount of these compounds have been discharged into the environment. PCB exposure can cause liver damage, respiratory disorders, thyroid gland disorders, muscle and joint pain, headaches, loss of appetite, nausea, vomiting and abdominal pain, chloracne (a severe, persistent acne-like rash), reproductive problems including increased spontaneous abortion rates, still births, underweight births and decreased post-natal survival, and cancer as it is a Class 2 Carcinogen (probable human carcinogen). These complications are due to traded mixtures which typically consist of 40-70 congeners. These congeners have been reported to cause serious effects on endocrine, immune, nervous and reproductive systems and cancer. The National Occupational Health and Safety Commission (NOHSC) has determined a short term exposure limit (STEL) for PCBs containing 42 % chloride up to 2 mg/m^3 and PCB's containing 54 % chloride up to 1 mg/m^3. In recent years, PCBs have been detected in aquatic systems in Central and Southern Chile.

Global reduction and withdrawal of persistent organic pollutants (POPs) discharge into the environment has been build up by the Stockholm Convention in 2001. In this context, bioremediation is an attractive technology to decontaminate affected sites. Microorganisms play a major role in the removal of these organic pollutants from the environment. The biodegradation of 4-chlorobiphenyl and its complex products were studied with *Achromobacter* sp. strain and a *Bacillus brevis* strain. *Pseudomonas* sp. strain DJ-12 was used due to genetic organization of genes responsible for the crucial steps of the catabolic degradation of 4-chlorobiphenyl. Bacterial strains can oxidize mono- and dichlorinated biphenyls to the corresponding chlorobenzoic acid and several other minor chlorinated metabolites. This study describes bacterial degradation of PCBs and analyzes the strategies to optimize bioremediation of these organic pollutants.

Bio-stimulation of the native micro-flora and bio-augmentation with selected microorganisms has been applied for the removal of PCBs from contaminated environments. PCB bioremediation, specifically in soil or sediments, is limited by a number of factors including PCB availability, incomplete catabolic breakdown, low expression of catabolic genes, and toxicity of PCBs and their metabolic intermediates).

MATERIAL AND METHODS

4-Chlorobiphenyl of analytical grade was procured from Sigma-Aldrich and used for the present study. All other chemicals used were of analytical grade. Millipore water was used for preparation of various solutions. For the isolation of potential bacterial strains able to degrade PCBs, soil was taken from the hydrocarbon contaminated area of Ropar, Punjab, India.

Instruments

The spectra were taken with UV–Vis spectrophotometer (Shimadzu 1650). HPLC analyses were performed on Shimadzu CTO- 10ASVP instrument equipped with a UV-Vis detector and C-18 column (symmetry, 4.6×150 mm). The mobile phase was acetonitrile: water (78:22 v/v). The injection volume was 20 µl, with a flow rate of one ml/min and wavelength of 254 nm.

Biodegradation Studies

Media and culture conditions

Minimal media with the following constituency were used for growth of bacterial cultures with an incubation temperature of 30°C. Minimal media used in the study contained 1.6 g disodium hydrogen phosphate, 0.2 g potassium dihydrogen orthophosphate, 1 g ammonium sulphate, 0.2 g magnesium sulphate, 0.01 g ferrous sulfate, 0.02 g calcium chloride and 0.1 g sodium chloride in 1 L of the solution.

Isolation and characterization of bacteria

Serial dilution and plating techniques were utilized for the isolation of bacteria from hydrocarbon contaminated soils. Four different isolates obtained were screened for their ability to grow on PCB. Minimal media with 100mM 4-Chlorobiphenyl as the sole source of carbon and energy were used for primary screening with growth being monitored spectrophotometrically by taking OD at 600nm at 24 h intervals. From these four strains, only the potential strain designated as M1(S) was chosen for further studies on the basis of its growth at high 4-chlorobiphenyl concentrations.

Identification of strains

The organism designated as M1(S) was identified as *Pseudomonas synxantha* by 16sRNA sequencing method. Primers used for identification of microbes in this method are 27F (5’ AGAGTTTGATCCTGGCTCAG 3’) and 1492R (5’ CAGCATTGTTCCATYGGCAT 3’).

RESULTS AND DISCUSSION

Isolation and screening of micro-organism

Four pure bacterial cultures were isolated from hydrocarbon contaminated soil sample area of Ropar, Punjab, India. Potential biodegradation studies showed that only one bacterial isolate, M1(S) was able to metabolize 4-chlorobiphenyl at 100 mM/ml concentration in minimal media. This bacterial strain was identified as *Pseudomonas synxantha* and deposited in NCBI Genebank with the accession number JQ406550.

Biodegradation experiment

The biodegradation studies were carried out with potential isolate *Pseudomonas synxantha* and the persistence of 4-chlorobiphenyl was monitored by UV-Visible Spectrophotometer, HPLC and MALDI analysis. Degradation of 4-Chlorobiphenyl was observed during different time intervals. It took about 96 h for almost 87% of mineralization (Tab. 1; Fig. 1).

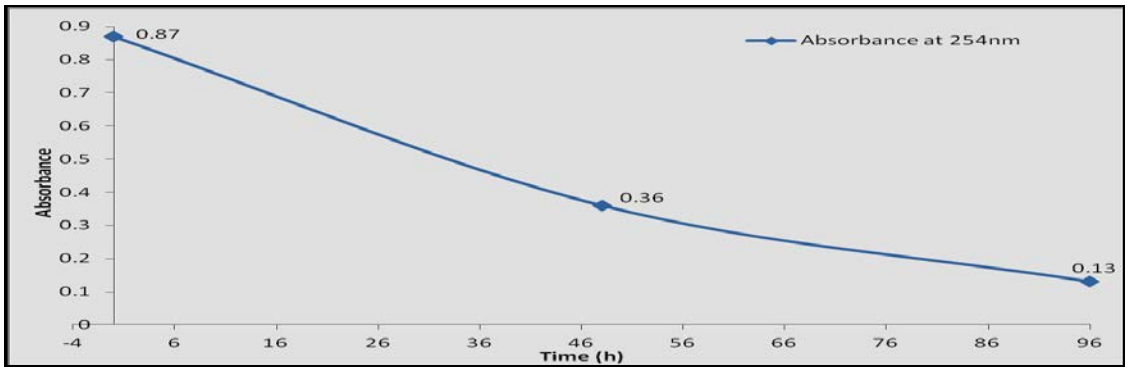

Figure 1: Percentage degradation of 4-Chlorobiphenyl with respect to time interval.

Table 1: Percent degradation of 4-CBP (100 mM/ml) by *Pseudomonas synxantha*.

Incubation period (hours)	Percentage degradation
0 h	0%
48 h	59%
96 h	87%

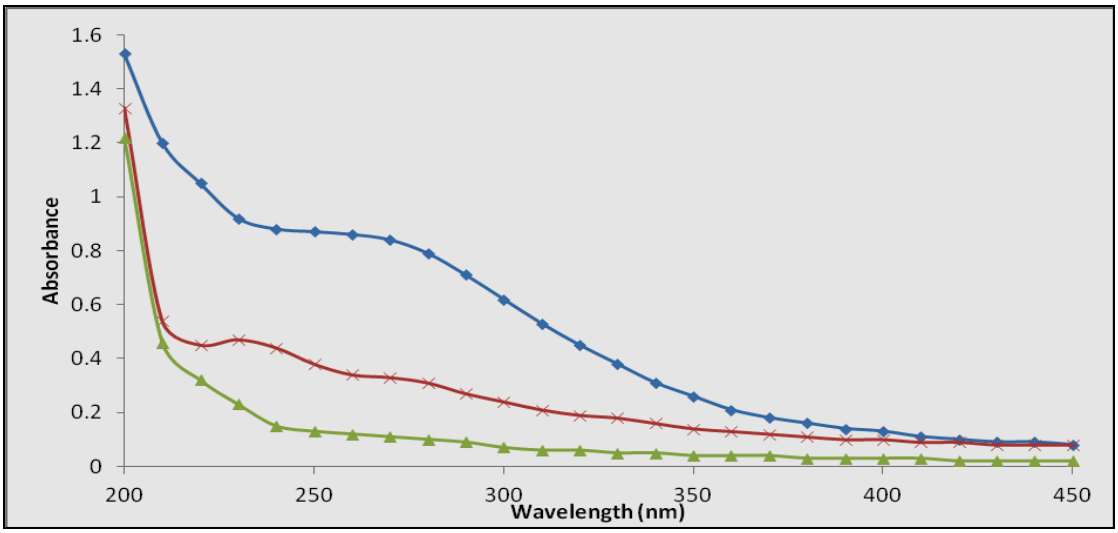

Figure 2: UV-Vis Scanning of 4-Chlorobiphenyl at 0 h, 48 h and 96 h.

UV-Vis scanning - UV-Vis scan (200-450 nm) at different time intervals showed degradation and decrease in concentration. Peak observed at 254 nm (0 h) was decreased without any shift in λ_{max} up to complete degradation of 4-Chlorobiphenyl (96 h), as clearly shown in figure 2.

HPLC analysis - The HPLC analysis of 4-CBP sample collected at the 0 h incubation showed one major peak at 5.467 min. As the biodegradation completed after 96 h, the parent compound was observed with decreased absorbance, thus concentration was observed at 5.483 min (Fig. 3).

MALDI analysis - MALDI analysis was carried out to investigate the metabolites formed during the biodegradation process. Peak at 190.059 m/z was observed in control while in degraded compound the peak at 190.059 was decreased with formation of metabolites at 211.9603 m/z (Figs. 4 and 5).

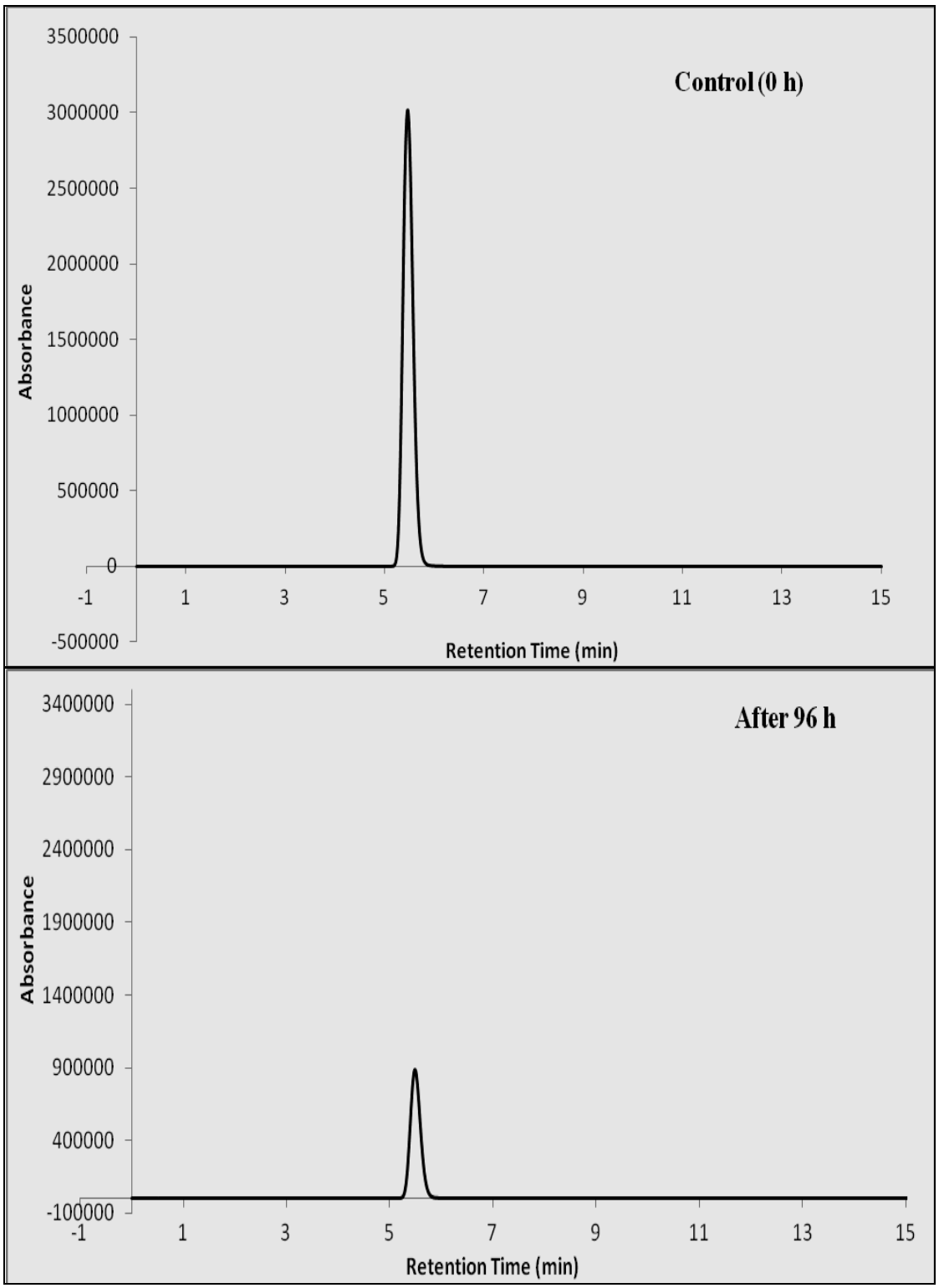

Figure 3: HPLC scan of 4CBP at 0 h (control) and after 96 h (biodegraded).

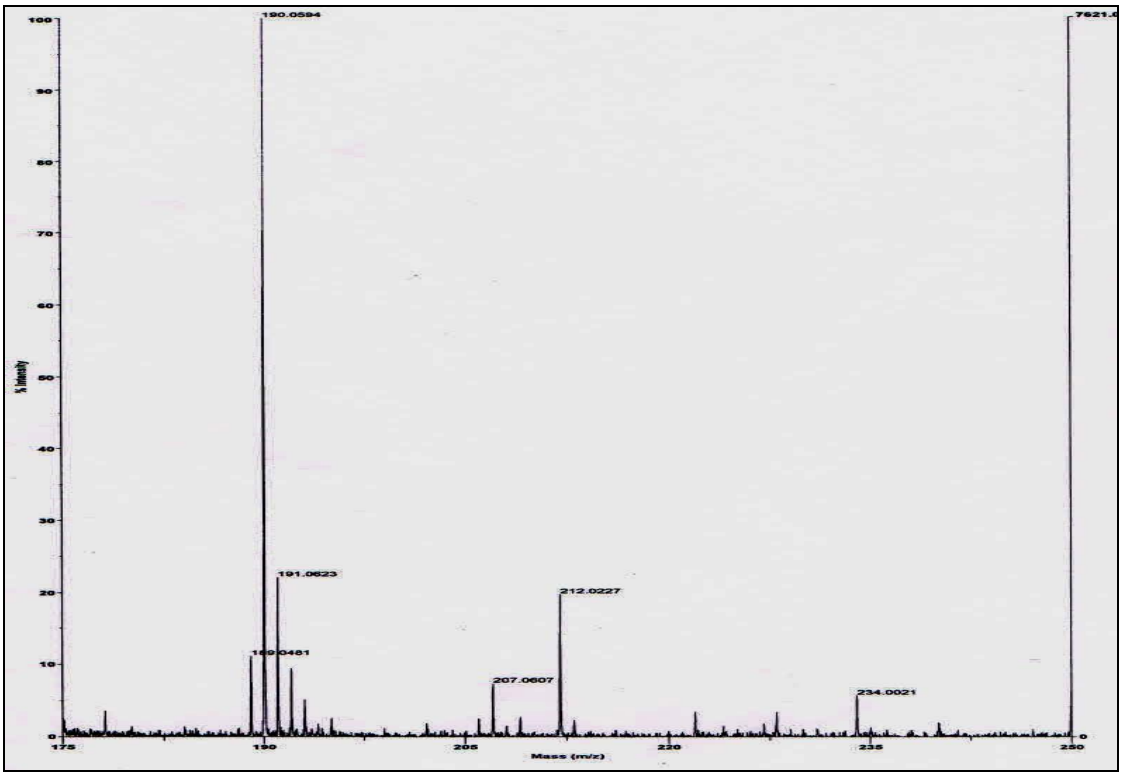

Figure 4: MALDI of 4-Chlorobiphenyl (Control).

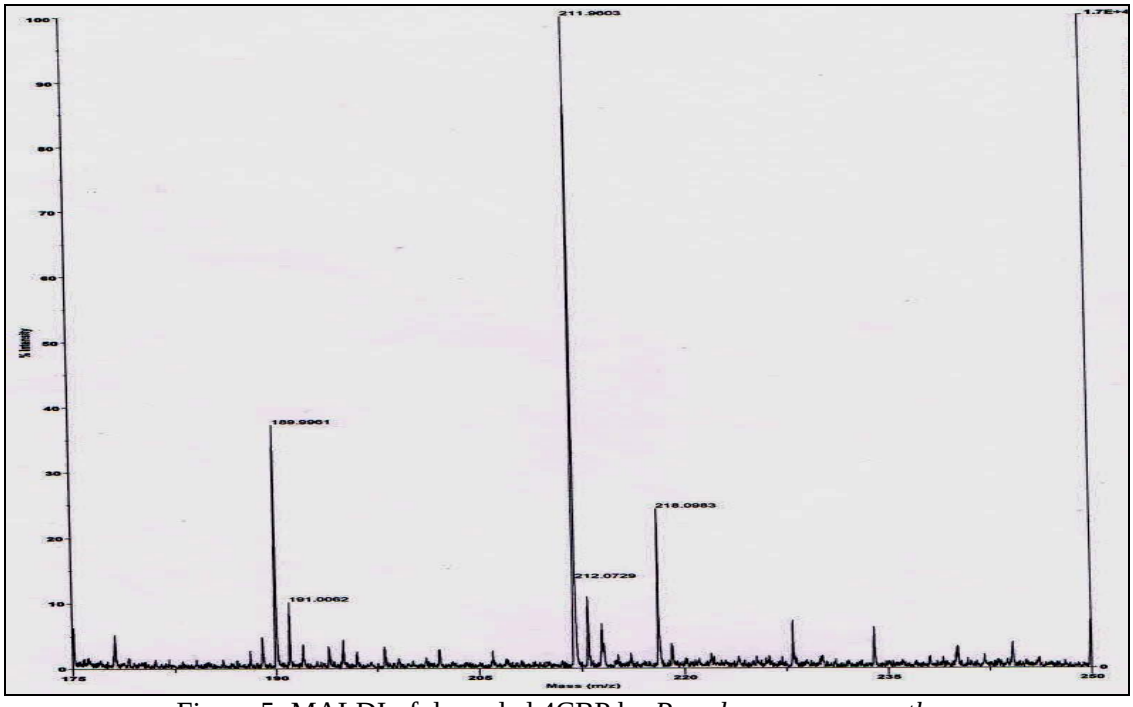

Figure 5: MALDI of degraded 4CBP by *Pseudomonas synxantha*.

CONCLUSIONS

With the help of techniques such as MALDI, HPLC, Uv-Vis spectroscopy it is clear that bacterial strain *Pseudomonas synxantha* isolate was able to degrade PCBs under aerobic conditions.

The use of the bacteria is an important and significant means to degrade contamination caused due to chlorobiphenyls. It can be used to treat this environment pollutant.

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