

ICHTHYOFAUNA STATUS FROM THE SUCEAVA CATCHMENT AREA FROM 2001 TO 2005

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INTRODUCTION

The Suceava River, a Siret River right tributary, measures 172.3 km in length, while its catchment area has 2616 km². The Suceava average discharge measured at the river mouth is 14.1 m³/s and its solid discharge is 5.9 kg deposits/s.

The Suceava represents an average-size river (II). 40% from its course flows through mountainous and submountainous areas, while 60% through hilly regions.

Due to industrial and domestic wastes coming from the Suceava locality, the river became heavily polluted, but the pollution level decreased after 1990. However, no important river regularization works were made on this particular river course, except for a small dam upstream Suceava.

MATERIAL AND METHODS

A complex study was carried out from November 2001 to September 2005 regarding the status of native and anthropogenic fish communities from the Suceava catchment area. 21 sites were sampled in the years 2001, 2003 and 2005. The sampling stations are depicted in fig. 1.

The sampling sites were chosen in order to show fish community changes induced by natural habitat transformations (slopes, water discharge, the nature of the sediment, hydro-chemical parameters etc.) but also man-induced changes (water pollution, river regularization etc.).

The fish material was collected by means of electronarcosis (with direct current), according to the ichthyofauna monitoring methods from natural and man-made habitats (Pricope *et al.* 2004).

Several phases were included in processing fish material. In the field we sorted the captured fish species and we determined the absolute abundance (total number of individuals / capture) and the total biomass (weight/capture). At the same time, the following determinations regarding the habitat status were made:

- placing the 21 sampling sites using a GPS (see table 1);
- estimating the altitude and the river slope in the sampling sites (see table 2);

- recording the main hydro-chemical parameters (t⁰, pH, O₂, conductivity) (see table 2);
 - estimating the habitat status (the nature of the sediment, the water velocity, water depth in the sampling sites) (see table 2);
 - establishing the fishing area (m²).
- In the laboratory, the data processing included the following:
- estimating the numerical (ind./100 m²) and weight (g/100 m²) stock in order to establish the fish association and the fish regions;
 - estimating the Shannon – Wiener biodiversity index, in order to show the evolution of fish community biodiversity in the Suceava river, from headwaters to mouth;
 - estimating the integrity status by means of the Index of biological integrity (IBI) in the sampling sites (Karr and Dudley 1986, modified by Battes 1999).

Table 1 Placing the sampling sites from the Suceava River using a GPS during 2005

No.	Sampling sites	Northern latitude			Eastern longitude		
		(°)	(')	(")	(°)	(')	(")
1.	Brodina brook	47	52	586	25	25	676
2.	Suceava - Nisipitu	47	52	107	25	20	151
3.	Suceava - Brodina	47	53	473	25	26	320
4.	Suceava - Straja	47	54	576	25	31	744
5.	Suceava - Vicovul de Jos	47	54	598	25	42	762
6.	Suceava - Dornești	47	52	661	25	59	329
7.	Suceava - Ițcani	47	40	664	26	12	346
8.	Suceava - Ipotești	47	36	977	26	19	643
9.	Suceava - Liteni	47	31	561	26	32	343

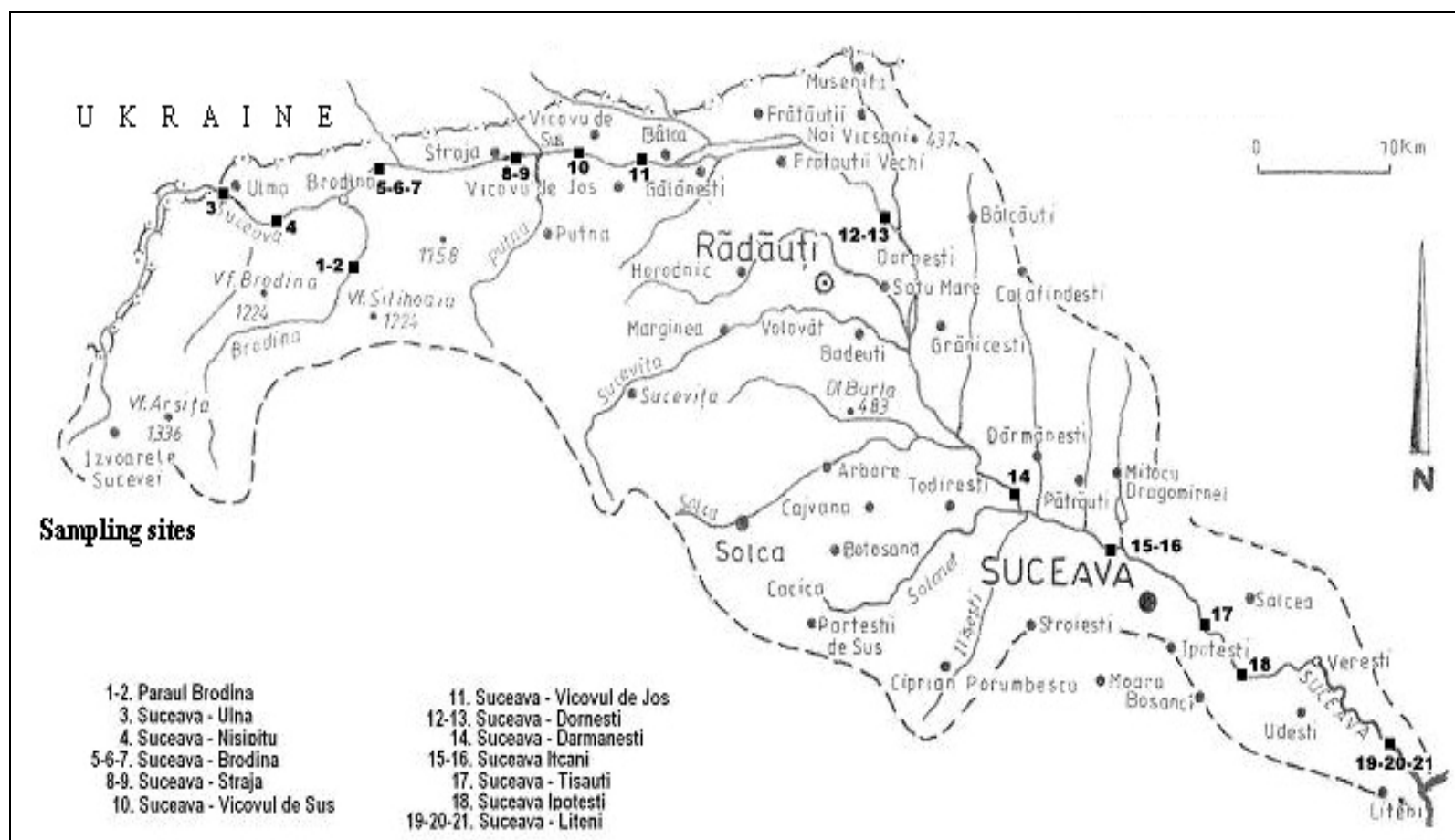


Fig. 1 The Suceava River catchment area with the 21 sampling sites located along the main river course and on its main tributaries

Table 2. Data concerning water quality, altitude and habitat status in the sampling Sites from the years 2003 and 2005

No	Sampling sites	Period	Hydro-chemical parameters				Altitude	Habitat status	Water velocity (m/s)	Others
			t° C	pH	O ₂	µS				
1.	Brodina brook	2005	17.0	7.75	8.25	254	539	Stony bottom	0,4	-
2.	Suceava - Nisipitu	2005	16.0	7.84	8.05	269	669	Ø<15	0,5	slope 15‰
3.	Suceava-Brodina	2003	19.6	7.80	8.95	309	-	-	-	-
4.	Suceava-Brodina	2005	17.0	7.65	7.60	286	591	Ø>25 (10%) Ø<10 (80%) Sand (10%)	0,6	slope 20‰
5.	Suceava-Straja	2005	17.2	7.80	7.25	296	531	Ø>20	0,5	-
6.	Suceava-Vicovul de Jos	2005	13.0	7.85	6.75	386	449	Ø>10	0,3	slope 13‰
7.	Suceava-Dorneşti	2005	15.2	7.80	7.00	385	355	Ø<8 (mud)	0,2	-
8.	Suceava-Iţcani	2003	21.4	7.65	7.99	464	-	Ø<20 (20%) boulders 60% gravel 20% sand	-	H < 20 cm
9.	Suceava-Iţcani	2005	16.9	7.70	7.30	507	296	Ø<10	0,3	turbid water
10.	Suceava-Tişăuţi	2003	25.0	5.88	6.30	472	-	-	-	-
11.	Suceava-Ipoteşti	2005	19.3	7.40	7.70	512	264	Ø<5 (gravel)	0,4	-
12.	Suceava-Liteni	2003	24.0	7.98	8.87	481	-	Stony bottom	-	-
13.	Suceava-Liteni	2005	20.6	7.80	6.10	539	230	Ø<5 (gravel; mud))	0,3	-

RESULTS AND DISCUSSIONS

In the following we present the list of fish species collected until 1960 (Bănărescu 1964) and

after 2000 – according to the classification introduced by Nalbant 2003.

The fish species list from the Suceava catchment area:

I. Family Petromyzontidae	1. <i>Eudontomyzon danfordi</i> (Reagan, 1911) – Danubian lamprey
II. Family Salmonidae	2. <i>Salmo fario</i> (Linnaeus, 1758) – trout
	3. <i>Rhabdofario mykiss</i> (Walbaum, 1792) – rainbow trout
	4. <i>Hucho hucho</i> (Linnaeus, 1758) – huchen (Danube salmon)
III. Family Thymalidae	5. <i>Thymallus thymallus</i> (Linnaeus, 1758) – grayling
IV. Family Cyprinidae	6. <i>Carassius carassius</i> (Linnaeus, 1758) – crucian carp
	7. <i>Carassius gibelio</i> (Bloch, 1783) – gold fish
	8. <i>Barbus barbus</i> (Linnaeus, 1758) – barbel
	9. <i>Barbus petenyi</i> (Haeckel, 1852) – afterbarbe
	10. <i>Rhodeus amarus</i> (Bloch, 1782) – bitterling
	11. <i>Gobio obtusirostris</i> (Valenciennes, 1844) – gudgeon
	12. <i>Rheogobio uranoscopus</i> (Agassiz, 1828)
	13. <i>Pseudorasbora parva</i> (Schlegel, 1842) – topmouth gudgeon
	14. <i>Squalius cephalus</i> (Linnaeus, 1758) – chub
	15. <i>Phoxinus phoxinus</i> (Linnaeus, 1758) – minnow
	16. <i>Alburnoides bipunctatus</i> (Bloch, 1872) – schneider
	17. <i>Alburnus alburnus</i> (Linnaeus, 1758) – bleak
	18. <i>Vimba carinata</i> (Pallas, 1814) – vimba bream

	19. <i>Chondrostoma nasus</i> (Linnaeus, 1758) - undermouth
V. Family Nemacheilidae	20. <i>Orthrias barbatulus</i> (Linnaeus, 1758) – loach
VI. Family Cobitidae	21. <i>Cobitis (taenia) danubialis</i> (Băcescu, 1993) – spined loach
	22. <i>Sabanejewia balcanica</i> (Karaman, 1922)
VII. Family Gadidae	23. <i>Lota lota</i> (Linnaeus, 1758) – burbot
VIII. Family Percidae	24. <i>Perca fluviatilis</i> (Linnaeus, 1758) – perch
IX. Family Odontobutidae	25. <i>Odontobutis glenii</i> (Dybowski, 1877)

Table 3. depicts the fish species that existed before 1960 and after 2000. 17 fish species lived in the Suceava catchment area before 1960, when the human impact was low. The Danubian salmon (that disappeared since the late 19th century), the burbot and the crucian carp were the three species disappeared from the study area.

22 species were found after the year 2000. This increase in species number was due to three factors: first, voluntary introduction (in case of rainbow trout that escaped from its enclosures); second, the invasion of native species from the Siret catchment area (like bitterling, gold fish, perch or vimba bream) and third, the invasion of some alien species

(like the topmouth gudgeon, brought from China after 1962 with the culture Eastern-Asian cyprinids). More recently (2001), an invasive species also coming from Eastern Asia (the Amur River basin) was discovered: *Perccottus glenii*. Table 4 presents the numerical (ind./100 m²) and weight (g/100 m²) stocks in the sampling sites.

The numerical stock recorded lower values (that did not exceed 10) in the upper regions of the river, which represented a typical situation. The values increased gradually up to 60 ind./100 m² at the sampling site located upstream Suceava. Downstream of the city of Suceava the numerical stock decreased to 10-20 ind./100 m² (which represented low values for this region) due to domestic and industrial wastes.

Table 3. Fish species list from the Suceava River (2005)

No.	Species	Before 1960	After 1960			
			2001 (November)	2003 (August)	2005 (September)	Total 2001/2005
1.	<i>Salmo fario</i>	x	x	x	x	x
2.	<i>Rhabdofario mykiss</i> *	-	-	-	x	x
3.	<i>Hucho hucho</i>	x	-	-	-	-
4.	<i>Thymallus thymallus</i>	x	x	-	-	x
5.	<i>Phoxinus phoxinus</i>	x	x	x	x	x
6.	<i>Orthrias barbatulus</i>	x	x	x	x	x
7.	<i>Alburnoides bipunctatus</i>	x	x	x	x	x
8.	<i>Barbus petenyi</i>	x	x	x	x	x
9.	<i>Chondrostoma nasus</i>	x	x	x	x	x
10.	<i>Barbus barbus</i>	x	x	x	x	x
11.	<i>Squalius cephalus</i>	x	x	x	x	x
12.	<i>Rhodeus amarus</i>	-	x	x	x	x
13.	<i>Gobio obtusirostris</i>	x	x	x	x	x
14.	<i>Rheogobio uranoscopus</i>	x	x	x	x	x
15.	<i>Lota lota</i>	x	-	-	-	-
16.	<i>Carassius carassius</i>	x	-	-	-	-
17.	<i>Carassius gibelio</i>	-	x	x	x	x
18.	<i>Pseudorasbora parva</i>	-	x	x	x	x
19.	<i>Alburnus alburnus</i>	-	x	x	x	x
20.	<i>Sabanejewia balcanica</i>	x	x	x	-	x
21.	<i>Vimba carinata</i>	-	-	-	x	x
22.	<i>Odontobutis glenii</i>	-	x	-	x	x
23.	<i>Perca fluviatilis</i>	-	-	x	-	x
24.	<i>Cobitis (taenia) danubialis</i>	x	-	x	x	x
25.	<i>Eudontomyzon danfordi</i>	x	x	-	-	x
Total		17	18	16	18	22

* - escaped from enclosu res

Table 4. Numerical and weight stock in the sampling sites from the Suceava River from 2001 to 2005

No.	Fish regions		Sampling sites	Period	Numerical stock (ind./100 m ²)	Average numeric al stock /site	Average numeric al stock /region	Weight stock. g/100m ²	Average weight stock /site	Average weight stock /region
1.	Grayling region	Brodina brook	2001	7.05	9.08	13.47	87.61	250.4	267.29	
2.			2005	10.66			413.2			
3.		Suceava - Ulna	2001	7.08	12.36		69.40	99.97		
4.		Suceava - Nisipitu	2005	17.64			130.54			
5.		Suceava - Brodina	2001	11.29	18.97		137.8	184.21		
6.			2003	4.26			60.88			
7.			2005	41.37			353.95			
8.	Afterbarbe region	Suceava - Straja	2001	10.00	13.02	29.77	127.70	101.98	244.16	
9.			2005	16.04			76.26			
10.		Suceava- Vicovul de Sus Suceava- Vicovul de Jos	2001	8.18	9.12		146.67	108.55		
11.			2005	10.06			70.44			
12.		Suceava - Dornești	2001	70.00	67.19		805.50	521.96		
13.			2005	64.39			238.43			
14.	Chub region	Unpo lluted	Suceava - Dărmănești	2001	64.00	64.0	37.66	387.92	387.92	248.42
15.			Suceava -	2003	5.58	11.32		106.44	108.93	
16.			Ițcani	2005	17.07			111.43		
17.		Polluted	Suceava - Tișăuți	2003	23.01	17.89	16.3	42.01	80.62	82.16
18.			Suceava - Ipotești	2005	12.77			119.24		
19.			Suceava - Liteni	2001	9.27	14.71		82.56	83.7	
20.				2003	16.77			35.13		
21.				2005	18.10			133.43		

The weight stock recorded more or less constant values, that ranged between 100 and 250 g/100m², values considered to be representative for the river course upstream Suceava.

The maximum values of weight stock (387.92 - 521.96 g/100m²) were recorded in the Dornești and Dărmănești sampling sites, indicating a rich fish community. Downstream of the city of Suceava, the weight stock decreased five to six fold due to pollution (about 80g/100 m²).

Moreover, the main fish regions of the Suceava catchment area were identified, according to the estimated stock of each species.

They were established according to the species with the maximum numerical and weight stock. Thus, the following fish regions were found on the Suceava river course:

- *The trout region* – at the river headwaters; on its main tributaries from the mountainous areas and 10-15 km downstream;
 - *The grayling region* –downstream the river course until the Straja locality (even though the grayling was not dominant);
 - *The chub region* – with two distinct subregions:
 - upstream the city of Suceava – unpolluted;
 - downstream the city of Suceava – polluted.
- This region stretched to the Suceava river mouth, where the chub (an ubiquitous species) was best adapted to the modified environmental conditions caused by pollution.

Biodiversity

In the sampling sites, the biodiversity ranged within normal limits for fish community including 4 to 11 fish species (see table 5 and figure 2).

Table 5. The biodiversity in the Suceava catchment area between 2001 and 2005

No.	Sampling sites	Period	Biodiversity index / site	Species number	The average (Biodiversity index)	Average number of species	Fish regions		The average/ fish region	Average species number/ region
1.	Brodina brook	2001	1.216	4	1.296	4.5	GRAYLING REGION		1.036	5.57
2.		2005	1.375	5						
3.	Suceava - Ulna	2001	0.883	6	0.756	6.0				
4.	Suceava - Nisipitu	2005	0.628	6						
5.	Suceava - Brodina	2001	1.215	6	1.338	6.0				
6.		2003	1.390	5						
7.		2005	1.409	7						
8.	Suceava - Straja	2001	1.432	6	1.220	5.5	AFTERBARBE REGION		1.251	8.0
9.		2005	1.009	5						
10.	Suceava-Vicovul de Sus	2001	1.277	8	1.303	8.0				
11.	Suceava-Vicovul de Jos	2005	1.328	8						
12.	Suceava - Dornești	2001	1.310	10	1.231	10.5				
13.		2005	1.153	11						
14.	Suceava - Dărmănești	2001	1.927	9	1.927	9.0	CHUB REGION	Unpo lluted	1.849	10.0
15.	Suceava - Ițcani	2003	1.714	10	1.771	10.0				
16.		2005	1.827	11						
17.	Suceava - Tișăuți	2003	1.123	6	1.259	7.0		Pollured	1.477	8.2
18.	Suceava - Ipotești	2005	1.287	8						
19.	Suceava - Liteni	2001	1.605	6	1.695	9.0				
20.		2003	1.416	7						
21.		2005	2.064	14						

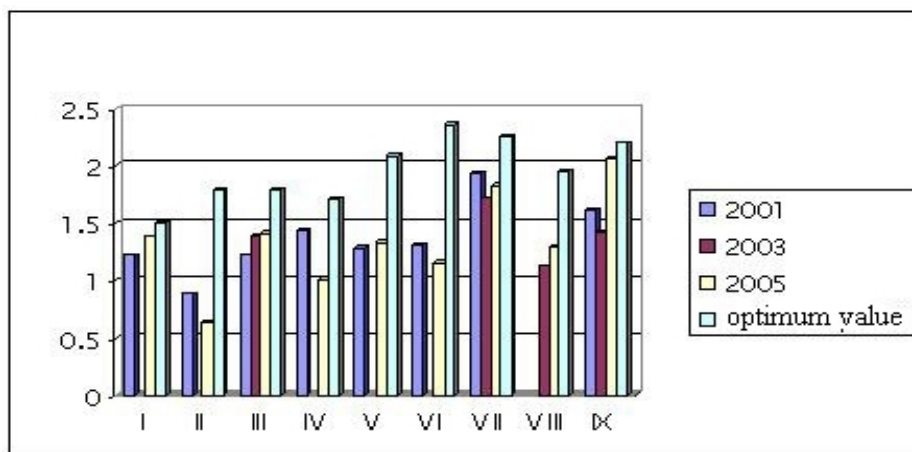


Fig. 2 The value of the real and optimum biodiversity index values at the sampling sites between 2001 and 2005 in the Suceava catchment area

I: 1-2 Brodina brook; II: 3-4 Suceava-Ulna, Nisipitu; III: 5-6-7 Suceava-Brodina; IV: 8-9 Suceava-Straja; V: 10-11 Suceava-Vicovul de Sus, Vicovul de Jos; VI: 12-13 Suceava-Dornești; VII: 14-15-16 Suceava-Dărmănești, Ițcani; VIII: 17-18 Suceava-Tișăuți, Ipotești; IX: 19-20-21 Suceava-Liteni.

The biodiversity index ranged between 1.2 and 1.3 in the unpolluted area, recording an increase from 1.0 to 1.8 due to increases in species number from 5 to 10. In the mountainous region of the Suceava (Ulna, Nisipitu), the lower biodiversity

values might be explained by the sampling in a ballast-processing area. In the middle stretches of the river, the low diversity values (at Dornești for example) were due to the samplings carried out in a dead arm where chub was dominant, thus affecting the equitability.

Downstream Suceava (Tișăuți, Ipotești), the low biodiversity values were caused by low species

number (6) and by the obvious chub domination (it represented up to 70% from the capture) (see figure 3).

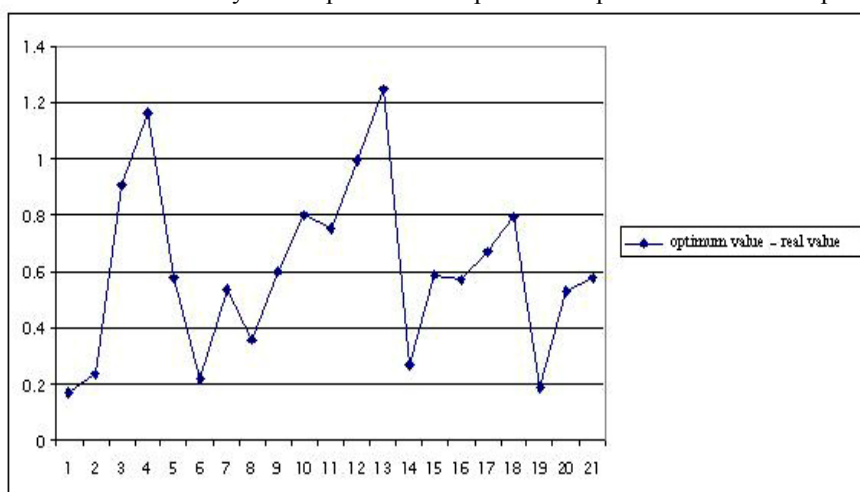


Fig. 3. The difference between the real and the optimum values of the biodiversity index in the sampling sites from the Suceava catchment area

1-2 Brodina brook; 3-4 Suceava-Ulna, Nisipitu; 5-6-7 Suceava-Brodina; 8-9 Suceava-Straja; 10-11 Suceava-Vicovul de Sus, Vicovul de Jos; 12-13 Suceava-Dornești; 14-15-16 Suceava-Dărmănești, Ițcani; 17-18 Suceava-Tișăuți, Ipotești; 19-20-21 Suceava-Liteni.

Table 6. Fish community integrity in the Suceava catchment area between 2001 and 2005

No.	Sampling sites	Period	Index value /site	Index average value/site	Fish region		Index average value/region	
1.	Brodina brook	2001	52 / III	49.5 / III	GRAYLING REGION		52.86 (II – III)	
2.		2005	47 / IV					
3.	Suceava - Ulna	2001	55 / II	56 / II				
4.	Suceava - Nisipitu	2005	57 / I					
5.	Suceava - Brodina	2001	46 / IV	53 / II				
6.		2003	54 / II					
7.		2005	59 / I					
8.	Suceava - Straja	2001	53 / II	51 / III	AFTERBARBE REGION		54.0 (II)	
9.		2005	49 / III					
10.	Suceava - Vicovul de Sus Suceava - Vicovul de Jos	2001	53 / II	53 / II				
11.		2005	53 / II					
12.	Suceava - Dornești	2001	57 / I	58 / I				
13.		2005	59 / I					
14.	Suceava - Dărmănești Suceava - Ițcani	2001	55 / II	57 / I	CHUB REGION	Unpolluted	57 (I)	
15.		2003	57 / I					
16.		2005	59 / I					
17.	Suceava - Tișăuți	2003	47 / V	56.5 / IV				49 (III)
18.	Suceava - Ipotești	2005	46 / IV					
19.	Suceava - Liteni	2001	50 / III	50.67 / III				
20.		2003	49 / III					
21.		2005	53 / II (III)					

The variation of biodiversity index values between 2001 and 2005 showed an increase of diversity values in most of the common sampling sites considered between 2001 and 2005. Moreover, the species number also increased with one or two

units during this period of time. The most important increase was recorded in the polluted area (Liteni), where the index value went up from 1.4 and 6 units to 2.06 and 14 units, respectively. This particular phenomenon indicated an obvious improvement of fish

communities from the polluted area (downstream Suceava).

Integrity Table 6 presents the Index of biological integrity (IBI) values, calculated for every sampling site and fish region. In the unpolluted area, upstream Suceava, the index values were extremely good (II-III), indicating that fish community structure and function did not change severely compared to the period before 1960, when the human impact was not significant. This was caused by reduced interventions in the ecosystem (almost no regularization works) and low overfishing caused by poaching (the particular region was near the Ukrainian frontier). The maximum integrity was recorded upstream Suceava, showing that the presence and the self sustainability of these communities remained unchanged. However, in the polluted region, downstream Suceava, the integrity decreased to IV-V, indicating a strongly affected ecosystem, having a very low self sustainability. The integrity reached level III near the mouth of the Suceava River, indicating a partial recovery of fish communities. Integrity index reached level II in 2005 at the Liteni sampling site, which was extraordinary for a polluted area. This fact might be explained by the powerful floods from the year 2005, which washed and cleaned the polluted habitat. In September 2005, at the Suceava river mouth, 14 species were identified, together with an integrity level of II, characteristic to less affected fish communities. This spectacular recovery was due to a severe drawback in industrial pollution (especially chemical pollution) after the year 1990 downstream Suceava.

CONCLUSIONS

Three native species disappeared from the Suceava catchment area after 1960 (the Danubian salmon, the burbot and the crucian carp). Several native species belonging to the Siret catchment area had expanded their territory (the bitterling, the gold fish, the perch and the vimba bream). The following alien species were introduced: the rainbow trout (at the beginning of the 20th century, it escaped from its enclosures, but it cannot breed in the wild); the topmouth gudgeon (introduced by chance, brought from China in 1962 with the culture Eastern-Asian cyprinids) and *Perccottus glenii* (natural invasive species coming from the Amur River basin, first recorded in 2001 and then collected from all lower river basin in 2005)

1. The numerical (ind./100 m²) and weight (g/100 m²) stock in unpolluted area (upstream Suceava) recorded normal values (mean, even large figures), indicating a productive ecosystem and a low affected habitat. The highest values were recorded upstream Suceava. These values reached almost

maximum for this particular type of river (60-70 ind./100 m² and 500-800 g/100 m², respectively). On the other side, in the polluted regions (downstream Suceava), the stock recorded low values for this particular zone (not exceeding 10 ind./100 m² and 50 g/100 m², respectively). However, due to lower pollutant load caused by floods (that washed the waterbed polluted mud), the stock from this region recovered between 2001 and 2005, reaching 20 ind./100 m² and 130 g/100 m², respectively.

2. The biodiversity index recorded normal values for unpolluted zone (>1.2). In some sampling sites, the number of species and the index value decreased, due to gravel exploitation from the upper Suceava course or to sampling in dead arms (when only one or two species became dominant-like in Dornești site) or to water pollution downstream Suceava (Tișăuți – Ipotești). The taxonomical units increased in number between 2001 and 2005, together with the values of biodiversity index, especially in the polluted region (at the Liteni station- near the Suceava river mouth).
3. Fish community integrity was less affected in unpolluted regions, IBI recording levels II and even I upstream Suceava, indicating a decreased human impact (river regularization, overfishing). The self sustainability of native species was unaffected, thus ensuring the presence of native species.

A problem was encountered in case of grayling, which was collected in upper river Suceava in 2001 but not in 2003 or 2005. The low number of individuals collected could explain the drawback of its habitat, which now included only regions less accessible to fishing.

Downstream Suceava, the integrity decreased to levels IV and V, due to water pollution. At the Suceava mouth, the integrity reached level III. Moreover, between 2001 and 2005, the integrity recovered, reaching level III, so that the self sustainability came back to normal functional levels. This particular phenomenon might be explained by the severe floods from the summer of 2005, which washed away the pollutants from the habitat.

Generally speaking, a recovery and improvement of fish community and aquatic ecosystem status was observed in the entire Suceava catchment area. This river (at least upstream the city of Suceava) is less affected by river regularization or overfishing.

We strongly recommend the transformation of this river stretch in protected area for the existing native species (trout, grayling, schneider, afterbarbe etc.)

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