

STUDY ON THE STATUS OF FISH COMMUNITIES ON TRIBUTARIES SITUATED IN THE MOUNTAIN AREA OF BISTRITA RIVER UPSTREAM RESERVOIRS

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Key words: *abundance, biodiversity, fish communities, integrity index, Bistrița River*

INTRODUCTION

The populations of fish in natural waters is the final link in the food chains structure in these ecosystems. Knowledge of their structure give us some indication of the degree to which human actions were affected by these ecosystems.

The fish fauna of the Bistrita River Basin has undergone significant changes over the past 50-60 years. This is because the middle and lower course of the river, were arranged a series of lakes and dam reservoirs, with added water pollution due to industrial development and poaching.

All this led to the extinction of species characteristic of other species minimizing the areas and the appearance of resistant species.

This study tries to highlight the status of fish communities on the Bistrita River tributaries in the area upstream of Lake Bicaz.

Thus, it can highlight the degree to which they were affected, compared with the population status of Bistrita River, upstream reservoir in Bicaz and Poiana Teiului (Stoica et al., 2013).

MATERIAL AND METHODS

The structure of fish communities was highlighted by investigations into 10 points by collecting main Bistrita River tributaries upstream of the lake in Poiana Teiului (see figure 1).

Collection of fish samples was done by electrofishing in the months from May to July (2003 and 2006) when the fish fauna is active.

According to the Water Framework Directive 2000/60/EC, from electro-fishing method is standardized at European level inventory ichthyofauna of lotic ecosystems (EN 14011:2003). This has the advantage that it does not kill the fish, as they are identified, measured and weighed in the field, after which they are released. Further processing of laboratory data by calculating

ecological indices gives us clues to the structural and functional changes on fish communities.

RESULTS AND DISCUSSIONS

In each collection point were recorded and data on the quality and condition of aquatic habitats. Table 1 presents the issues related to the surface collected, the nature of the substrate on the bottom, speed, depth and altitude, and GPS coordinates (see Table 2) for the location of collection points.

Fishing area in 10 points was between 350 and 2000 m², being optimal for highlighting real structure of fish communities. The water depth was from 0.2 to 1 m, with an average speed of 0.8 m / s typical of mountain water. The prevailing riverbed boulders, gravel and sand sometimes, being characteristic of mountain water. Maximum altitude from which samples were taken is 954 m tributary Dorna (point 1), and the minimum of 678 m on Sabasa (point 10), left tributary of the Bistrita River.

Physico-chemical water quality were determined almost all collection points given four parameters (water temperature, pH, conductivity and dissolved oxygen in water). Samples were collected in May (2003) and July (2006) at water temperatures between 13 and 16°C, the normal mountain waters.

Generally pH is normally the neutral slightly alkaline, with the exception of 4 – Neagra Șarului where the value is about 5. This is due to the acidity of waters that flow from settling tanks at the former mining Calimani fish fauna was completely destroyed.

Water conductivity has a very important role for electric fishing. It ranged between 100 and 200 μS / cm, except for the tributary Sabasa (10) where 354 μS / cm, values that ensure maximum efficiency in electrofishing.

The amount of oxygen dissolved in the water to optimum values are ecosystem the type.

Table 2. Physico-chemical water and GPS coordinates collection points

No	Parameters Sampling sites	Date	t ⁰ (°C)	pH	Cond. (μS/cm)	O ₂ (mg/l)	GPS coordinates	
							Lat. N	Long. E
1.	Dorna – downstream hydropower	2003	-	-	-	-	-	-
		2006	13,7	7,5	101	-	47° 16' 577"	25° 05' 341"
2.	Dorna – jonction Roșia	2003	-	-	-	-	-	-
		2006	15,9	7,6	199	-	47° 20' 975"	25° 20' 259"
3.	Dorna – upstream Dorna Căndreni	2003	15,0	7,5	103	5,6	-	-
		2006	16,4	7,6	159	-	47° 21' 528"	25° 11' 436"
4.	Neagra Șarului – Șarul Dornei	2003	15,2	5,03	181	5,04	-	-
5.	Barnar – upstream jonction Bistrita 3 km	2003	-	-	-	-	-	-
6.	Neagra Broștenilor – downstream hydropower	2003	14,5	7,52	130	6,05	-	-
		2006	13,2	7,6	190	-	47° 10' 803"	25° 34' 477"
7.	Neagra Broștenilor – jonction Negrișoara	2003	-	-	-	-	-	-
		2006	14,7	7,7	131	-	47° 10' 424"	25° 38' 236"
8.	Neagra Broștenilor – upstream Neagra	2006	16,5	7,5	139	-	47° 12' 262"	25° 41' 256"
9.	Borca – upstream jonction Bistrita 3 km	2006	11,4	7,3	144	-	47° 09' 706"	25° 44' 995"
10.	Săbasa – upstream jonction Bistrita 7 km	2006	16,4	7,3	354	-	47° 12' 883"	25° 56' 178"

To get a clear image of changes in the composition of fisheries associations in Table 3 presents the situation in species composition before 1960 (after P. Bănărescu 1964) and identified during our collections 2003-2006. It can be seen that the number of species increased from 10 tributaries before human impact, to 11 in our collections. In reality the situation is not very good because huchen that after Bănărescu 1964 Dorna was present tributary to the Poiana Stampei, has not been identified in our collections.

They also identified two species that were not on tributaries such as rainbow trout, trout specimens escaped from the area and common gudgeon, euribiontă resistant species that has adapted to the new habitat.

Compared to the present situation on the river Bistrita (Stoica et al. 2013), the human impact affected tributaries less fish fauna, with the exception of some areas as the right tributary of the Neagra

Șarului where fish fauna was completely destroyed due mining of Călimani.

Based on data collected in the field, absolute abundance and total biomass relative to the surface of which it was collected, we determined Stock numeric and gravimetric each collection point (see Tables 4 and 5). The stock has been relatively low number (2-3 specimens / 100 m²) in most collection points, except points 2 and 3 tributary Dorna reaching 22 specimens / 100 m². This is explained by the fact that affluent Dorna has a higher rate of other downstream tributaries and the main course of the river Bistrita influence is shown by the large number of species recorded in the two collection points (7 species).

The gravimetric stock values are 50-150 / 100 m² in most collection points less than 50 g / 100 m² points located near springs.

Both stock numeric and the gravimetric recorded value 0, collection point 4 – Neagra Șarului where fish fauna disappeared completely.

Table 3. List of fish species before 1960 (after P. Bănărescu, 1964) and current (2003-2006) of the upper basin Bistrita River tributaries

No	Species		1960 (after P. Bănărescu 1964)	2003- 2006
	Scientific name	Common name		
1	<i>Salmo fario</i> Linnaeus, 1758	Browun trout	+	+
2	<i>Rhabdofario mykiss</i> (Walbaum, 1792)	Rainbow trout	-	+
3	<i>Hucho hucho</i> (Linnaeus, 1758)	Huchen	+	-
4	<i>Thymallus thymallus</i> Linnaeus, 1758	Grayling	+	+
5	<i>Phoxinus phoxinus</i> Linnaeus, 1758	Eurasian minnow	+	+
6	<i>Cottus poecilopus</i> Heckel, 1836	Alpine bullhead	+	+
7	<i>Squalius cephalus</i> (Linnaeus, 1758)	Chub	+	+
8	<i>Alburnoides bipunctatus</i> Bloch, 1782	Schneider	+	+
9	<i>Barbus petenyi</i> Heckel, 1852	Mediterranean barbel	+	+
10	<i>Orthrias brabatulus</i> Linnaeus, 1758	Stone loach	+	+
11	<i>Gobio obtusirostris</i> Valenciennes, 1844	Common gudgeon	-	+
12	<i>Eudontomzyon danfordi</i> Regan, 1911	Carpathian lamprey	+	+
Total			10	11

Table 4. The numeric stock (specimens/100m²) in the sampling sites

No	Sampling sites	Species										Total	
		Browun trout	Rainbow trout	Grayling	Eurasian minnow	Alpine bullhead	Chub	Schneider	Mediterranean barbel	Stone loach	Common gudgeon		Carpathian lamprey
1.	Dorna – downstream hydropower	0,22	-	-	0,7	1,8	-	-	-	0,38	-	-	3,1
2.	Dorna – jonction Roşia	-	-	0,27	8,15	-	0,09	0,18	0,37	0,27	0,09	-	9,42
3.	Dorna – upstream Dorna Căndreni	-	-	0,09	16,8	0,12	0,33	3,49	-	0,1	0,27	0,16	21,4
4.	Neagra Şarului – Şarul Dornei	-	-	-	-	-	-	-	-	-	-	-	0
5.	Barnar – upstream jonction Bistrita	2,33	-	-	-	0,66	-	-	-	-	-	-	2,99
6.	Neagra Broşteni – downstr. hydropower	0,69	0,02	0,39	0,02	0,24	-	-	-	-	-	-	1,36
7.	Neagra Broşteni – jonction Negrişoara	1,29	-	0,24	-	0,02	-	-	-	-	-	-	1,55
8.	Neagra Broşteni – upstream Neagra	1,45	-	0,83	0,41	0,62	-	-	0,2	0,41	-	-	3,92
9.	Borca – upstream jonction Bistrita 3 km	1,9	-	-	-	0,23	-	-	-	-	-	-	2,13
10.	Săbasa – upstream jonction Bistrita	0,62	-	-	0,31	2,03	-	-	-	-	-	-	2,96

Table 5. The gravimetric stock (g/100m²) in the sampling sites

No	Sampling sites	Species										Total	
		Browun trout	Rainbow trout	Grayling	Eurasian minnow	Alpine bullhead	Chub	Schneider	Mediterranean barbel	Stone loach	Common gudgeon		Chişcar
1.	Dorna – downstream hydropower	6,1	-	-	3,5	9,8	-	-	-	3,15	-	-	22,6
2.	Dorna – jonction Roşia	-	-	21,6	45,1	-	0,74	1,2	4,9	1,29	1,11	-	76,0
3.	Dorna – upstream Dorna Căndreni	-	-	4,56	38,3	1,04	24,22	19,9	-	2,5	3,44	1,0	95,0
4.	Neagra Şarului – Şarul Dornei	-	-	-	-	-	-	-	-	-	-	-	0
5.	Barnar – upstream jonction Bistrita	13,3	-	-	-	6,33	-	-	-	-	-	-	19,6
6.	Neagra Broşteni – downstr hydropowr	26,9	1,55	18,3	0,22	3,77	-	-	-	-	-	-	50,81
7.	Neagra Broştenilor – jonct. Negrişoara	44,5	-	53,8	-	0,67	-	-	-	-	-	-	99,06
8.	Neagra Broştenilor – upstream Neagra	85,8	-	64,7	1,87	2,5	-	-	4,58	4,37	-	-	164
9.	Borca – upstream jonction Bistrita	113	-	-	-	11,4	-	-	-	-	-	-	124,5
10.	Săbasa – upstream jonction Bistrita	31,7	-	-	2,81	33,4	-	-	-	-	-	-	67,95

Table 6 presents the values of biodiversity index (H') calculated at each collection point. This index gives us information on the degree of balance regarding the ratio of the number of specimens in each species that enter into the structure of fish communities. The index is maximum for all the species of fish or composition are represented equally in the number of specimens. Rule, the maximum was recorded at the point of collection of most species present, as in point 8 on Neagra Brostenilor upstream shedding in Bistrita River (1,615).

The most points the index has a value between from 0.6 to 0.8, indicating the presence of relatively balanced fish community. In a single point of collection was recorded value 0 (4. Neagra Şarului) where fish fauna was completely destroyed.

By calculating ecological indices constant (C), dominance (D) and ecological significance index (W) has revealed the structure of fishery associations present on the Bistrita River tributaries in the area upstream of Lake Bicaz (see Table 7).

Table 6. Biodiversity sampling sites on the Bistrita River tributaries in the upper basin

No	Sampling sites	Number of species	H' (2003-2006)
1.	Dorna – downstream hydropower	4	0,834
2.	Dorna – jonction Roşia	4	0,664
3.	Dorna – upstream Dorna Căndreni	5	0,866
4.	Neagra Şarului – Şarul Dornei	0	0
5.	Barnar – upstream jonction Bistrita 3 km	4	0,529
6.	Neagra Broştenilor – downstream hydropower	2	0,639
7.	Neagra Broştenilor – jonction Negrişoara	2	0,632
8.	Neagra Broştenilor – upstream Neagra	6	1,615
9.	Borca – upstream jonction Bistrita 3 km	2	0,348
10.	Săbasa – upstream jonction Bistrita 7 km	3	0,824

Table 7. The structure of fish communities on tributaries mountain basin of the Bistrita River

I. The trout zone			II. The grayling zone		
Type	Species	W	Type	Species	W
I	Brown trout	39	I	Eurasian minnow	68,08
II	Alpine bullhead	16,38	II	Grayling	11,6
III	Eurasian minnow	8,28		Alpine bullhead	10,4
IV	Grayling	3,03	IV	Schneider	2,94
V	a	Stone loach		Stone loach	2,41
		Chub		Chub	0,46
	b	Common gudgeon	V	Common gudgeon	0,48
				Brown trout	0,27

I – leading species ($W > 20$); II – characteristic species ($20 > W > 10$); III – complementary species ($10 > W > 5$); IV – associated species ($5 > W > 1$); V – accidental species ($1,0 > W > 0,1$) ($W < 0,1$)

In the trout zone the brown trout is leading species, with which appear as characteristic species and complementary alpine bullhead and grayling. Appear as associated species and accidental chub and common gudgeon, euribionte resistant species that were not encountered in this area.

In the grayling zone, eurasian minnow species is the leading, grayling appears as characteristic species, instead dominated by biomass. Brown trout, a species that was once characteristic area reached accidental species level. Also, as in the trout zone appear euribionte resistant species (chub and common gudgeon) at accidental species.

In Figure 2 it can be observed fisheries zone of Bistrita River tributaries in the upper basin. Before 1960 (after P. Bănărescu 1964) Bistrita River tributaries upstream of Lake Bicaz, were represented by the trout zone. Only the affluent Dorna representative downstream Poiana Stampei was the grayling zone, and was dominant to all brown trout streams.

Currently, it retains the old zoning fish tributaries, except where Șarului Black tributary fish fauna was completely destroyed due to polluted water flowing into the river from the former mining of Călimani. Unlike the main course of the river, where zoning fisheries have changed radically (Stoica et al., 2013), the human factor has acted tributaries to a lesser extent, with some exceptions, which allowed the conservation of fish communities

Index of Biological Integrity (IBI) is an important parameter in assessing the status of fish

communities. To determine the IBI is necessary to calculate parameters such as composition and species richness (see Table 8), trophic spectrum of fish species, the existence and individuals with abnormalities, tumors or patients.

Table 8. Fishery species composition in the tributaries – after P. Bănărescu, 1964 in the upper basin of Bistrita

No	Species	Fishery zoning before 1960	
		I. The trout zone	II. The grayling zone
1.	Brown trout	+	+
2.	Huchen	-	+
3.	Grayling	+	+
4.	Chub	-	+
5.	Eurasian minnow	+	+
6.	Schneider	-	+
7.	Mediterranean barbel	+	+
8.	Stone loach	+	+
9.	Alpine bullhead	+	+
Total		6	9

Based on their score determining fish community integrity classes for small rivers from I (excellent - unaffected) to V (destroyed - no fish). Table 9 presents IBI values in the 10 collection points on the Bistrita River tributaries in the upper basin upstream from Lake Bicaz.

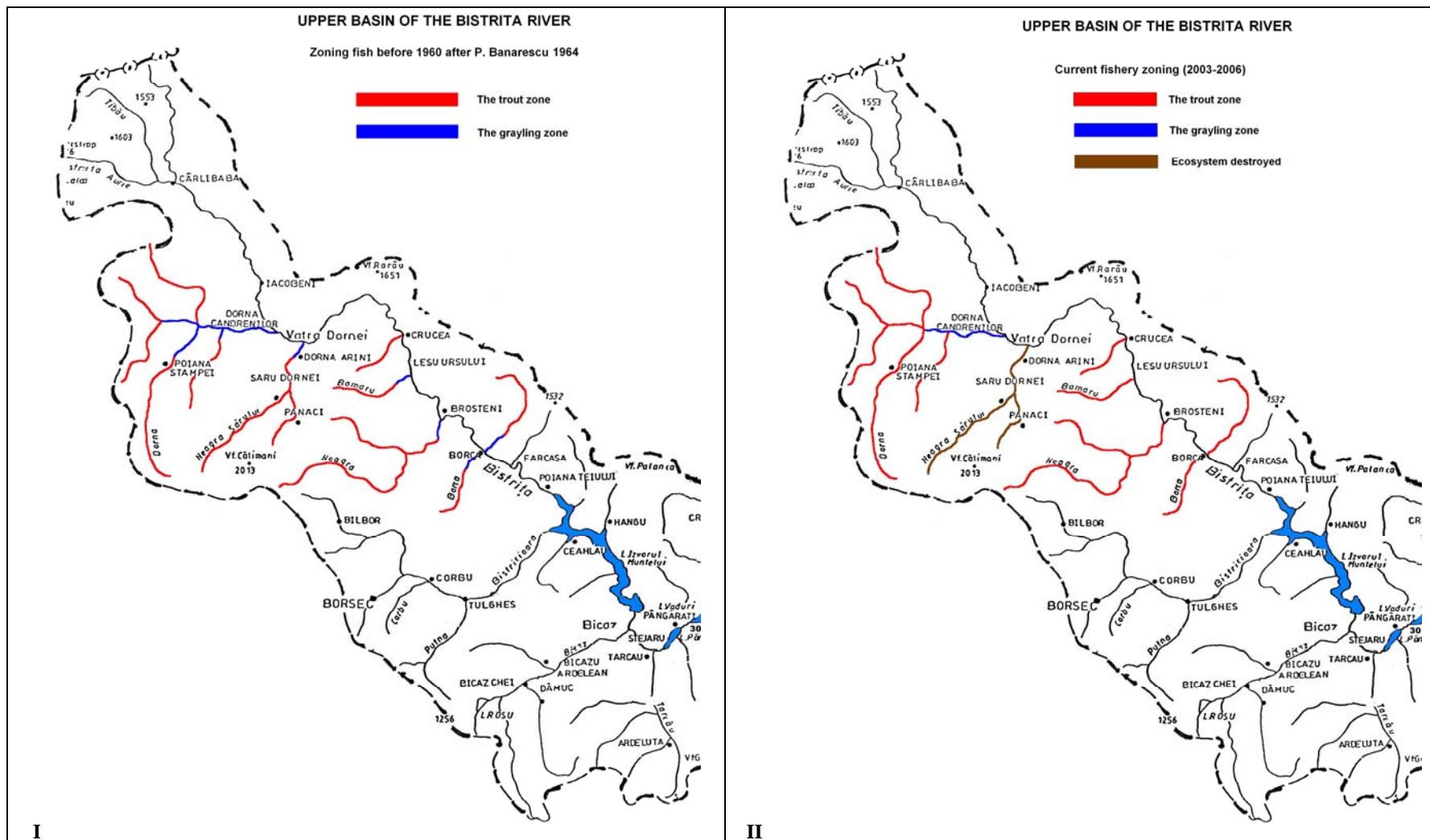


Fig.2. Fishery zoning Bistrita river tributaries in the upper basin (I - before 1960; II- 2003-2006)

Table 9. Index biological integrity (IBI) in collection point

Parameters		Sampling sites									
		1	2	3	4	5	6	7	8	9	10
Composition and richness in species	Total number of species in the pre-existing	3	5	3	1	1	3	3	5	1	3
	Total number of cyprinids	1	5	3	1	1	1	1	1	1	1
	Total number of salmonids	5	1	5	1	5	5	5	5	5	5
	Total number of other species	5	5	3	1	3	5	3	5	3	1
	Total number of native species	3	5	3	1	1	3	3	5	1	3
	Number of species introduced	5	5	5	1	5	1	5	5	5	5
Trophic composition	Total species extinct	1	1	1	1	1	1	1	1	1	1
	Species proportion zoobentofag	5	5	5	1	3	5	5	5	5	5
	Proportion of carnivore species	1	1	1	1	1	1	1	1	1	1
	Species proportion eurifag	5	5	5	5	5	5	5	5	5	5
	Proportion of herbivorous and detritivore	5	5	5	5	5	5	5	5	5	5
Population abundance and condition	Numerical stock (ind./100 m ²)	3	3	5	1	1	3	3	3	1	3
	Weight stock (g/100 m ²)	3	3	3	1	3	3	3	5	3	3
	Number of hybrids	5	5	5	1	5	5	5	5	5	5
	Sick individuals (with abnormalities)	5	5	5	1	5	5	5	5	5	5
Index value / site		50	59	57	23	45	51	53	60	47	51
Classes of integrity		I	I	I	V	II	II	I	I	II	II

Of the 10 collection points, 9 points situation is good and very good (integrity levels I-II), which means that the fish fauna of these streams had very little damage, to human aggression. Only a single point 4 - Neagra Șarului integrity level reaches V, fauna fish being completely destroyed because acid water with a pH of 5, which come from the former sulfur mining Călimani. Although this operation do not work anymore during the rains are discharged from the settling basins polluted waters that destroy fish fauna in this affluent and affecting fish fauna of the Bistrita river downstream to near Zugreni (Stoica et al., 2013).

Din cele 10 puncte de colectare, în 9 puncte situația este bună și foarte bună (nivele de integritate I-II), ceea ce înseamnă că fauna piscicolă de pe aceste cursuri de apă a avut foarte puțin de suferit, față de agresiunile antropice. Doar într-un singur punct, 4 – pe Neagra Șarului, nivelul de integritate

atinge valoarea V, fauna piscicolă fiind distrusă în totalitate, datorită apelor acide cu pH de 5, care vin de la fosta exploatare de sulf din Călimani. Deși această exploatare nu mai funcționează, în timpul ploilor sunt deversate din bazinele de decantare apele poluate care distrug fauna piscicolă din acest afluent și care afectează fauna piscicolă de pe cursul râului Bistrița în aval, până aproape de Zugreni (Stoica și colab., 2003).

Table 10 shows the situation IBI by fishery zoning, each collection point. It can be seen that only a collection point was placed in the grayling (3. Dorna - I. Dorna Căndreni) where integrity index recorded very good value (I).

Other sampling sites were located in the trout zone, which have been very good and good value (I and II), except Neagra Șarului tributary, where the level of damage reaches the maximum value (V).

Tabel 10. Punctajul obținut și nivele de integritate a ihtiocenozelor pe actualele zone piscicole

Fishery zoning	Sampling sites	IBI
The trout zone	1. Dorna – downstream hydropower	50 / I
	2. Dorna – jonction Roșia	59 / I
	4. Neagra Șarului – Șarul Dornei	23 / V
	5. Barnar – upstream jonction Bistrita 3 km	45 / II
	6. Neagra Broștenilor – downstream hydropower	51 / II
	7. Neagra Broștenilor – jonction Negrișoara	53 / I
	8. Neagra Broștenilor – upstream Neagra	60 / I
	9. Borca – upstream jonction Bistrita 3 km	47 / II
	10. Săbasa – upstream jonction Bistrita 7 km	51 / II
The grayling zone	3. Dorna – upstream Dorna Căndreni	57 / I

CONCLUSIONS

The number of species present in tributaries rose to 10 before human impact, to 11 in our collections. In reality the situation is not very good because huchen that after Bănărescu 1964, Dorna was present tributary to the Poiana Stampei, has not been identified in our collections. Two species were identified that were not on tributaries such as rainbow trout, trout specimens escaped from the area and common gudgeon, a species resistant to various environmental conditions.

The numeric stock recorded relatively low (2-3 specimens /100 m²) in most collection points, except points 2 and 3 tributary Dorna reaching 22 specimens /100 m². This is explained by the fact that affluent Dorna has a higher rate of other downstream tributaries and the main course of the river Bistrita influence is shown by the large number of species recorded in the two collection points (7 species). Stock gravimetric values are 50-150 / 100 m² in most collection points less than 50 / 100 m² points located near springs.

Biodiversity index recorded maximum where most species were identified as in point 8 on Neagra Brostenilor upstream shedding in Bistrita River (1,615). The most points the index has a value between from 0.6 to 0.8, indicating the presence of relatively balanced fish community.

Currently fishery zoning is preserved ancient tributaries, except where Neagra Șarului tributary fish fauna was completely destroyed due to water pollution from former mining of Călimani. Unlike the main course of the river, where fisheries zone have changed radically, the human factor tributaries acted lesser extent, allowing the conservation of fish communities

Of the 10 collection points, 9 points situation is good and very good (integrity levels I-II), which means that the fish fauna of these streams had very little damage, to human aggression. Only a single point 4 - the Neagra Șarului integrity level reaches V, fauna fish being completely destroyed because acid water with a pH of 5, which come from the former sulfur mining Călimani

ABSTRACT

This paper tries to highlight the extent to which were affected fish communities on the Bistrita River tributaries in the upper basin. For this purpose samples were taken from 10 collection points both on tributaries of right and left of the Bistrita River.

Sampling was done in the spring and summer when fish species are active foraging and reproduction. In each collection point were recorded a number of physico-chemical water parameters (temperature, conductivity, pH, amount of O₂ dissolved in water), habitat status data (collected

surface, water depth, speed, altitude and GPS coordinates) and raw data on fish samples (number of specimens per species and biomass).

Through data processing and calculation of indices ecological, biodiversity index could highlight the current status of fish fauna, which was comparable to that existing before the human impact after 1960.

By determining the IBI was revealed that the fish communities of the Bistrita river tributaries, upstream from Lake Bicăz, were the least affected, except tributary Neagra Șarului.

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