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ICHTHYOFAUNA STATUS IN THE SIRET CATCHMENT AREA, WITH EMPHASIS ON THE EFFECT OF THE JANUARY 2001 POLLUTION

BY

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The present paper aims to evaluate the evolution of ichthyofauna structure and function in the Siret River, from the point where it enters the Romanian territory to where it flows into the Danube. The present status of aquatic ecosystems was analyzed by means of ichthyofauna prospective monitoring, as a result of the human impact due to water pollution (especially the cyanide pollution occurred in January 2001) and to river regularization of the middle reach of the Siret River.

Introduction

In the past four or five decades, profound structural changes occurred in the Siret River catchment area, due on the one hand to water pollution downstream of urban sites (Suceava, Piatra Neamţ, Bacău etc.) and downstream of industrial sites (Săvineşti, Roznov, Oneşti etc.) and on the other hand to river regularization from the upper (Rogojeşti, Bucecea) and middle river course (Lakes Galbeni, Răcăciuni, Bereşti, Călimăneşti). This particular paper reviews the effects of cyanide compounds pollution on the middle reach of the river, occurred in January 2001, including also the natural recovery of fish communities after this strong human impact.

Material and methods

The fish material was collected by means of electronarcosis in case of rivers and by means of fixed gill nets in case of dam reservoirs (CEN – TC – 230 – Water analysis). The sampling period included the years between 1999 and 2004, especially the years 2002-2004, for the area polluted with cyanide compounds.

Fish sampling and handling were carried out according to methods used in the European Union. Species taxonomy followed the reviewed list of freshwater fish (Nalbant, 2003).

Fish community quantitative parameters included the absolute abundance, total biomass (for rivers) and fishing effort (CPUE for lakes). Numerical stock (ind./100m^2)

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and weight stock (g/100m^2) were also determined for river fish populations. In order to estimate the fish association structure, the following ecological indices were calculated: the constancy- C; the dominance-D and the index of ecological significance.

Shannon – Wiener biodiversity index estimated the biodiversity for every sampling site. For an accurate estimation of biodiversity variation, considering the number of species collected in every sampling station, maximum biodiversity for every site in an ideal situation (when all species had an equal number of individuals) was compared to the real biodiversity for the same number of species.

The Index of Biological Integrity (IBI) was determined according to the method used by Karr and Dudley (1981); Karr *et al*. (1986), modified by Battes (1999).

The red list of endangered fish species was made according the methods elaborated by Battes *et al.* (2001), based on the values of the numerical and weight stock and the coefficient of ecological significance, calculated for the accidental species (II).

Results and discussions

The results were processed for different river stretches according to the cleaning state and the degree of river regularization, for an accurate illustration of the data. Thus, the river course was divided into three different zones:

1. The upper and middle catchment area, without hydrotechnical regularization (the Siret River from the point where it entered our country to upstream of Lake Galbeni); this region includes:

- the 1st zone- (I)- an unpolluted and unchanged region (from the Romanian border to the junction with the Suceava River)
- the 2nd zone (II)- the region strongly polluted with cyanides in January 2001 (from the junction with the Suceava River to the junction with the Moldova River)
- the 3rd one (III)- a polluted region (from downstream of the junction with the Moldova River to upstream of Lake Galbeni)

2. The middle catchment area, including the hydrotechnical regularizations (the 4th zone- IV), from upstream of Lake Galbeni to downstream of Lake Călimănești (The Old Adjud);

3. The lower catchment area (the 5th zone- V), from downstream of Lake Călimănești to the region where the Siret flows into the Danube (see figure 1).

Fish species taxonomy and their ecological status

Table 1 presents the list and classification of fish species from the Siret catchment area before the strong human impact occurred in 1960 and after the industrial water pollution and river regularization of the middle river course.

Fifty two fish species were identified in the entire river catchment area in the last 40-50 years, of which:

- 42 were native species existing before 1960;
- 34 were native species remained after 2000;
- 10 were native species, recording habitat decreases;

- 5 were species recording habitat increases;
- 3 were alien species acclimatized in near-by fisheries from the Chinese Eastern-Asian cyprinid complex;
- 2 were invasive species.

Table 2 depicts the fish species from the investigated areas collected in the middle and upper river course in the 60's (which represented the control populations) and in the years 2002-2004. The effect of water pollutants discharged by industry from Suceava locality was estimated, together with the effects of water cyanide pollution from the detergent factory in Fălticeni, which occurred in January 2001.

Compared to the situation in 1960 (the species existing before the impact), species number decreased after 2000 with 44.4% in zone I, with 41.4% in zone II and with 55.6% in zone III, which indicated a general drawback in all three regions. In zone II, the most affected one, the number of new species was about 20.7% compared to 5.6-7.4% in other regions, showing that species invasion from the tributaries was favored by the presence of depopulated habitats caused by the human impacts.

Numerical and weight stock

Table 3 and figure 2 present the evolution of the numerical and weight stock in the investigated areas in the past 40-50 years. A drastic decrease was recorded after 2000 compared to the year 1960, due to the general human impact including the industrial development, hydrotechnical regularization, overfishing (uncontrolled poaching) etc.

As concerns stock situation for every investigated zone, the following aspects were observed:

- in zone I – the samplings from 2002-2004 indicated relatively constant and large values, of about 30-50 ind./100m^2, and 400 g/100m^2 respectively; human impact was much lower compared to the affected areas;
- in zone II- an aggressive pollution occurred (leading to mass mortality in 2001); the numerical and weight stock decreased to 5.93 ind./100m^2 and 47g/100m^2, respectively. The values from 2003 and 2004 indicated a numerical and weight recovery (35 ind./100m^2 and 300g/100m^2, respectively), up to the values recorded in zone I;
- in zone III- a polluted region, the same gradual recovery process was observed, similar to the zone II;
- in zone IV, on the lower Siret River, the values did not reflect an increase of fish stocks, but their habitat characteristics (the bottom nature, the dynamic character of riverbeds etc.). In 2002 fish community was sampled from a region with gravel on the bottom and high water velocity, compared to the site sampled in 2003, a lentic region with muddy bottom.

The weight stock quantitative evolution of fish communities is depicted in figure 3, showing a positive period between 2002 and 2004.

Biodiversity

In order to assess the biodiversity variation of fish communities, maximum and real values of the Shannon-Wiener index were calculated, relative to the number of

collected species in every sampling site. For maximum biodiversity values, all species were considered numerically equal; for the real values, the actual number of individuals identified from every species was considered.

Usually, the biodiversity value variation is proportional to the number of collected species and any deviation of biodiversity curve indicates a change caused by limiting factors.

Figure 4 shows the biodiversity value curves in the considered sampling sites and in the five zones. In zone I, biodiversity values ranged from 1.4 to 1.7, lower in 2002 and 2003 compared to the control status from 1994, but larger in 2004. In zone II- a polluted region, upstream of the Dolhasca bridge, in the 4th site, polluted with cyanide compounds, biodiversity values were very similar (about 1.6) for the years 2002, 2003 and 2004. Beginning with the 5th site (Lespezi), all index values decreased under 1.3 (or under 0.8 at Ion Creanga sampling site), as a result of the toxic effect of cyanide compounds. Mean values of biodiversity index exceeded 1.5 in zone III, where the toxic action of cyanide compounds was diminished due to water volume brought by the Moldova River. The recovery of fish community structure was increased in 2004. In 2004, biodiversity recorded high values in Mirceşti sampling site (a strongly polluted site), thus indicating a structural recovery of fish communities in time. In zone V values calculated for 2003 and 2004 were higher than those from 1996 (especially in the 11th sampling site).

This evolution is shown by the differences between the maximum and the real biodiversity values, calculated for each zone (fig. 5). In zone I, unpolluted, the value differences were relatively large, ranging from 0.7 to 0.95, indicating a well-structured community in all investigated years. In zone II, the differences were smaller (0.28 in 2002 and 0.36 in 2003), showing that the number of individuals belonging to every species decreased drastically due to poisoning with cyanide compounds (see the numerical stock), most species becoming numerically equal. The structure recovered in zone III, but it didn't reach the status characteristic to zone I (0.55 compared to 0.75). In 2004, the evolution was similar to the one from 2002-2003, but the differences were comparable to the year 1994 (the considered control status), thus indicating an increased structure recovery. In zone V, a structural drawback was recorded, due to decreased values of differences in 2003 and 2004.

Table 4 depicts the absolute mean values of biodiversity in the sampling sites and in the five zones, in the years 2002, 2003 and 204.

Biological integrity

The Index of Biological Integrity (IBI) is calculated according to the method elaborated by Karr and Dudley (1981, 1986) and modified by Battes (1991). The results are included in tables 4 and 5 and in figure 6.

In the considered control status from 1994, an integrity decrease to the third level (III) was recorded in zone II, probably due to the pollution coming from the industrial region of Suceava locality. In zone III, a recovery of fish community structure to the

integrity level II (similar to the unpolluted region) was recorded. In the hydrotechnical regularization regions (dam reservoirs), the index value decreased to the level V.

As a result of the pollution from January 2001, the degradation level strongly increased in 2002 and 2003, reaching levels V and VI in zone II. A partial recovery was recorded, up to the level IV and V in zone II, while in zone V the index decreased to the level VI (very drastic destruction). In 2004, fish community structure recorded a strong recovery, to the level III (in zones I and II) and to level II (in zones III and V). In dam reservoirs, the integrity level recorded low values (level V).

After the year 2004, fish communities, from the middle and upper reaches of the Siret River course,recorded an accelerated process of natural recovery. This phenomenon would be finalized in the next 5-10 years, when large-bodied species would reach maturity and reproduce.

Red list of endangered species

The degree of endangerment of accidental and rare species was established based on the numerical and weight stock and on the ecological significance index (W).

Endangered and vulnerable fish species, together with species in a critical state, identified in the Siret River, are depicted in table 6. According to our study, the following species were included: six species in critical state (*Abramis ballerus*-grass carp, *Cyprinus carpio*- carp, *Tinca tinca*- tench, *Acerina cernua*- ruff, *Esox lucius*- pike and *Noemacheilus barbatusus*- loach); nine endangered species (*Barbus meridionalis*, *Blicca bjorkna*- white bream, *Carassius auratus*- gold fish, *Sabanejewia aurata balcanica*, *Stizostedion lucioperca*- pikeperch- in rivers; and *Aspius aspius*, *Gobius kessleri*, *Gobio kessleri*- sand gudgeon; *Eudontonmyzon danfordi*- Carpathian brook lamprey- in lakes); and three vulnerable species (*Alburnoides bipunctatus, Leucaspius delineatus* and *Cobitis taenia*- spined loach).

Many species considered to be affected in the main Siret River course were abundant in the tributaries. An accurate situation of endangerment status of fish species from the Siret catchment area would be accomplished only as a result of a fish community monitoring from all tributaries of the Siret River.

Conclusions

1. The number of fish species collected after 2002 was usually smaller with about 40-56%, compared to the one captured before 1960. Depending on water pollution and/or river regularization, the drawback reached 40%, up to 60%.

In the strongly polluted area (with cyanide compounds in 2001), six new species appeared (about 20% from the total number of species), besides those existing in 1960, as a result of habitat availability after the elimination of native fish associations, existing before the pollution.

2. Fish community numerical and weight stock decreased four to six fold compared to the year 1960, due to the increasing human impacts. A drastic stock drawback was caused by the cyanide pollution in 2001. The stock decreased eight to

tenfold in the year 2002. In 2003-2004 the stock recovered gradually, reaching about 70% from the one that existed before.

In the dam reservoirs, the stock was comparable to the one from the unpolluted regions, due to the development of ubiquitous and eurybiont species (gold fish, bream, vimba bream etc.)

3. Biodiversity changed severely during the pollution period in 2001. Thus, the biodiversity index value decreased in zones II and III. In 2004, it recorded values comparable to those from 1994, when the region was less affected by pollution.

4. Fish community integrity was also severely affected by water pollution and river regularization. The integrity level in zone I (unpolluted) was about II. Due to pollution, the integrity level characteristic to zone II decreased to V-VI, strongly affecting the fish community sustainability and development.

Beginning with 2003, but mostly in 2004, a recovery of that particular area was recorded, reaching the integrity level III. The recovery was faster and complete in zone III.

Middle river course regularization affected more profoundly the fish community integrity, because it changed the habitat, together with the feeding and breeding conditions. Hence, the integrity level decreased to VI, with a slight recovery up to the level V. Lake fish associations faced changes, structural and functional, much more profound compared to those characteristic to the lotic environments.

5. Endangered species were numerous (6 species in a critical state, 9 endangered and 3 vulnerable species), due to chronic and acute water pollution and to the middle river course regularization.

An accurate assessment of the present status of considered fish communities will be possible only after a monitoring program including all main tributaries of the Siret River.

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Table 1 Fish community taxonomy and the ecological status in the Siret catchment area

No	Family	Species	Popular name	Ecological situation				
				COURSE SIRET				Species chorology
				Total basin	Basin medium and superior (river)	Basin medium (lake)	Basin inferior (river)	
1.	I	*Eudontomyzon danfordi* (Regan, 1911)	Hadină		+			
2.		*Lampetra planeri* (Bloch, 1784)	Cicar					
3.	II	*Acipenser ruthenus* (Linnaeus 1758)	Cegă					
4.	III	*Esox lucius* (Linnaeus 1758)	Ştiucă	+	+		+	
5.	IV	*Cyprinus carpio* (Linnaeus 1758)	Crap	(+)		(+)	(+)	
6.		*Carassius carassius* (Linnaeus 1758)	Caracudă	+		+		0
7.		*Carassius gibelio* (Bloch, 1783)	Caras	+	+	+	+	x
8.		*Barbus barbus* (Linnaeus, 1758)	Mreană	+	+	+	+	
9.		*Barbus petenyi* (Heckel, 1852)	Moioagă	?	+	-		
10.		*Rhodeus amarus* (Bloch, 1782)	Boarţă	+	+		+	0
11.		*Gobio obtusirostris* (Valenciennes, 1844)	Porcuşor comun	+	+	+	+	
12.		*Romanogobio vladykovi* (Fang , 1943)	Porcuşor de şes	+			+	0
13.		*Romanogobio kessleri* (Dybowski, 1862)	Porcuşor de nisip	+	+	+		0

14.		*Abramis ballerus* (Linnaeus, 1758)	Cosac cu bot ascuțit					
15.		*Pseudorasbora parva* (Schlegel, 1842)	Murgoi bălțat	+	+	+	+	xxx
16.		*Rutilus carpathorossicus* (Vladykov, 1930)	Babușcă	+		+	+	0
17.		*Leuciscus leuciscus* (Linnaeus, 1758)	Clean mic	+			+	
18.		*Squalius cephalus* (Linnaeus, 1758)	Clean	+	+	+	+	x
19.		*Idus idus* (Linnaeus, 1758)	Văduviță					0
20.		*Scardinius erythrophthalamus* (Linnaeus, 1758)	Roșioară	+		+	+	
21.		*Leucaspius delineatus* (Heckel, 1843)	Fufă					0
22.		*Alburnoides bipunctatus* (Bloch, 1782)	Beldiță	+	+			
23.		*Alburnus alburnus* (Linnaeus, 1758)	Oblete	+	+	+	+	
24.		*Aspius aspius* (Linnaeus, 1758)	Avat	+		+	+	
25.		*Blicca bjoerkna* (Linnaeus, 1758)	Batcă	+	+	+		
26.		*Vimba carinata* (Pallas, 1814)	Morunaș	+		+		
27.		*Abramis brama* (Linnaeus, 1758)	Plătică	+		+	+	x
28.		*Abramis sapa* (Linnaeus, 1758)	Cosac cu bot turtit	+			+	
29.		*Chondrostoma nasus* (Linnaeus, 1758)	Scobar	+	+	-		
30.		*Pelecus cultratus* (Linnaeus, 1758)	Săbiță					
31.		*Tinca tinca* (Linnaeus, 1758)	Lin	+	+			0

32.		*Phoxinus phoxinus* (Linnaeus, 1758)	Boiştean					
33.		*Ctenopharyngodon idella* (Valenciennes 1844)	Cosaş	(+)			(+)	xx
34.		*Hypophthalmichthys molitrix* (Valenciennes1844)	Sânger	(+)		(+)	(+)	xx
35.		*Hypophthalmichthys nobilis* (Valenciennes1844)	Novac	(+)		(+)	(+)	xx
36.	V	*Orthrias barbatulus* (Linnaeus, 1758)	Grindel	+	+		+	
37.	VI	*Misgurnus fossilis* (Linnaeus, 1758)	Țipar	+		+		0
38.		*Cobitis danubialis* (Băcescu, 1993)	Zvârlugă	+		+	+	
39.		*Sabanejewia balcanica* (Karaman, 1922)	Câră	+	+		+	
40.		*Sabanejewia vallachica* (Nalbant, 1957)	Câră de Muntenia	+		+	+	
41.	VII	*Silurus glanis* (Linnaeus, 1758)	Somn	+	+		+	
42.	VIII	*Anguilla anguilla* (Linneaus, 1758)	Anghilă					
43.	IX	*Lota lota* (Linnaeus, 1758)	Mihalț					0
44.	X	*Pungitius platygaster* (Kessler, 1859)	Plevuşcă de baltă			+		
45.	XI	*Perca fluviatilis* (Linnaeus, 1758)	Biban	+	+	+	+	
46.		*Stizostedion lucioperca* (Linnaeus, 1758)	Șalău	+	+		+	
47.		*Zingel zingel* (Linnaeus, 1758)	Pietrar					
48.		*Zingel streber* (Siebold (1868)	Fusar					

49.		*Gymnocephalus cernuus* (Linnaeus, 1758)	Ghiborț	+		(+)	+	x
50.	XII	*Lepomis gibbosus* (Linnaeus, 1758)	Biban soare	?				xxx
51.	XIII	*Proterorhinus marmoratus* (Pallas, 1814)	Moacă de brădiș	+	+		+	x
52.		*Neogobius fluviatilis* (Pallas, 1814)	Guvid de baltă	+	+		+	X

I	Familiy	Petromyzontidae	VIII	Familiy	Anguillidae	o	- native species-habitat drawback
II	Familiy	Acipenseridae	IX	Familiy	Gadidae	x	- native species-habitat increase
III	Familiy	Esocidae	X	Familiy	Gasterosteidae	xx	- acclimatized alien species
IV	Familiy	Cyprinidae	XI	Familiy	Percidae	xxx	- invasive species
V	Familiy	Nemacheilidae	XII	Familiy	Centrarchidae	+	- species with natural reproduction
VI	Familiy	Cobitidae	XIII	Familiy	Gobiidae	(+)	- species with artificial reproduction
VII	Familiy	Siluridae				■	- species present before 1960
							- species present after 2000

Table 2 Fish species collected before 1960 and after 2000 in the upper and middle stretches of the Siret River, depending on its pollution degree

No	Species	Zone I				Zone II				Zone III		
		1960	2002	2003	2004	1960	2002	2003	2004	1960	2003	2004
1.	Chişcar	-	-	-	-	-	-	x	-	-	-	-
2.	Cegă	-	-	-	-	-	-	-	-	x	-	-
3.	Ştiucă	x	x	-	x	x	-	-	-	x	-	-
4.	Crap	x	-	-	-	x	-	-	-	x	-	x
5.	Caracudă	x	-	-	-	x	-	-	-	x	-	-
6.	Caras	x	x	-	x	x	x	-	x	x	x	x
7.	Mreană	x	x	x	x	x	x	x	x	x	x	x
8.	Moioagă	x	-	-	-	-	-	-	x	-	-	-
9.	Boarță	x	-	x	x	x	-	x	x	x	-	x
10.	Porcuşor comun	x	x	x	x	x	x	x	x	x	x	x
11.	Porcuşor de şes	-	-	-	-	-	-	-	-	x	-	-
12.	Porcuşor de nisip	x	x	x	x	x	x	x	x	-	-	-
13.	Cosac cu bot ascuțit	-	-	-	-	-	-	-	-	x	-	-
14.	Murgoi bălțat	-	x	-	-	-	x	-	-	-	-	-
15.	Babuşcă	-	-	-	-	x	-	-	-	x	-	-
16.	Clean mic	x	-	-	-	x	-	-	-	-	-	-
17.	Clean	x	x	x	x	x	x	x	x	x	x	x
18.	Văduviță	-	-	-	-	-	-	-	-	-	-	x
19.	Roşioară	x	x	-	x	x	x	-	-	x	-	x

20.	Fufă	-	-	-	-	x	-	-	-	x	-	-
21.	Beldiță	x	-	-	x	-	-	x	x	-	-	-
22.	Oblete	x	x	x	x	x	x	x	x	x	-	-
23.	Avat	x	-	-	-	x	-	-	x	x	x	x
24.	Batcă	x	-	-	-	x	-	-	x	x	-	-
25.	Morunaș	x	-	-	-	x	-	-	-	x	-	-
26.	Plătică	x	-	-	-	x	-	-	-	x	-	-
27.	Cosac cu bot turtit	-	-	-	-	-	-	-	-	x	-	-
28.	Scobar	x	x	x	x	x	x	x	x	x	x	-
29.	Săbiță	-	-	-	-	-	-	-	-	x	-	-
30.	Lin	x	x	-	-	x	-	-	-	x	-	-
31.	Boiștean	-	x	-	-	-	-	-	-	-	-	-
32.	Grindel	x	-	-	-	-	-	-	x	-	-	x
33.	Țipar	-	-	-	-	x	-	-	-	x	-	-
34.	Zvârlugă	x	-	-	x	x	-	-	x	x	-	x
35.	Cără	x	x	x	-	x	x	x	-	-	-	-
36.	Cără de Muntenia	-	-	-	-	-	-	-	-	x	-	-
37.	Somn	-	-	-	-	x	x	-	x	x	-	x
38.	Mihalț	x	-	-	-	x	-	-	-	x	-	-
39.	Plevuşcă de baltă											
40.	Biban	x	x	x	x	x	-	x	x	x	x	x
41.	Șalău	-	-	-	-	-	-	-	-	x	x	x
42.	Pietrar	x	-	-	-	x	-	-	-	x	-	-
43.	Fusar	-	-	-	-	x	-	-	-	x	-	-
44.	Ghiborț	x	-	-	-	x	-	-	x	x	x	-
45.	Biban soare	-	-	-	-	-	-	-	-	x	-	-

46.	Moacă de brădiş	-	-	-	-	-	-	-	x	x	-	x
47.	Guvid de baltă	-	-	-	-	-	-	x	x	x	x	X

Zone I – unpolluted (between the Siret locality and the river junction with the Suceava River); Zone II – acute pollution with cyanide compounds (in January 2001); (between Dolhasca and the river junction with the Moldova River); Zone III – polluted (between the point where the Moldova River flows into the river and Bacau locality – upstream of Lake Galbeni)

Table 3 Comparative data regarding the numerical and weight stock of fish communities from river regions, depending on human impacts (water pollution, river regularization) on the Siret River course

Zone	Stock (ex. / 100mp)				Biomass (g / 100mp)			
	1960	2002	2003	2004	1960	2002	2003	2004
I	235,00	26,52	55,23	35,54	2457,20	429,63	392,99	405,97
II	70,00	5,93	24,44	35,20	618,80	46,68	137,8	309,42
III	136,00	18,13	28,87	54,75	713,00	33,87	124,28	178,25
IV	-	11,86*	-	-	-	874,0*	-	-
V	180,00	-	5,22	97,07	815,40	-	68,13	203,85

* - mean number value: ind. / 100 m^2 from all lakes in the middle Siret catchment

I – unpolluted zone (between the Siret locality and the river junction with the Suceava River); II – strongly polluted zone with cyanide compounds (between Dolhasca and the river junction with the Moldova River); III – polluted zone (between the point where the Moldova River flows into the river and Bacău locality – upstream of Lake Galbeni); IV – river regularization zone (Lake Galbeni, Lake Răcăciuni, Lake Bereşti, Lake Călimăneşti); V – the lower Siret River (downstream of Lake Călimăneşti, to the river junction with the Danube)

Table 4 Fish stock, biodiversity and integrity from the upper and middle stretches of the Siret River (upstream of Lake Galbeni)

Zone		Collecting sampling		Biodiversity			Integrity			No species		
				2002	2003	2004	2002	2003	2004	2002	2003	2004
Unpolluted zone	I	1	Vășcăuți	1,4479	1,469	-	III	IV	-	12	8	-
		2	Huțani	1,7493	1,2346	-	III	III	-	9	8	-
		3	Am.vărs Suceava	-	-	1,6835	-	-	II	-	-	14
		Media		**1,5986**	**1,3518**	**1,6835**	**3,0**	**3,5**	**2,0**	**10,5**	**8,0**	**14**
Pollute zone	II	4	Pod Dolhasca	1,6907	1,5931	1,631	VII	VII	VI	6	7	14
		5	Lespezi	1,9164	-	1,2619	VII	-	VII	8	-	5
		6	Mircești	1,4208	-	1,7696	V	-	IV	7	-	11
		7	Ion Creangă	1,3635	-	0,7973	VI	VII	-	7	-	10
	III	8	Drăgești	-	1,7654	-	-	-	V	-	9	-
		9	Holt	-	1,5451	1,754	-	VI	V	-	8	12
		Media		**1,5975**	**1,6345**	**1,4428**	**6,25**	**6,67**	**6,75**	**7,0**	**8,0**	**9,6**
Siret – av. lakes	V	10	Adjudu Vechi	-	0,7709	1,754	-	VII	VI	-	4	11
		11	Pod Cosmești	-	1,9204	1,5895	-	VI	VI	-	8	11
		12	Movileni	-	-	1,3795	-	-	V	-	-	11
		13	Lungoci	-	0,6365	-	-	-	-	-	2	-
		Media		**-**	**1,1093**	**1,5743**	**-**	**6,5**	**5,67**	**-**	**4,67**	**11,0**

Table 5 Integrity classes of fish communities from the Siret catchment area, depending on the collection period and the investigated areas

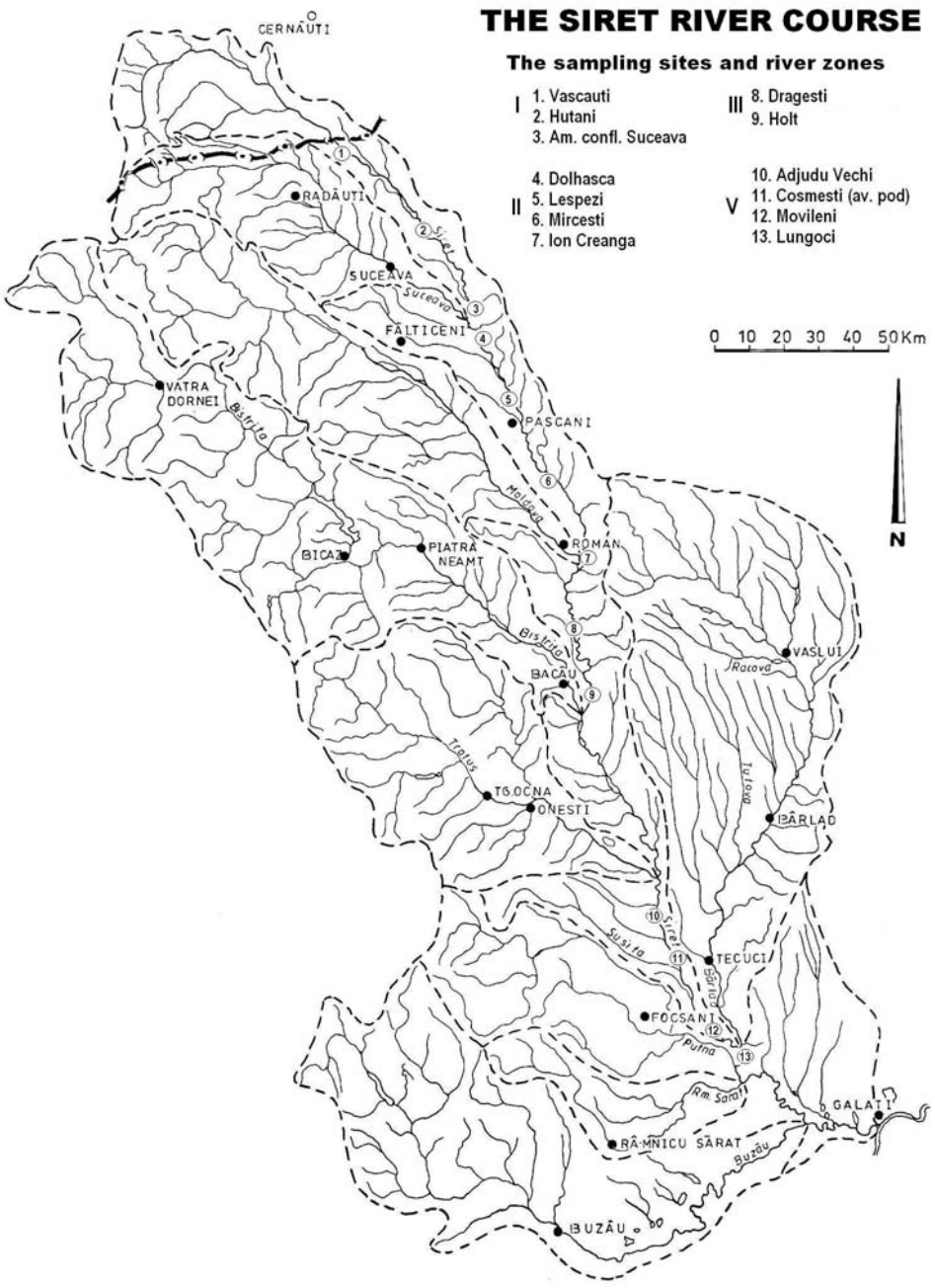
No	Period	Score	Investigated river stretches				
			Zone I (river)	Zone II (river)	Zone III (river)	Zone IV (lakes)	Zone V (river)
1	1994	Integrity class	II	III	II	V	-
		Score bonity	54	52	53	48	-
2	2002	Integrity class	III	V	IV	-	-
		Score bonity	51	44	48	-	-
3	2003	Integrity class	III	VI	V	-	VI
		Score bonity	48	38	50	-	38
4	2004	Integrity class	III	III	II	-	III
		Score bonity	52	53	54	-	52

I – Siret – am. confl. Cu Suceava; II – Suceava (vărsare) – Moldova (vărsare);
III – av. Vărsare Moldova – Bacău; IV – Lacurile de baraj – Galbeni, Răcăciuni, Bereşti, Călimăneşti; V – Siret – av. Călimăneşti

Table 6 List of endangered fish species from the Siret River (dwelling lotic habitats)

No	Species	S (%)		% / A			Endangerment degree
		2003	2004	1994	2003	2004	
1.	Grindel		0,01 ***				***
2.	Cosac			0,05***			***
3.	Crap		0,027**			0,03***	***
4.	Lin					0,03***	***
5.	Ghiborț	0,07**	0,013***			0,03***	***
6.	Știucă		0,01***			0,03***	***
7.	Moioagă		0,03**				**
8.	Batcă		0,03**			0,06**	**
9.	Caras	0,1**					**
10.	Cară	0,1**					**
11.	Șalău					0,09**	**
12.	Avat	0,05**					**
13.	Guvid de baltă	0,09**					**
14.	Chișcar	0,02**					**
15.	Porc. de nisip				0,07**		**
16.	Beldită	0,06*					*
17.	Fufă			0,11*			*
18.	Zvârluga			0,11*			*

** * - critical state: $W \leq 0.005$; $S \leq 0.01$; $(\%) \leq 0.05$
** - endangered: $W \leq 0.05$; $S \leq 0.1$; $(\%) \leq 0.1$
* - vulnerable: $W \leq 0.5$; $S \leq 1.0$; $(\%) \leq 1.0$


THE SIRET RIVER COURSE
The sampling sites and river zones
I
1. Vascauti
2. Hutani
3. Am. confl. Suceava
II
4. Dolhasca
5. Lespezi
6. Mircesti
7. Ion Creanga
III
8. Dragesti
9. Holt
V
10. Adjudu Vechi
11. Cosmesti (av. pod)
12. Movileni
13. Lungoci
0 10 20 30 40 50 Km
N
CERNĂUTI
RADĂUȚI
SUCEAVA
Suceava
Siret
FĂLTICENI
VATRA DORNEI
Bistrița
PAȘCANI
Moldova
ROMAN
PIATRA NEAMȚ
BICAZ
Bistrița
BACĂU
VASLUI
Racova
Trotuș
TG.OCNA
ONEȘTI
Bârlad
PÂRLAD
Siret
Șușița
TECUCI
Siret
FOCȘANI
Putna
Rm. Sărat
GALAȚI
RÂMNICU SĂRAT
Buzău
BUZĂU

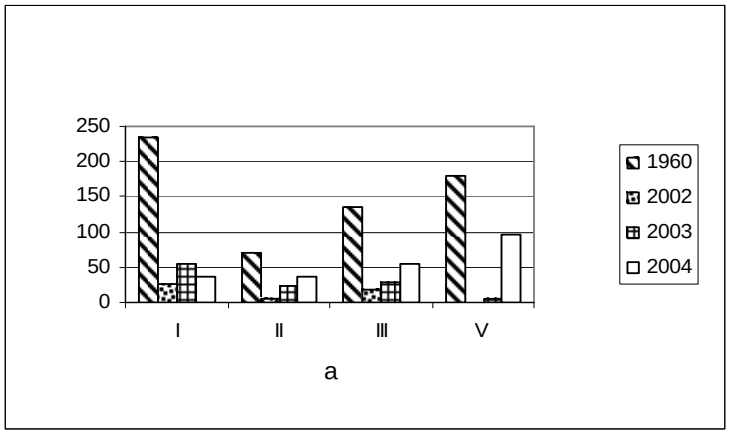


Fig.1. The Siret River course - the sampling sites and river zones

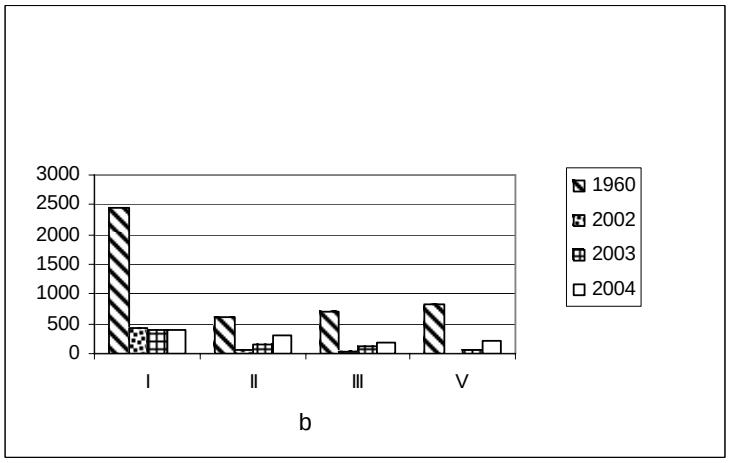


Fig. 2. Evolution of the numerical stock (ind./100m^2) (a) and of the weight stock (g/100m^2) (b) in every river zone on the Siret River course, during the past 40-50 years

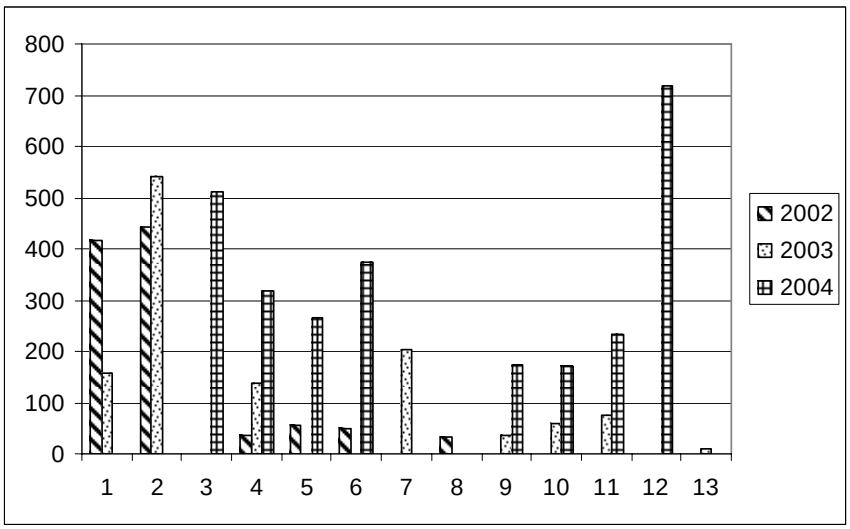


Fig. 3. Variation of the weight stock (g/100m^2) in the considered sampling sites during 2002, 2003 and 2004: Upstream from the flow of the Suceava River; Bridge
Collecting samples: 1 - Văscăuți, 2 - Huțani, 3 - am. vărs. Suceava, 4 - Dolhasca, 5 - Lespezi, 6 - Mirceşti, 7 - Ion Creangă, 8 - Drăgeşti, 9 - Holt, 10 - Adjudu Vechi 11 - Cosmeşti, 12 - Movileni, 13 - Lungoci

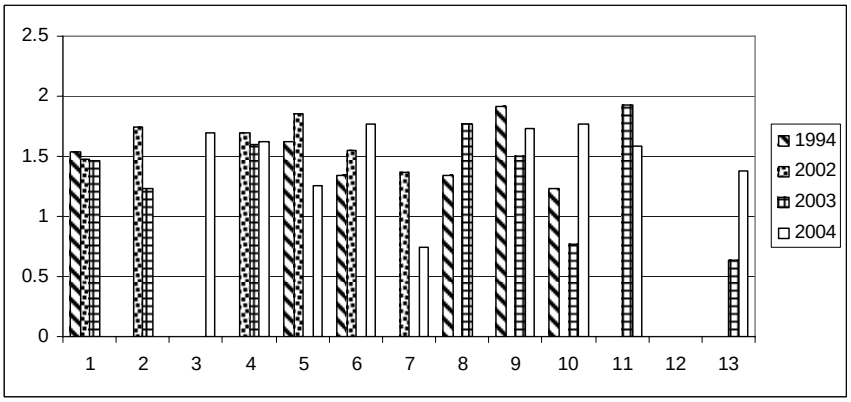


Fig. 4. Biodiversity values in the considered sampling sites and in the five river zones
Collecting samples: 1 - Văscăuți, 2 - Huțani, 3 - am. vărs. Suceava, 4 - Dolhasca, 5 - Lespezi, 6 - Mirceşti, 7 - Ion Creangă, 8 - Drăgeşti, 9 - Holt, 10 - Adjudu Vechi 11 - Cosmeşti, 12 - Movileni, 13 - Lungoci

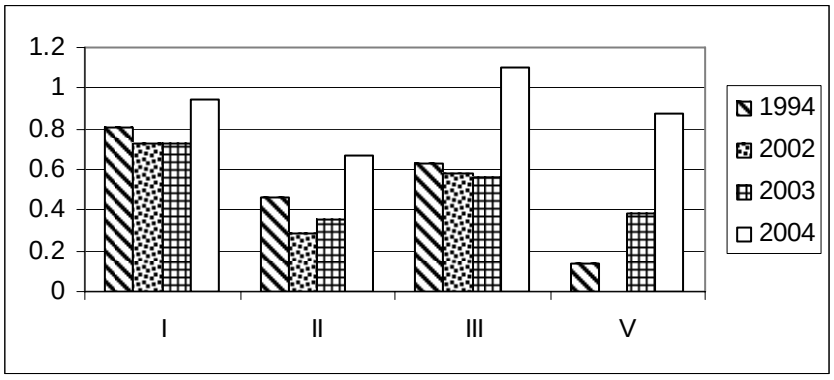


Fig. 5. Value variation of the differences between the maximum and the real biodiversity in the investigated zones

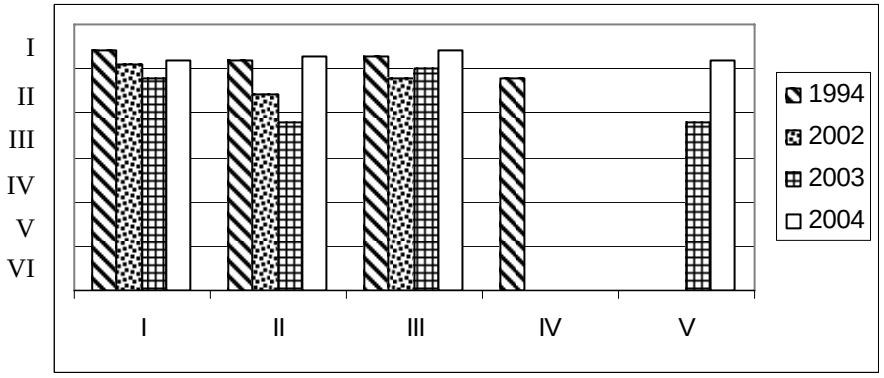


Fig. 6. Fish community integrity classes in every river stretch in the years 1994, 2002, 2003 and 2004