

DATA CONCERNING THE FISH FAUNA OF THE MOLDOVA RIVER BASED ON SURVEYS OF ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364 NATURA 2000 SITES

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Abstract: The aim of this study was to carry out an ichthyological survey on four Natura 2000 sites (ROSCI0321, ROSCI0365, ROSCI0364, ROSCI0364) which covers the most part of Moldova River and its floodplain in order to elaborate management measures for the fish species of Community interest. Between May and August 2014 we conducted ichthyological surveys on these sites and we captured fish by electro-fishing from Moldova River, its tributaries, backwaters and artificial ponds. A total of 33 fish species were detected from 65 sampling stations in the four Natura 2000 sites (and close vicinity), of which eight were species of Community interest. In every protected area we detected the presence of other fish species of Community interest that were mentioned in the Standard Data Form of the sites, and we recommended one fish species in ROSCI0321, four in ROSCI0365, two in ROSCI0363 and four in ROSCI0364 to be added to the Standard Data Forms of these sites. These proposals were accepted and the list of these Standard Data Forms was extended in 2016. We identified the main threat factors and proposed management measures in order to ensure the long-term survival of the fish species.

Keywords: fish species of Community interest, Natura 2000 site, management measures, Moldova River

Rezumat: Date privind ihtiiofauna râului Moldova obținute în timpul evaluărilor efectuate în siturile Natura 2000 ROSCI0321, ROSCI0365, ROSCI0363 și ROSCI0364. Scopul studiului a fost evaluarea ihtiiofaunei din interiorul a patru situri Natura 2000 aflate de-a lungul râului Moldova în vederea elaborării măsurilor de management pentru conservarea speciilor de pești de importanță comunitară. Evaluările de ihtiiofaună au fost efectuate în perioada mai – august 2014 folosind un aparat de electronarcoză. Au fost colectate probe din râul Moldova, afluenții acestuia, brațele moarte aflate de-a lungul râului cât și din câteva lacuri artificiale. În total au fost identificate 33 de specii de pești din cele 65 de stații de colectare aflate în interiorul și în imediata vecinătate a siturilor Natura 2000. Dintre acestea opt specii sunt de importanță comunitară. În interiorul fiecărui sit Natura 2000 am detectat și alte specii de pești Natura 2000 decât cele aflate în formularul standard al siturilor și a fost propusă introducerea acestora în formularul standard al siturilor (o specie pentru ROSCI0321, patru pentru ROSCI0365, două pentru ROSCI0363 și patru pentru ROSCI0364). Aceste propuneri au fost acceptate, astfel în 2016 lista speciilor din formularul standard al acestor situri a fost completată. Totodată am identificat factorii principali care afectează populațiile de pești și au fost propuse măsuri de management în vederea asigurării supraviețuirii lor pe termen lung.

Cuvinte cheie: specii de pești de importanță comunitară, sit Natura 2000, măsuri de management, râul Moldova

Introduction

Moldova River has a length of 205 km, drains a basin of 4326 km² and it has a maximum altitude of 1225 m at its spring in Obcina Mestecănișului and minimum 180.9 m at the confluence with Siret River near Roman (Újvári, 1972). The substrate is made up mainly of stone, gravel and sand due to the slope and relatively high speed of the water. The hydrographic basin of Moldova River is symmetrical in the mountains but becomes

asymmetrical from Gura Humorului down due to the loss of tributaries from the left side. The Moldova River receives a total of 41 main tributaries (Davideanu & Davideanu, 2004).

In the literature we find quite a lot of data about fish fauna of the Moldova River (Antipa, 1909; Bănărescu *et al.*, 1960; Bănărescu, 1964, 1969; Apetroaie, 1973, 1975; Davideanu & Davideanu, 2004, Vornicu *et al.*, 2006; Vornicu, 2009). The first data are published by Grigore Antipa (1909), but more accurate data are published in the monumental work of Bănărescu (1964, 1969). Later Apetroaie (1973) publishes data on the zonation of fish fauna from mountain region of the Moldova River. In 1975 she also published data on the spread of cyclostomes in Suceava and Moldova River basins. In 2004, Davideanu & Davideanu published data obtained from the inventories carried out on the Moldova River in 1995. Vornicu *et al.* (2006) published data on the spread of fish species in the Moldova River and later, in his doctoral thesis, Vornicu (2009) published the results of inventories carried out between 2001 and 2008.

There are four Natura 2000 sites along Moldova River designated in 2011 and based on fish species among others: ROSCI0321 (429 ha), the upper part of Moldova River situated between Breaza and Câmpulung Moldovenesc; ROSCI0365 (5303 ha), situated between Păltinoasa and Ruși; ROSCI0363 (3215 ha), between Oniceni and Mitești, and the lower part of Moldova River, the ROSCI0364 (4720 ha), which is situated between Tupilați and Roman. The last site ends before the confluence with the Siret River. Between the last site and the confluence, there is the only dam at a micro hydropower plant built in 2014 on this river, which prevents the fish to swim upwards from the Siret River. In the upper part of the River, in Câmpulung Moldovenesc, is another migration barrier (concrete threshold) close to the confluence with the Sadova River. These Natura 2000 sites cover 76% of the length of Moldova River and every site covers the lower parts of its tributaries and their floodplain on both sides of the river.

Our aim was to carry out an ichthyological survey on the four Natura 2000 sites in order to elaborate management measures for the fish species of Community interest. Therefore our questions before the survey were:

1. Are the fish species of Community interest from the Standard Data Forms present in the sites?
2. What other fish species of Community interest are present in the sites, which can be recommended to be added to the Standard Data Forms of the sites?
3. What other fish species inhabit these sites?
4. What are the main factors that threaten the fish species of Community interest and which are the most appropriate management measures for these species in order to ensure their favourable conservation status in the long term run through an efficient Management Plan?

Material and Methods

Between May and August 2014 we conducted ichthyological surveys on the ROSCI0321, ROSCI0363, ROSCI0364 and ROSC0365 Natura 2000 sites (Fig. 1). We examined all potential habitats in these sites: Moldova River, its tributaries, backwaters and artificial ponds. Fish were captured by electro-fishing (SAMUS-725MP) (Pricope *et al.*, 2004). Samples were taken from 65 sampling stations (Fig. 2, Table 1): 13 stations in and near ROSCI0321, 24 in and near ROSCI0363, 14 in and near ROSCI0364 and 14 in and near ROSC0365. The length of a station was a minimum 100 m and the fishes were

identified based on external morphological characteristics (Bănărescu, 1964; Gyurkó, 1972; Pintér, 1989, 2002). After a few minutes, fishes were recovered and released without injury at a slower section of the water bodies (Keresztessy, 2007). Sampling stations were recorded with a GARMIN GPS and all the data, observations were recorded on data sheets.

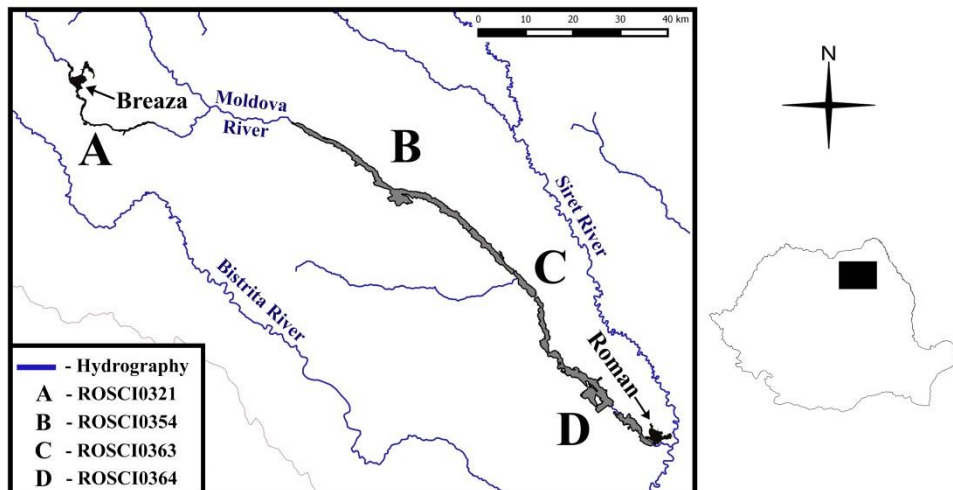


Figure 1. The study area.

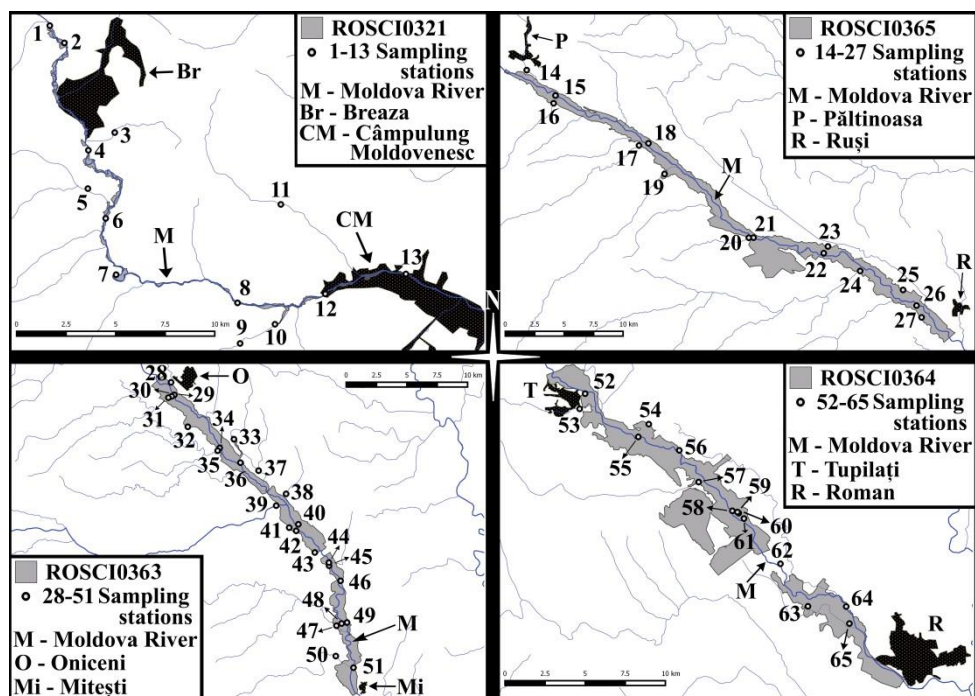


Figure 2. Location of the sampling station in the four Natura 2000 sites.

Table 1. The coordinates of the sampling stations.

Sampling station	X (Longitude)	Y (Latitude)	Sampling station	X (Longitude)	Y (Latitude)
1	25.303902	47.653911	34	26.492518	47.279265
2	25.313632	47.646063	35	26.490293	47.277308
3	25.347225	47.605325	36	26.514863	47.268129
4	25.329472	47.597379	37	26.534434	47.261963
5	25.32903	47.579975	38	26.563881	47.244374
6	25.340908	47.566456	39	26.552843	47.235822
7	25.347723	47.540904	40	26.576554	47.221672
8	25.428978	47.527853	41	26.566528	47.219316
9	25.430564	47.509458	42	26.574061	47.216856
10	25.454002	47.518071	43	26.593866	47.200575
11	25.458405	47.572377	44	26.608943	47.192867
12	25.487826	47.531703	45	26.60902	47.190564
13	25.541956	47.540483	46	26.62121	47.17922
14	25.954691	47.538728	47	26.615717	47.146057
15	25.98678	47.519102	48	26.621371	47.147597
16	25.984563	47.513188	49	26.62734	47.14826
17	26.080157	47.480158	50	26.614362	47.123585
18	26.090809	47.481719	51	26.633321	47.114721
19	26.108506	47.458184	52	26.665127	47.080887
20	26.202223	47.408587	53	26.660344	47.07244
21	26.207516	47.408622	54	26.71682	47.063055
22	26.286235	47.395942	55	26.707991	47.056036
23	26.29105	47.401009	56	26.741403	47.048025
24	26.326836	47.381864	57	26.7567	47.030003
25	26.374715	47.366874	58	26.78381	47.01348
26	26.38955	47.354779	59	26.78794	47.012724
27	26.394994	47.345691	60	26.789006	47.012091
28	26.440924	47.328553	61	26.793187	47.008997
29	26.444198	47.319171	62	26.822237	46.983195
30	26.44133	47.318159	63	26.843965	46.959028
31	26.43769	47.31724	64	26.875309	46.958376
32	26.458295	47.295398	65	26.877603	46.948816
33	26.508276	47.285577			

Results and Discussion

A total of 33 fish species were detected from the 65 sampling stations in the four Natura 2000 sites, of which eight were species of Community interest (Tables 1 and 2). If we compare our data with all the data collected from the literature (Table 3) regarding the fish species of this river, we can see that we could detect 80.5% of the fish species (33 out of 41) ever indicated from Moldova River. The lack of reliable data on either *B. petenyi* or *B. carpathicus* is present in the region made us to mark its name as *B. (meridionalis)* sp. (Kotlík *et al.*, 2002) (Table 2). The same is in the case of *Sabanejewia (aurata)* sp. (Table 2). The situation of the *Sabanejewia* genus is very unclear today. We caught specimens that are very similar to *S. balcanica* (especially in the upper part of the River, and especially in tributaries, but not only) and we caught specimens that are very similar to the *S. vallahica* (especially in the middle and lower part of the River, but not only). We caught both form in the same sampling station too. For clarifying this situation, genetic analysis must be effectuated. In the case of the Community interest species we used their old names in parentheses, the ones are mentioned in the Habitats Directive (Council Directive 92/43/EEC of 21 May 1992) for better understanding. We indicated the presence of two introduced species (*Onchorhynchus mykiss* and *Salvelinus fontinalis*) for fishing purposes, and three invasive species (*Pseudorasbora parva*, *Carassius gibelio* and *Perccottus glenii*). *Pseudorasbora parva*, which is native in Asia, was present in 21 sampling station. *Carassius gibelio* once is introduced, became invasive and gradually replaces the native *Carassius carassius* in the whole country (Gavriloaie, 2007). Probably the same scenario took place in the case of Moldova River and its floodplain, because while Bănărescu (1964) describes *Carassius carassius* as a common species in the ponds along the river, we detected its presence from one sampling station only. *Perccottus glenii* was never before indicated from this river. It is a new species for the country which is spread out in China, in the North-West of Korea, in the Amur basin and in Russia. Nalbant *et al.* (2004) collected a few juvenile specimens from the Suceava River, which may have come from Ukraine (Nalbant *et al.*, 2004). Bănărescu (1969) indicated the presence of *Lamperta planeri* from the river, but later, in 2004 after detailed examination of the only preserved specimen based on which *L. planeri* was described; Bănărescu himself indicated that the species is in fact *Eudontomyzon mariae*. During our survey we detected only larvae of *E. mariae*. Out of the eight species undetected by us but indicated in the literature, five species were indicated last time by Bănărescu (1964), which means that during the last 50 years possibly there has been different impacts which induced the disappearance of these species (Table 3), which were all indicated as very rare at the time. On the other hand these new surveys resulted two rare species (*Leucaspis delineatus*, *Tinca tinca*) and a national interest species (*Carassius carassius* – Government Emergency Ordinance No. 57/2007: Annex 4 B), which were indicated last time by Bănărescu (1964), and a species of Community interest (*Misgurnus fossilis*) which was never indicated from Moldova River and its floodplain in the literature according to our knowledge (Table 3).

Table 2. Occurrence of fish species according to different sampling stations
(* species of Community interest).

Species	Sampling stations
<i>Eudontomyzon mariae</i> *	1, 2, 4, 6, 8, 12, 13
<i>Rutilus rutilus</i>	61
<i>Scardinius erythrophthalmus</i>	33, 64
<i>Squalius cephalus</i>	14, 15, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 34, 35, 36, 38, 40, 42, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 61, 62, 63, 65
<i>Phoxinus phoxinus</i>	1, 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 28, 30, 31, 34, 35, 36, 38, 39, 40, 41, 42, 46, 47, 48, 49, 50, 52, 53
<i>Leucaspis delineatus</i>	25, 38, 30, 53
<i>Alburnus alburnus</i>	14, 18, 21, 24, 29, 35, 40, 48, 51, 55, 58, 61, 62, 65
<i>Alburnoides bipunctatus</i>	18, 21, 22, 40, 46, 48, 51, 52, 55, 58, 65
<i>Vimba vimba</i>	55
<i>Chondrostoma nasus</i>	17, 18, 19, 21, 22, 29, 34, 40, 44, 46, 47, 48, 51, 52, 55, 58, 62, 65
<i>Tinca tinca</i>	64
<i>Barbus barbus</i>	18, 21, 22, 29, 40, 46, 48, 51, 52, 58, 65
<i>Barbus (meridionalis) sp.*</i>	4, 6, 7, 13, 15, 18, 19, 20, 21, 22, 23, 24, 26, 29, 36, 37, 39, 40, 44, 46, 47, 48, 49, 50, 51, 52, 53, 55, 58, 62, 63, 65
<i>Gobio gobio</i>	14, 15, 19, 23, 24, 26, 27, 28, 29, 35, 36, 38, 39, 40, 45, 47, 49, 50, 51, 53, 55, 56, 57, 58, 59, 61, 62, 65
<i>Romanogobio (Gobio) uranoscopus*</i>	13, 15, 18, 21, 22, 26, 29, 34, 39, 40, 44, 46, 48, 50, 51, 52, 58, 63, 65
<i>Romanogobio (Gobio) kesslerii*</i>	18, 21, 22, 24, 26, 29, 40, 46, 48, 51, 52, 55, 58, 62, 65
<i>Pseudorasbora parva</i>	14, 22, 26, 27, 28, 29, 30, 34, 36, 38, 39, 40, 44, 45, 48, 49, 53, 55, 58, 59, 61
<i>Rhodeus (sericeus) amarus*</i>	28, 29, 30, 35, 36, 37, 38, 40, 47, 60, 62, 62
<i>Carassius carassius</i>	64
<i>Carassius gibelio</i>	23, 25, 27, 28, 29, 30, 33, 35, 36, 49, 54, 59, 60, 61
<i>Cyprinus carpio</i>	33
<i>Misgurnus fossilis*</i>	25, 33, 41, 42, 43, 64
<i>Cobitis (taenia) elongatoides*</i>	25, 26, 27, 30, 31, 34, 35, 37, 39, 41, 42, 44, 56, 59, 60, 61, 62
<i>Sabanejewia (aurata) sp.*</i>	13, 14, 15, 18, 19, 20, 21, 22, 24, 26, 36, 44, 29, 39, 40, 42, 45, 46, 48, 51, 52, 55, 58, 63, 65
<i>Barbatula barbatula</i>	1, 2, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 31, 34, 36, 39, 40, 41, 42, 43, 46, 48, 50, 58, 61, 62, 63
<i>Esox lucius</i>	27, 33, 43, 64, 56
<i>Thymallus thymallus</i>	1, 7
<i>Salmo trutta</i>	1, 2, 4, 5, 6, 7, 8, 9, 10, 23, 31
<i>Onchorhynchus mykiss</i>	8
<i>Cottus poecilopus</i>	2, 4, 7, 9, 10
<i>Perca fluviatilis</i>	38, 33
<i>Gymnocephalus cernuus</i>	28
<i>Perccottus glenii</i>	64
Sampling station types	
Moldova River	1, 2, 4, 6, 7, 8, 12, 13, 15, 18, 21, 22, 26, 29, 34, 40, 44, 46, 48, 51, 52, 55, 58, 62, 63, 65
Tributaries	3, 5, 9, 10, 11, 14, 16, 17, 19, 20, 23, 24, 27, 30, 31, 32, 35, 37, 38, 39, 41, 42, 43, 47, 50, 53, 57
Backwaters	25, 28, 36, 49, 54, 61, 64
Artificial ponds	33, 45, 56, 59, 60

Table 3. Species from Moldova River basin described from 1909 to date (A - Vornicu, 2009; B - Vornicu *et al.*, 2006; C - Davideanu & Davideanu, 2004; D - Vornicu & Iordache, 2004; E - Apetroaie, 1973; F - Bănărescu, 1964, 1969; G - Antipa, 1909).

Species	Current study	A	B	C	D	E	F	G
<i>Eudontomyzon mariae</i>	X					X	X	
<i>Rutilus rutilus</i>	X					X	X	
<i>Scardinius erythrophthalmus</i>	X	X						
<i>Squalus cephalus</i>	X	X	X	X	X	X	X	X
<i>Phoxinus phoxinus</i>	X	X	X	X	X	X	X	
<i>Aspius aspius</i>							X	
<i>Leucaspis delineatus</i>	X						X	
<i>Alburnus alburnus</i>	X	X	X	X		X	X	
<i>Alburnoides bipunctatus</i>	X	X	X	X		X	X	
<i>Blicca bjoerkna</i>							X	
<i>Vimba vimba</i>	X					X	X	
<i>Chondrostoma nasus</i>	X	X	X	X	X	X	X	
<i>Tinca tinca</i>	X						X	
<i>Barbus barbus</i>	X		X	X	X	X	X	X
<i>Bbarbus (meridionalis) sp.</i>	X	X	X	X		X	X	
<i>Gobio gobio</i>	X	X	X	X	X	X	X	
<i>Romanogobio (Gobio) uranoscopis</i>	X	X	X		X	X	X	
<i>Romanogobio (Gobio) kesslerii</i>	X	X			X	X	X	
<i>Pseudorasbora parva</i>	X	X	X	X				
<i>Rhodeus (sericeus) amarus</i>	X	X	X	X		X	X	
<i>Carassius carassius</i>	X						X	
<i>Carassius gibelio</i>	X	X	X		X			
<i>Cyprinus carpio</i>	X						X	
<i>Misgurnus fossilis</i>	X							
<i>Cobitis (taenia) elongatoides</i>	X	X	X			X	X	
<i>Sabanejewia (aurata) sp.</i>	X	X	X	X	X	X	X	
<i>Barbatula barbatula</i>	X	X	X	X	X	X	X	
<i>Silurus glanis</i>							X	
<i>Esox lucius</i>	X					X	X	
<i>Thymallus thymallus</i>	X	X		X		X	X	
<i>Hucho hucho</i>							X	
<i>Salvelinus fontinalis</i>	X	X		X			X	
<i>Salmo trutta</i>	X	X	X	X	X	X	X	
<i>Oncorhynchus mykiss</i>	X	X						
<i>Lota lota</i>						X	X	X
<i>Cottus gobio</i>		X		X		X	X	
<i>Cottus poecilopus</i>	X		X			X	X	
<i>Perca fluviatilis</i>	X	X					X	
<i>Gymnocephalus cernuus</i>	X			X				
<i>Zingel streber</i>							X	
<i>Perccottus glenii</i>	X							

ROSCI0321

A total of 10 fish species were detected from a total of 13 sampling stations (Fig. 3). The *E. mariae*, the only species of Community interest from the Standard Data Form of the site, was indicated by Bănărescu (1969) and Apetroaie (1973), but after that no data was provided about its presence (Table 3). Recently Bănăduc (2008) proposed the designation of Natura 2000 sites on Moldova River based on his own unpublished data from the last 5-

year period. We detected the presence of other 3 species of Community interest – *Romanogobio (Gobio) uranoscopus*, *Sabanejewia (aurata)* sp. and *Barbus (meridionalis)* sp., of which we recommended *Barbus (meridionalis)* sp. to be added to the Standard Data Form of the site. It was present in four sampling station and the lower part of the site was a suitable habitat for the species, while the other two species were present only at one station (that was located below the protected area) each in a low number, being present probably periodically in the lowest sections of Moldova River in the site. *E. mariae* and *B. (meridionalis)* sp. have both a favorable conservation status in the site. The main threat factors and the management measures proposed for ensuring the long term survival of this species are listed in Table 4.

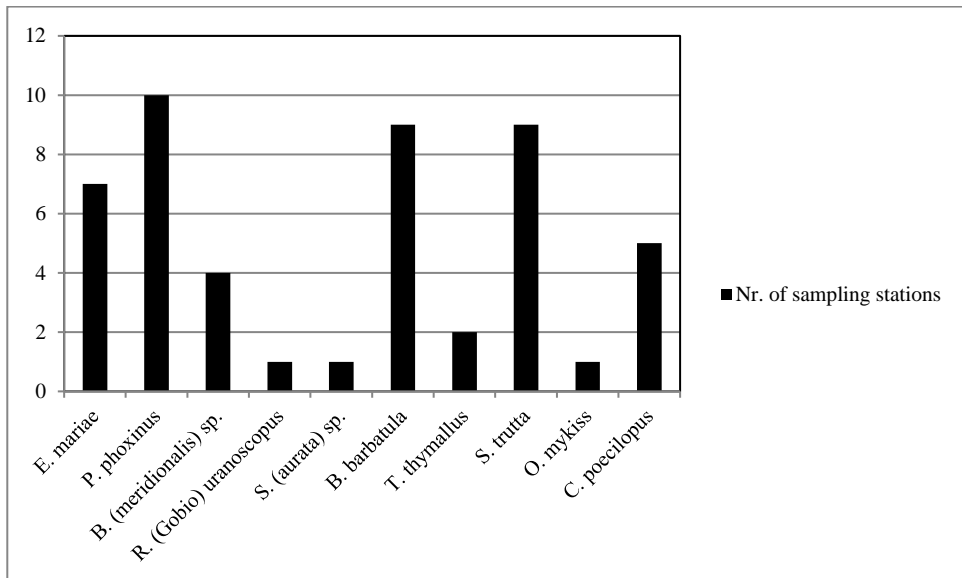


Figure 3. Occurrence of fish species in the ROSCI0321 Natura 2000 site.

ROSCI0365

A total of 19 fish species were detected from a total of 14 sampling stations (Fig. 4). The Community interest species – *Barbus (meridionalis)* sp., *Sabanejewia (aurata)* sp., from the Standard Data Form for the site were detected both from nine sampling stations and both with favourable conservation status within the site. We detected the presence of other four species of Community interest and we recommended all of them to be added to the Standard Data Form of the site: *Cobitis (taenia) elongatoides* – unfavorable-inadequate conservation status, due to its decrease of habitat and the cumulative effect of impacts and threats to the species; *Romanogobio (Gobio) uranoscopus* and *Romanogobio (Gobio) kesslerii* – both favorable conservation status, *Misgurnus fossilis* – unfavorable-bad conservation status, due to its low population size, decrease of habitat and the high cumulative effect of impacts and threats to the species. Although, *M. fossilis* was present at only one sampling station, its presence is important in order to raise awareness of the stakeholders regarding the importance of the species and its habitat. The conservation of its

habitat and other possible habitats is pivotal for this site and in general for the co-species of *M. fossilis* (Müller *et al.*, 2015). At this stage artificial propagation of this species and growth in captivity of juvenile can be a solution in order to repopulate the potential habitats (Imecs *et al.*, 2015). New habitats can also be created for this species based on its habitat requirements (Tatár *et al.*, 2015). The main threat factors and the management measures proposed for ensuring the long term survival of this species are listed in Table 4.

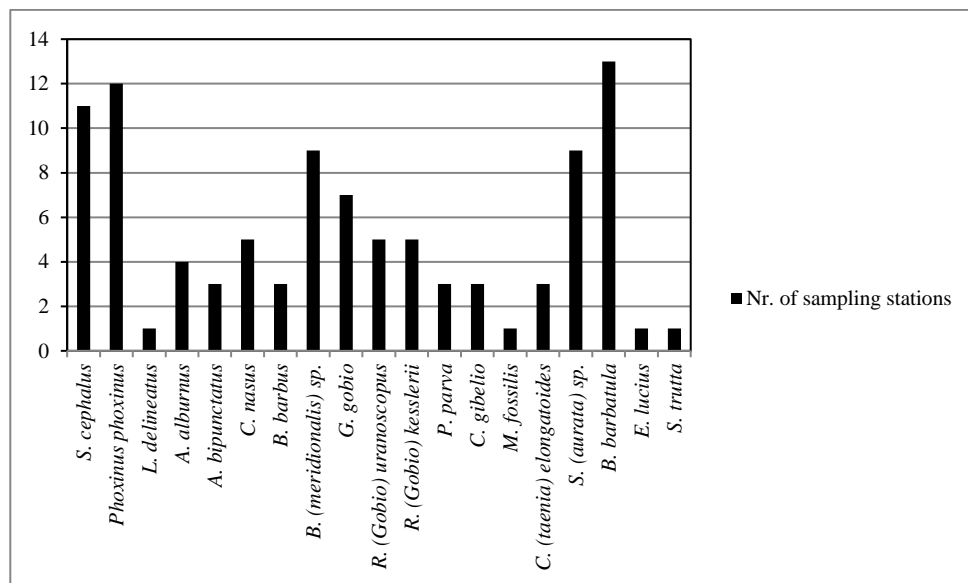


Figure 4. The occurrence of fish species in the ROSCI0365 Natura 2000 site.

ROSCI0363

A total of 24 fish species were detected from a total of 24 sampling stations (Fig. 5). The five Community interest species from the Standard Data Form of the site were all detected. Four of them had favorable conservation status – *Barbus (meridionalis) sp.*, *Romanogobio (Gobio) uranoscopus*, *Sabanejewia (aurata) sp.*, *Cobitis (taenia) elongatoides*, and *Rhodeus (sericeus) amarus* had unfavorable-inadequate conservation status, due to low population size and habitat loss (caused by sand and gravel extraction) and high cumulative effect of impacts and threats to the species. We detected the presence of other two species of Community interest – *Romanogobio (Gobio) kesslerii*, *Misgurnus fossilis*, both with favourable conservation status, and we recommended both of them to be added to the Standard Data Form of the site. The main threat factors and the management measures proposed for ensuring the long term survival of this species are listed in Table 4.

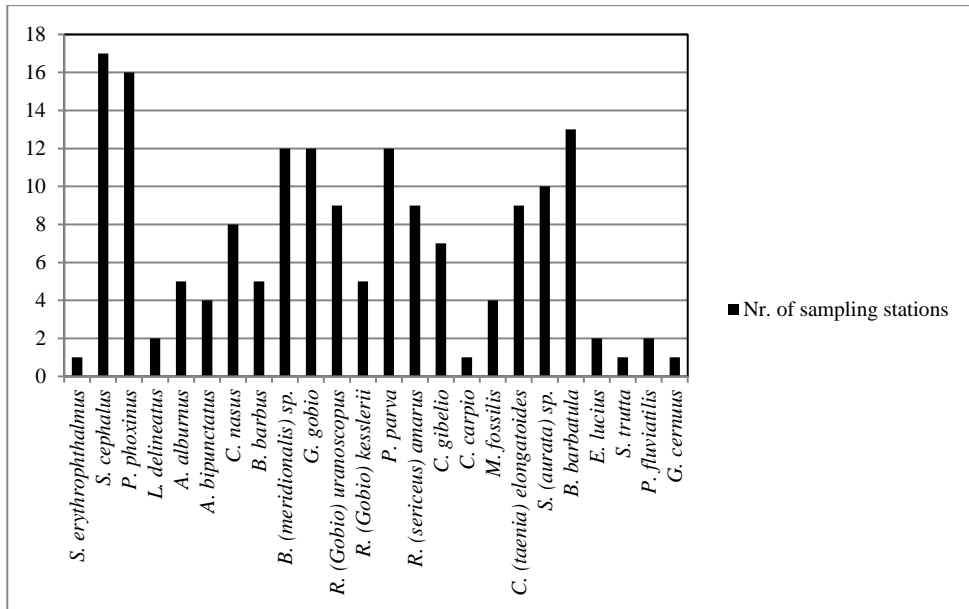


Figure 5. The occurrence of fish species in the ROSCI0363 Natura 2000 site.

ROSCI0364

A total of 25 fish species were detected from 14 sampling stations (Fig. 6). The three Community interest species from the Standard Data Form of the site were all detected. Two of them had favorable conservation status – *Barbus (meridionalis) sp.*, *Sabanejewia (aurata) sp.* and *Cobitis (taenia) elongatoides*, had unfavorable-bad conservation status, due to very low population size and increased habitat loss, which is associated with high cumulative effect of impacts and threats to the species. We detected the presence of other four species of Community interest species of which *Romanogobio (Gobio) kesslerii* and *Romanogobio (Gobio) uranoscopus* with favorable conservation status, and *Misgurnus fossilis* and *Rhodeus (sericeus) amarus* with unfavorable-bad conservation status. *R. (sericeus) amarus* had unfavorable-bad conservation status mainly because of the decrease of its habitat. Its habitat is decreased because the increasing sand and gravel extraction from Moldova River results the disappearance of *Unio* and *Anodonta* species to which *R. (sericeus) amarus* is tightly linked through its life cycle. Rigorous measures should be taken in order to stop this process, because if the *Unio* and *Anodonta* species will disappear due to the sand and gravel extraction, *R. (sericeus) amarus* will disappear with them. The status of *M. fossilis* here is similar to its status in ROSCI0365: it was present in only one sampling station and has a unfavorable-bad conservation status, due to its low population size, decrease of habitat and the high cumulative effect of impacts and threats to the species. It was present at only one sampling station along with *Tinca tinca*, *Carassius carassius* and *Perccottus glenii*. We recommended all of them to be added to the Standard Data Form of the site. The main threat factors and the management measures proposed for ensuring the long term survival of this species are listed in Table 4.

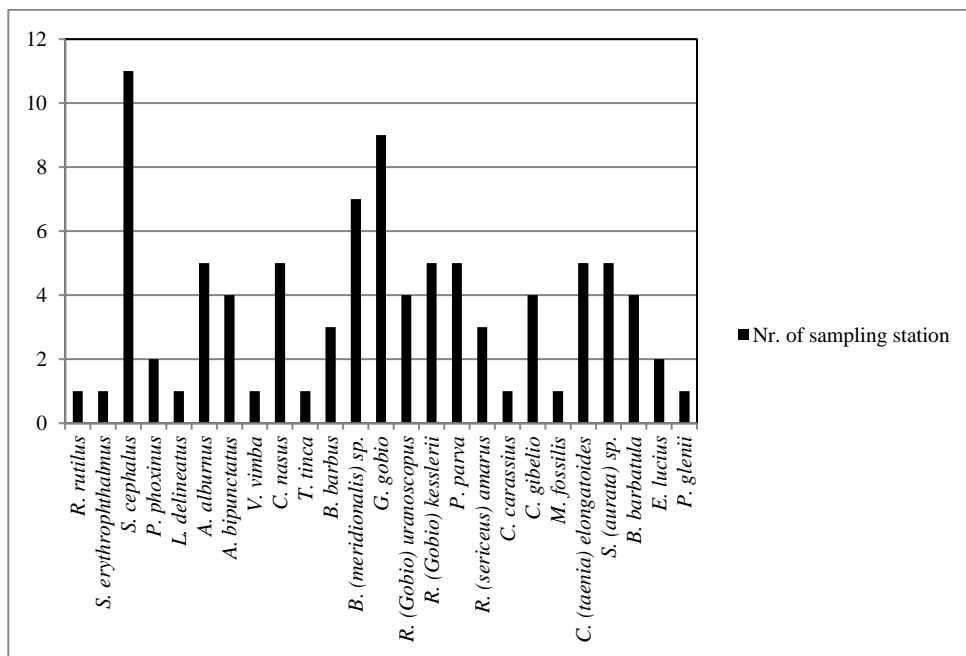


Figure 6. The occurrence of fish species in the ROSCI0364 Natura 2000 site.

Table 4. The main threat factors and management measures for the target species detected.

Species affeted	Threat factor	Management measures	Natura 2000 sites
<i>E. mariae</i> , <i>B. (meridionalis) sp.</i>	The lack of trees on the bank of the river/tributaries: causes the faster heating of the water and the decrease in dissolved oxygen level, also causes lack of the shelter places;	It is necessary planting trees (alder, willow) near river/streams to provide water surface shading. Cutting down trees from the banks of the river/tributaries should be banned.	ROSCI0321
<i>E. mariae</i> , <i>B. (meridionalis) sp.</i>	Expanding settlements along the river bank, building houses right next to them: entails the loss of floodplain, habitats, trees and the need for flood prevention works in the riverbad - barriers.	Human construction should be banned in the floodplaine, existing illegal buildings should be removed/replaced.	ROSCI0321
<i>E. mariae</i> , <i>B. (meridionalis) sp.</i>	Micro hydropower plants: loss of habitat, continuous disturbance, fragmentation.	The construction of new small hydropower plants and any work or interventions that lead to decreased debit (e. g. abstraction) or debit variations should be banned in the protected area and its vicinity.	ROSCI0321

Species affected	Threat factor	Management measures	Natura 2000 sites
<i>E. mariae</i> , <i>B. (meridionalis)</i> sp., <i>C. (taenia) elongatoides</i> , <i>M. fossilis</i> , <i>R. (Gobio) kesslerii</i> , <i>R. (Gobio) unanoscopus</i> , <i>R. (sericeus) amarus</i> , <i>S. (aurata)</i> sp.	Water pollution: settlements along the watercourses discharge wastewater into the river/stream;	The discharge of household wastes/wastewater and/or industrial in rivers/streams will be banned. Purification stations in the area to be repaired/upgraded to meet current standards. Big polluters should be eliminated.	ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364
<i>E. mariae</i> , <i>B. (meridionalis)</i> sp., <i>C. (taenia) elongatoides</i> , <i>R. (Gobio) kesslerii</i> , <i>R. (Gobio) unanoscopus</i> , <i>R. (sericeus) amarus</i> , <i>S. (aurata)</i> sp.	Exploitation of sand and gravel from the riverbed: results turbid water, fragmentation, loss of hiding, feeding and breeding habitats;	For gravel pits must be developed an integrated plan of operation (which can be implemented only on the law, regularly inspected by the custodian). It should be prohibited direct extraction of sand and gravel from the riverbed and the water can't be reintroduced in the river without proper decanting. If possible is necessary to designate "quiet areas", where extraction is banned during the implementation of the Management Plan. Areas should have minimum of 5 km length.	ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364
<i>E. mariae</i> , <i>B. (meridionalis)</i> sp., <i>C. (taenia) elongatoides</i> , <i>M. fossilis</i> , <i>R. (Gobio) kesslerii</i> , <i>R. (Gobio) unanoscopus</i> , <i>R. (sericeus) amarus</i> , <i>S. (aurata)</i> sp.	Maintenance and flood prevention: loss of hiding, feeding and breeding habitats, also causes the death of the fish specimens.	Consolidation of banks should be regulated by the custodian to prevent the homogenization of habitats. Flood prevention work must be developed without destroying banks, without concreting, without tree cutting and without construction of bottom thresholds. Maintenance should be executed only in autumn.	ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364
<i>B. (meridionalis)</i> sp., <i>S. (aurata)</i> sp., <i>R. (Gobio) kesslerii</i> , <i>R. (Gobio) unanoscopus</i>	Forest exploitation: clear-cutting results the driving of suspended solids (especially ground, mud from forest roads) in the minor river beds of streams by floods, causing death by clogging gills of fish species and also death of the eggs. Clear-cutted areas can't retain enough water during rainfall and this results also increased floods	Forest exploitation must be monitored and strictly regulated in a way that does not endanger the conservation of fish species: clear-cutting must be banned on the left and right riverside along the river/tributaries. Exploitation upstream the sites should be controlled because it has an effect on the sites fish fauna.	ROSCI0321, ROSCI0365

Species affected	Threat factor	Management measures	Natura 2000 sites
<i>B. (meridionalis) sp., Cobitis (taeanita) elongatoides, M. fossilis, R. (Gobio) kesslerii, R. (Gobio) uranoscopus, R. (sericeus) amarus, S. (aurata) sp.</i>	The presence of invasive fish species (<i>P. parva</i> , <i>C. gibelio</i> , <i>P. glenii</i>): habitat, food and reproduction competition for the protected species, which ends for the invasive species benefit.	Controlling the introduction of species in the natural and artificial habitats and prohibiting the introduction of invasive species (e.g. <i>Carassius gibelio</i> , <i>Lepomis gibbosus</i> , <i>Percottus glenii</i> , <i>Ictalurus nebulosus</i> , <i>Pseudorasbora parva</i>)	ROSCI0365, ROSCI0363, ROSCI0364
<i>B. (meridionalis) sp., C. (taeanita) elongatoides, M. fossilis, R. (Gobio) kesslerii, R. (Gobio) uranoscopus, R. (sericeus) amarus, S. (aurata) sp.</i>	Drying up: loss of hiding, feeding and most importantly the reproduction habitats.	In the case of habitats threatened with drying up must be maintained connectivity with the Moldova River or another source of water throughout the year, but especially in spring (during spawning).	ROSCI0365, ROSCI0363, ROSCI0364
<i>M. fossilis</i>	Reducing habitat connectivity due to anthropogenic impacts causes: fragmentation, population decrease and genetic isolation.	Any fragmentation in the habitat of the species that can prevent the movement of the fish should be banned. This is important especially in spring (during spawning). A separate rehabilitation measure is needed for the habitat of this species in order to conserve it. Another important measure: ensuring connectivity of its habitats with Moldova River, in order to ensure spread the larvae and juveniles during and after the spawning period.	ROSCI0365, ROSCI0363, ROSCI0364
<i>E. mariae, B. (meridionalis) sp., R. (sericeus) amarus, R. (Gobio) kesslerii, R. (Gobio) uranoscopus, S. (aurata) sp.</i>		The micro hydropower plant next to Roman needs to be equipped with a functional fish ladder, the concrete threshold from Câmpulung Moldovenesc also (it has a fish ladder, but is not functional). Other thresholds must be removed (concrete, wood) from the riverbeds; upstream and downstream migration/movement must be ensured through bypass channels and/or functional fish ladders. The construction of dams or other barriers higher than 20 cm should be banned everywhere.	ROSCI0321, ROSCI0363, ROSCI0364

Species affected	Threat factor	Management measures	Natura 2000 sites
<i>M. fossilis</i>	Transforming the habitat into a fishing lake: standing waters, if transformed into artificial lakes to serve fishermen, becomes a danger for the native species, because alien species will be introduced and the habitat characteristics will be changed.	The transforming of natural habitats into fishing lakes should be banned, all natural habitats conserved and intensive fishing should be excluded.	ROSCI0363, ROSCI0364, ROSCI0365
<i>B. (meridionalis) sp., Cobitis (taenia) elongatoides, M. fossilis, R. (Gobio) kesslerii, R. (Gobio) unanoscopus, R. (sericeus) amarus, S. (aurata)</i>	Creating new fishing lakes near the river. These anthropogenic habitats are perfect habitats for the invasive species which can escape in the natural waters.	Creating new fishing lakes near the river (closer than 500 m) should be banned. Connection with the river of the new fishing lakes (which are minimum 500 m away) is prohibited.	ROSCI0363, ROSCI0364, ROSCI0365
<i>E. mariae, B. (meridionalis) sp., C. (taenia) elongatoides, M. fossilis, R. (Gobio) kesslerii, R. (Gobio) unanoscopus, R. (sericeus) amarus, S. (aurata)</i>	Poaching: several types is practiced, even with electricity. Electricity kills not only the desired individuals, but all the organisms in the water.	Every type of poaching should be eliminated, the watercourses need to be monitored continuously.	ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364
<i>E. mariae, B. (meridionalis) sp., C. (taenia) elongatoides, M. fossilis, R. (Gobio) kesslerii, R. (Gobio) unanoscopus, R. (sericeus) amarus, S. (aurata)</i>	Storage of waste on the waterfront (especially sawdust): sawdust introduces in the water results the clogging gills of fish species and lack of oxygen.	Storage of waste and sawdust should be banned, riversides should be monitored and existing waste should be removed/replaced.	ROSCI0321, ROSCI0365, ROSCI0363, ROSCI0364

Conclusions

1. We could detect the presence of all the fish species of Community interest that were present in the Standard Data Form of the Natura 2000 sites along the River Moldova.
2. A total of 33 fish species were detected from the 65 sampling stations in the four Natura 2000 sites, of which eight were species of Community interest (Table 2; 3). In every protected area we detected the presence of other fish species of Community interest: ROSCI0321 – *Barbus (meridionalis) sp., Romanogobio (Gobio) unanoscopus, Sabanejewia (aurata) sp.* (of which we recommended only the *B. (meridionalis) sp.* to be added to the Standard Data Form of the site); ROSCI0365 – *Cobitis (taenia) elongatoides, Misgurnus*

fossilis, *Romanogobio (Gobio) kesslerii*, *Romanogobio (Gobio) uranoscopus* (we recommended all of them); ROSCI0363 – *Misgurnus fossilis* and *Romanogobio (Gobio) kesslerii* (we recommended both); ROSCI0364 – *Misgurnus fossilis*, *Rhodeus (sericeus) amarus*, *Romanogobio (Gobio) kesslerii*, *Romanogobio (Gobio) uranoscopus*. We recommended all of them to be introduced on the Standard Data Forms of the sites, and these recommendations were accepted and the list of the fish species of these sites was completed.

3. We identified the main threat factors and proposed management measures in order to ensure the long-term survival of the fish species of Community interest of the four Natura 2000 site surveyed (Table 4). These management measures once implemented, they will ensure the long-term survival of all the fish species detected. The main threat factors are the exploitation of sand and gravel, habitat fragmentation, invasive fish species, water pollution, flood protection works and the drying up of habitats. From the Community interest fish species detected the *Misgurnus fossilis* is in the greatest danger: it is present in only 6 sampling stations and its habitat is mainly isolated, exposed to human impact. The conservation of its remaining habitat and other possible habitats is inevitable and at this stage artificial propagation of this species and its rare co-species (*Carassius carassius*, *Tinca tinca*) and growth in captivity of juveniles can be a solution in order to repopulate the potential habitats and to displace the invasive species (Imecs *et al.*, 2015). Besides the ex-situ conservation measures new habitats can also be created for these species based on their habitat requirements (Tatár *et al.*, 2015).

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