Hydrobiologia **389:** 89–100, 1998.

The importance of qualitative inventory sampling using electric fishing and nets in a large, tropical river (Brazil)

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Received 6 August 1997; in revised form 25 September 1998; accepted 27 October 1998

Key words: large tropical river, Paraná, diversity, qualitative sampling, electric fishing, gillnet, seine net

Abstract

Qualitative fish sampling (single catch) using three methods (electric fishing, gillnets, seine nets) was assessed at three sites in the Ivai River (Paraná State, Brazil) to check their usefulness for quick inventory investigations. Electric fishing at a constant effort (15 min per each) was considered to be the best sampling technique. Taxon richness was calculated as the expected number of species using a rarefraction technique. Samples of 300–325 individuals, and 6–10 repetitions in neighbouring segments were sufficient. Even though electric fishing was conducted with the same effort in similar segments at each site there were many differences in species abundance. This suggests that the estimated fish specimen number obtained with constant effort is of limited validity on one sampling occasion and may be best considered as an 'index of density' only. The differences may partially be caused by the segments being located along the right and left bank of the large river (problem of different habitats). Qualitative and quantitative differences between electric fishing, gill-netting and seine-netting samples were very high at a high significance level. Nevertheless, as 22.4% taxa were caught only by gill or seine nets, these gears were important for complementing the species list.

Introduction

Knowledge of the Paraná State ichthyofauna is limited to the section of the Paraná River that constitutes the state's western border (Agostinho et al., 1995), to its largest tributary, the Iguaçu River (Severi & Cordeiro, 1994; Agostinho et al., 1996) and to two small streams (Penczak et al., 1994).

The main source of energy in Paraná State is from hydro-electricity energy, but the number of dams and hydropower plants is increasing. Dams are known to have major impacts on biotic communities, especially on obligate riverine fish species (Petts, 1984; Orth & White, 1993; Moyle, 1994; Penczak et al., 1998). Their impact is aggravated by other human influences such as pollution, engineering and deforestation. The situation is exacerbated because of the number of endemic species vulnerable to environmental changes (Agostinho et al., 1996), and because some may not yet be known and could be lost to science (May 1988).

A rational conservation of the environment or of specific populations without having learned their present status is practically impossible. Hence, besides quantitative investigations required for fishery management (production, yield, recruitment, etc.) inventory investigations, which may be based on comparable qualitative samples, are important in predicting potential impacts of future water management decisions (Knight & Bain, 1996). Such surveys are less expensive and time-consuming than quantitative surveys (Knight & Bain, 1996).

The aim of this study was to estimate the representativeness of fish samples in sections of a large river, based on single catch per section by electric fishing and use of gill nets and seines.

The representativeness of the single samples obtained with these different methods was estimated using two data sets: (1) comparison of fish samples from adjoining sections of a site and sampled using constant effort of electric fishing, and (2) comparison of the quantitative and qualitative species composition within a sample set obtained with the three gears.

As there were noticeable differences in the ichthyofauna composition between the electrofished sections of a site, an additional question, how did sections' impacts on the ichthyofauna differ in view of their being located on the right or left river bank of a site, was formulated? This question is useful because large rivers encompass a great variety of habitats (Sedell et al., 1989) and lateral, vertical, and temporal dimensions of such systems are so wide (Ward & Stanford, 1989; Neiff, 1990) that the respective heterogeneity may be tautological with a high diversity of unique environments.

Material and methods

Study area

The study was carried out in the Ivai River, a tributary of the Paraná River (Figure 1). The river is 685 km long, with a catchment of 3545 km^2 and begins at the confluence of two rivers, the Patos and the São João, close to the town of Ivai. Its catchment constitutes 18% of Paraná State and the construction of six new reservoirs on the main river channel for hydropower (SUREHMA & GTZ, 1992) is planned there by the year 2015.

Site 1 is located over argillaceous rocks and siltstone, site 2 over cretaceous rocks with basalt intrusions, and site 3 over sandstone. Soil differs also in the three following sites: 1st – podsols red-yellow; 2nd – latosol deep-red, and 3rd – hydromorphic soils (Stevaux, 1991). Original vegetation was savannah in site 1, tropical rain forest in sites 2 and 3, while at present pasture dominates over arable land (Table 1).

The banks of the Ivai River are highly deforested, except at site 2. In its upper part (site 1) the river is a little polluted by inputs of nutrients from arable land. In the middle course (site 2) the concentration of solutes increases due to a moderate release of domestic sewage, and downstream (site 3) there is additional pollution from a manioc flour factory. Concentrations of solutes do not necessarily increase downstream (Table 1) because nutrients may be re-used by organisms and temporarily stored – 'nutrient spiraling' (Webster & Patten, 1979; Allan, 1995).

Site characteristics are included in Table 1. Macrophytes were substituted by periphyton at site 2, where it was particularly abundant. The length of both banks covered by electric fishing in sites 1, 2 and 3 was 2.5, 3.0 and 1.8 km, respectively. Except for site 2 the same numbers of sections were sampled along each bank.

Sampling methods

Electric fishing and netting were carried out in late spring 1994 in sites 1, 2, 3 on 21, 16 and 18 November, respectively. Electric fishing was conducted from a boat using full-wave rectified current (1 KW generator, output 220 V, 3–4 A) and two anode dipnets, while boating downstream with the river current approximately 2–4 m from the bank. Each fishing effort was 15 min (catch per unit of effort = CPUE), which was equivalent to 300–400 m of river, depending on the current velocity.

The gillnets were 20 m (stretch length) by 1.7 m deep. One set contained ten nets, with mesh knot to

Table 1. The morphology and physico-chemical characteristics of sites. Explanations: $^{a)}$ m – mud, s – sand, gr – gravel, r – rocks, $^{b)}$ t – trees, sh – shrubs, g – grass, $^{c)}$ in littoral zone, $^{d)}$ total Kjeldahl nitrogen, $^{e)}$ p – pasture, a – arable land. See text for further explanations

Parameters	Sites		
	1	2	3
Mean width (m)	60	130	90
Mean depth (m)	1.5	1.6	1.2
Maximum depth (m)	3.0	2.0	2.0
Substratum $^{a)}$	s>m	r>gr	s>m
Macrophyte cover (%)	0	0	0
Trees along banks (%)	20	70	5
Riparian vegetation type$^{b)}$	t>sh>g	t>sh	t>sh
Velocity (m·s^{-1})$^{c)}$	0.2	0.3	0.2
Water temperature (°C)	22.4	28.7	27.4
pH	7.2	7.3	7.3
Conductivity (μS·cm^{-1})	36	69	62
Dissolved oxygen (mg·l^{-1})	7.37	7.54	6.79
Alkalinity (μeq·l^{-1})	266	596	482
Nitrogen (mg·l^{-1})$^{d)}$	0.67	0.50	0.46
Phosphorus (μg·l^{-1})	59	68	86
Water transparency (m)	0.30	0.15	0.25
Adjacent area$^{e)}$	p>a	p>a	p
Rainfall (mm)	1700	1400	1300
Isotherms (°C)	20	21	22

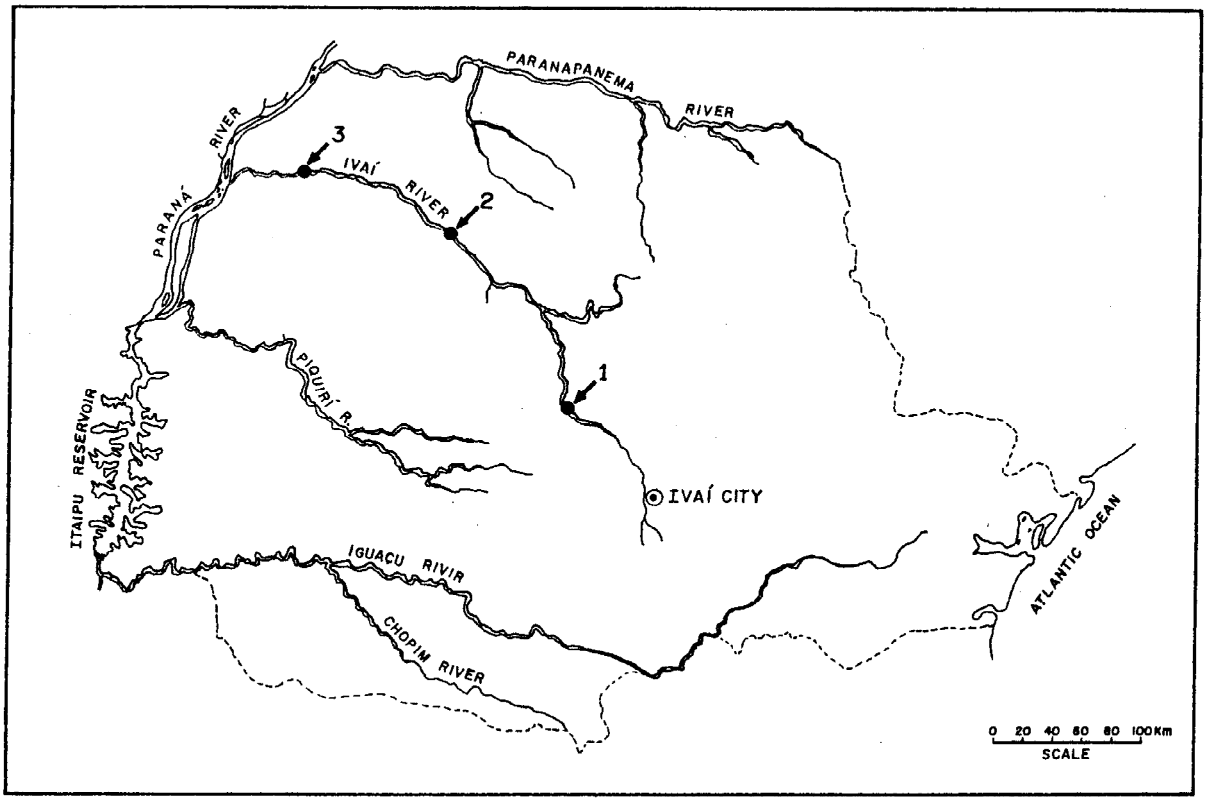

Figure 1. Main rivers of Paraná State. Ivai River with three sampling sites marked.

knot of 3, 4, 5, 6, 7, 8, 10, 12, 14 and 16 cm, to reduce the effects of size selectivity (Lagler, 1978). One end of the net was fixed to the bank and the other attached by ropes to a stone lying in the river bed. To reduce the pressure of water current exerted on the net, it was set at an acute angle, slightly less than 45%, to the downstream bank.

Seine nets used at site 2 were 20 m long, 2.4 m deep with mesh knot to knot of 8 mm. A semi-circular area of the river (littoral zone) was surrounded with the net, which was then drawn into the bank (Penczak et al., 1997).

All fish caught were anaesthetized and then fixed in 10% formalin solution.

In the text and tables shortened names of species are used, with full names being given in the Appendix.

Data analysis

Differences in the abundance of individual taxa caught by electric fishing in the sections at each site were tested using the *t* paired test. Species were considered blocks. The same protocol was used to test differences between the left and right bank of a site and between electric fishing and netting. The abundance data were $\log(x+1)$ transformed to stabilize variance (Steel & Torie, 1980).

Because species number invariably increased with sample size and sample sizes were not equal when using a constant effort a rarefraction technique was employed to compute the expected number of taxa (Hurlbert, 1971):

$$E(Sn) = \sum \left\{ 1 - \left[\left(\frac{N - N_i}{n} \right) / \frac{N}{n} \right] \right\},$$

where $E(Sn)$ = expected number of species, n = standardised sample size, N = total number of individuals recorded, and N_i = number of individuals in the ith species (Magurran, 1988; Ludwig & Reynolds, 1988).

Results

Number of species

A total of 3340 fish specimens belonging to 67 taxons (Appendix) were collected, 3013 by electric fishing

Table 2. Results of sampling at site 1 in the Ivai River. 1. Single electric fishing from boat in neighbouring segments (S) along right (R) and left (L) banks with CPUE equal to 15 min. 2. Gillnet catches with CPUE equal to 24 h.

Taxa	Electric fishing									Gillnet
	S1L	S2L	S3L	Total L	S4R	S5R	S6R	Total R	Total L+R	Total[a]
A. bimacul	8	20	12	40	5	10	7	22	62	2
A. lacustr	6	3	7	16	3	11	3	17	33	8
A. nasutus	9	3	6	18	2	2		4	22	
B. ihering	6	22	8	36		65	161	226	262	
Brycm sp	9	121	11	141	15	155	142	312	453	1
C. britski	7	1	4	12	3	2		5	17	2
G. brasili		5	5	10	1	18	5	24	34	1
G. carapo			1	1			2	2	3	
G. knerii										1
H. derbyi						4	1	5	5	6
H. lacerda		1		1			2	2	3	6
H. malabar			1	1					1	
H. margina	19	2	4	25	4		1	5	30	
Hemigramu					1	1		2	2	
Hypoptopo					1			1	1	
Hypost sp.	3	6	6	15	5	4	4	13	28	
Hypos sp.b.										3
I. labrosu										2
L. amblirh	1			1		1		1	2	
L. octofas						2		2	2	2
M. levis							1	1	1	
Odontosti	10	2	16	28	6	29	7	42	70	
Oligosarc	3	7	7	17	5	8	3	16	33	
P. maculat										1
P. tortuosus						6		6	6	
S. insculp						7	1	8	8	8
S. macruru		1	1	2	3	3		6	8	1
S. nasutus	1			1	5		3	8	9	4
Schizodon	1	4	2	7		4	3	7	14	
T. neivai					1	2	6	9	9	
Total	83	198	91	372	60	334	352	746	1118	48

[a] One set of gillnet. See text for further explanation.

and 327 by nets (Tables 2–4). The number of species and individuals in section 6 of site 2 (Table 3) differed from two others because experimental electric fishing was conducted at a distance of 20–30 m off the right bank where a fast water current and maneuvering the boat between rocks much reduced the catch efficiency. However insufficient, this experiment was important for determining the species list, capturing the only specimen of *Hypostomus albopunctatus*, and only the second *Nannorhamdia* sp. The first specimen was caught by the seine net in the Ivai River (Table 3). Further mid-river electric fishing was abandoned so as not to endanger the boat crew.

Although most taxa (42) were caught by electric fishing, nets contributed 15 taxa to the species list (Tables 2–4). These included four pelagic ones, which usually escape from a boat with a noisy generator (Table 5).

Analysis of the electric fishing samples in sections using the rarefraction technique (Figure 2) showed that, for the smallest number of individuals in a sample (vertical line in the figure) at sites 1, 2 and 3, 42–79%,

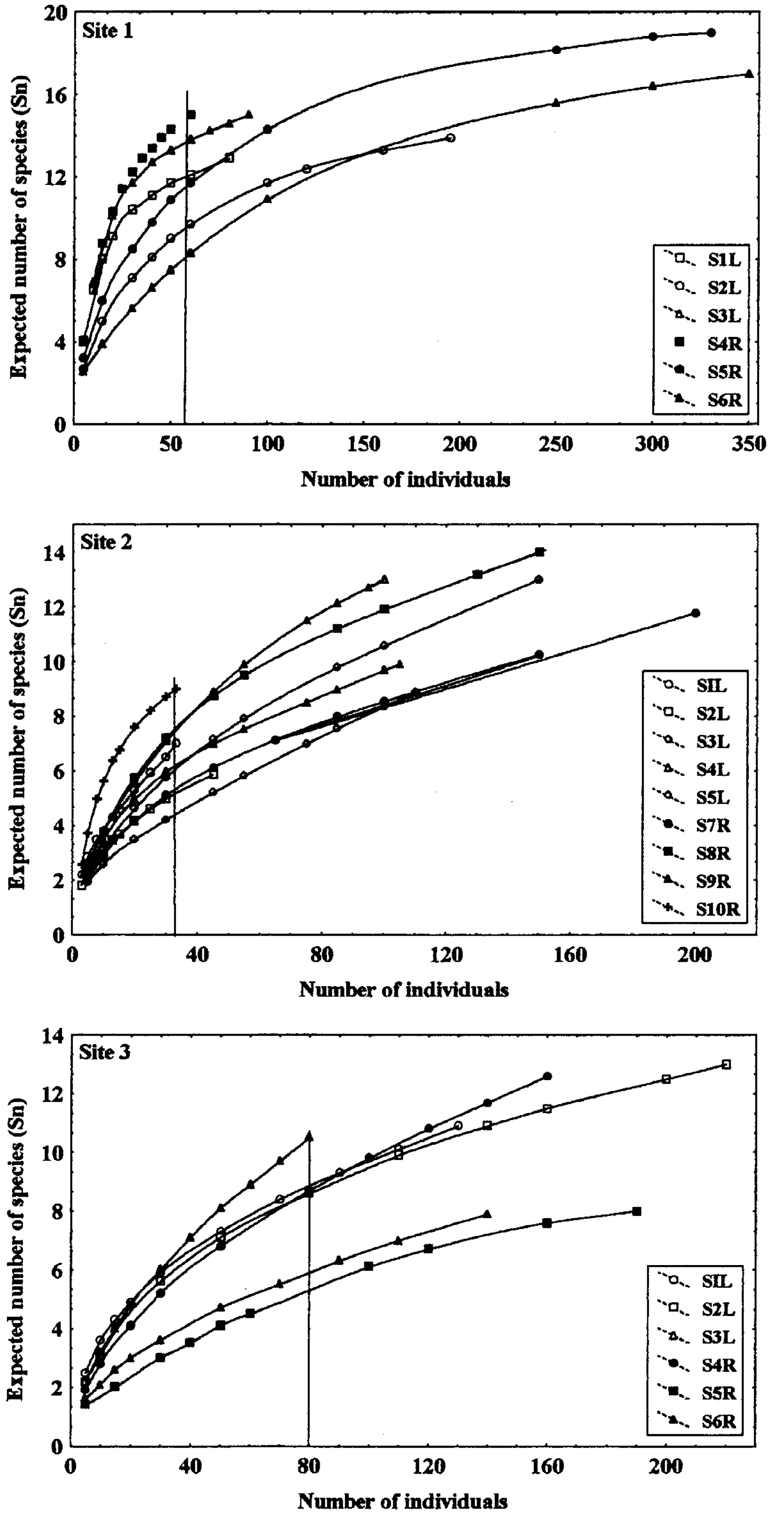

Figure 2. Rarefraction curves for the fish communities for each segment located at three sites in the Ivai River. Vertical line indicates lowest numbers of individuals sampled at a given site.

Table 3. Results of sampling at site 2 in the Ivai River.

Taxa	Electric fishing													Total seine-nets[a]
	S1L	S2L	S3L	S4L	S5L	S6L	Total L	S7R	S8R	S9R	S10R	Total R	Total L + R	
A. albifro					1		1						1	
A. bimacul				1	1		2	10	6		3	19	21	4
A. nasutus									3	5		8	8	5
A. nuchali														1
A. piracic										6		6	6	
A. affinis				3			3		7			7	10	3
Apteronot	3			1			4		1			1	5	1
B. ihering			1				1						1	4
B. strami	15	33	87	64	112		311	161	102	74	5	342	653	158
C. britski	1		1	2	4		8	10	7	1		18	26	3
C. haroldo		2	1	1	1		5						5	
C. zebra			3		6	1	10	1	8	7		16	26	4
E. triline										1		1	1	
E. virescens									1			1	1	
F. hahni	1		1	4	4		10	1		1		2	12	3
G. carapo		1		3	1		5	1	3			4	9	1
H. albopun						1	1						1	
H. regani				1			1						1	
Hypost. sp.	12	9	16	16	15	3	71	15	9	10		34	105	23
I. labrosu		1	1				2				4	4	6	5
L. amblirh								1	1			2	2	
L. obtusid														1
L. striatu				2			2		1			1	3	
Loricaria sp.											2	2	2	
M. interme														1
M. levis				2	3		5		1			1	6	3
M. platana						1	1	1			1	2	3	
Nannorha						1	1						1	1
P. gobioid	1						1						1	
P. ornatus														1
P. gracilis	1	2					3			1	11	12	15	1
R. paranen											1	1	1	8
R. hilarii			1		1		2	2	1			3	5	4
S. insculp								1			5	6	6	10
S. margina														1
S. marmora					1		1						1	
S. altopar				1	1		2	4		1	1	6	8	2
Total	34	48	112	101	151	7	453	208	151	107	33	499	952	248

[a]With four seine-nets. Explanations as in Table 2.

29–64% and 39–77% of the species were recorded, respectively. At site 1, taxon richness did not increase after 300–325 individuals were caught.

Differences between sections (electric fishing)

Each section was sampled only once using electric fishing, with a constant unit effort. Although the results were used for comparisons, they are best treated

Table 4. Results of sampling at site 3 in the Ivai River.

Taxa	Electric fishing									Gillnet
	S1L	S2L	S3L	Total L	S4R	S5R	S6R	Total R	Total L + R	Total[a]
A. bimacul	6	5	4	15	8	4	1	13	28	2
A. lacustr			1	1					1	2
A. nasutus	2	8		10	5	2	10	17	27	
A. piracic	4	14	2	20	2	1		3	23	
Brycm sp.	84	164	64	312	135	176	125	436	748	
C. britski	22	17	9	48	10	2	2	14	62	
C. zebra	1	1	1	3					3	
C. notomel					1			1	1	
C. paranae							1	1	1	
F. hahni	10			10	1	2	3	6	16	
G. carapo	1	2		3					3	
G. knerii										1
H. littora										1
H. malabar	1	1		2	1	1			2	4
H. margina		3		3	2			2	5	
H. regani										3
H. unitaen		1		1			1	1	2	
Hyphessob			1	1	1			1	2	
Hypost. sp.			1	1	1	2		3	4	2
I. labrosu										4
L. octofas							1	1	1	
Loricarich		1		1					1	2
M. interme			2	2					2	
M. levis		2		2					2	
Oligosarc			1	1					1	
P. lineatu										1
P. gracilis		1		1					1	
Potamotry										1
R. paranen	1			1					1	
R. vulpinu										6
R. hilarii					1			1	1	
S. altopar	1		1	2	1			1	3	
T. paragua										6
Total	133	220	87	440	169	190	144	503	943	31

[a] One gillnet set. Explanation as in Table 2.

as an index of abundance as it was impossible to calculate variance and error from the data.

Using transformed data the level of difference and statistical significance between section samples was calculated (Table 6). The recorded differences were 27, 33 and 20% in sites 1, 2 and 3, respectively. However, when the Bonferroni criterion (Sokal & Rohlf, 1995) was used to keep type I error at 0.05, no differences were detected.

Differences between banks

Differences between pooled left and right sections in sites 1, 2 and 3 were significant at $p = 0.014$ (t-test 2.61, d.f. 29), $p = 0.006$ (2.90, 36) and $p = 0.037$ (2.18, 32), respectively.

Differences between gears

At site 1, differences between number of fish per taxon for electric fishing and gillnet sampling were very high

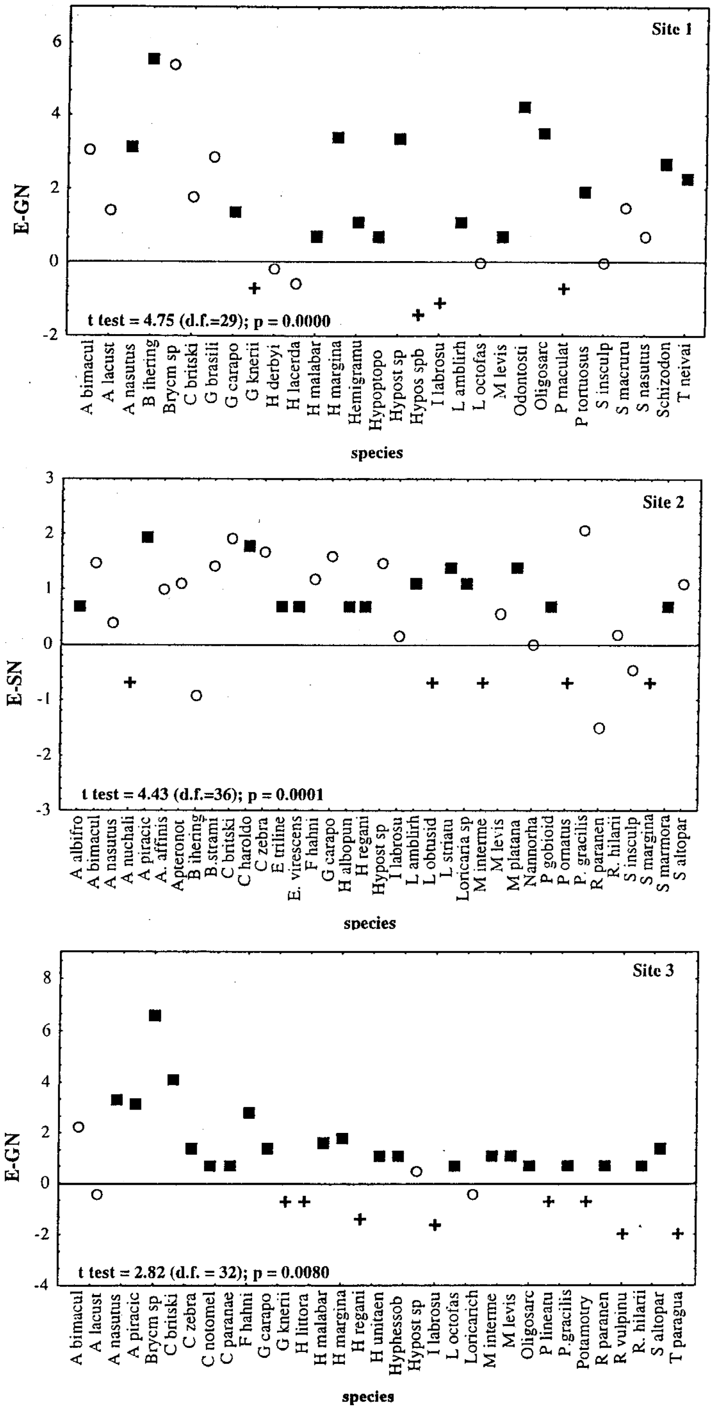

Figure 3. Differences between number of fish per taxon collected by electric fishing (E), gillnets (GN) and seine nets (SN) using transformed data. Open circles (◯) indicate taxa caught by all gears, filled squares (■) indicate taxa caught by electricity, and crosses (+) indicate taxa caught by nets.

Table 5. Number (No.) of fish taxa and individuals (indiv) collected by electric fishing (E) and nets at three sites in the Ivai River. GN – gillnet; SN – seine net.

Parameters	Sites		
	1	2	3
No. indiv by E	943	952	1118
Time of E (h)	1.5	2.5	1.5
No. of indiv by h^{-1} of E	629	381	745
No. indiv by net	48 (GN)	248 (SN)	31 (GN)
Time of netting (h)	24 (GN)	0.66 (SN) [a)]	24 (GN)
No. of indiv by h^{-1} of netting	2 (GN)	376 (SN)	1.3 (GN)
Total no. by E and net	991	1200	1149
No. taxa by E only	15	13	21
No. taxa by net only	4 (GN)	5 (SN)	8 (GN)
No. taxa by E and net	11	19	4
Total no. of taxa	30	37	23

[a]Time of one SN was 10 min (4 hauls).

(p = 0.0000) and not much lower at site 3, where the same gears were applied (Figure 3). Differences between electric fishing and seine netting had the narrowest range (cf. ‘y’ axis, Figure 3). The number of fish captured per taxon with the seine net was high and almost the same per hour of sampling as that of electric fishing (Table 5). Of course, comparisons of the gears’ performance in terms of time (CPUE) have as their objective only giving future researchers a clue to how much time is required in similar investigations and how efficient the investigations may be. The gears rely on different time and space scales and for quantitative studies respective comparisons do not make sense.

Discussion

“Obviously, altered habitats contain altered fish fauna” (Moyle, 1994) and this is partially true for the Ivai River. Yet low levels of organic pollution or partial destruction of ecotone zones (Table 1) are not very destructive as compared with the potential changes following the planned construction of several dams and hydropower plants (Petts, 1984; Orth & White, 1993). Hence, it is not yet too late to investigate the fish fauna of the Paraná State rivers, considering that as many as 67 taxa were identified in the Ivai during three days sampling.

Significant differences were recorded in total abundance and number of taxa caught by each method, the highest numbers of each being obtained by electric fishing. These differences were much higher than those recorded by Growns et al. (1996) and Knight & Bain (1996). This is interesting because while the electric current parameters on the outlet were much lower in our study and our water conductivity was also low (no conductivity data are available in their studies), we managed to capture 3.5 times more fish h^{-1}. In the case of site 2, where sampling with electric current and seine net was used, numerical differences between gears were slight, but, in contrast to the gillnet, the seine net is included in active gears (Hayes, 1983).

Growns et al. (1996) suggest that electric fishing is capable of sampling inactive as well as active species, while gillnets “are generally limited to sampling swimming fish”. Using different terms, pelagic and benthic, it was calculated that the ratio of pelagic to benthic taxa for the net and electric fishing was 4:5 and 13:22, respectively, which does not indicate any net preference for benthic species. The ‘two advantages’ of electric fishing over gillnetting (greater number of species and sampling precision) claimed by Growns et al. (1996) find a certain support in our investigations and Knight & Bain (1996). However, we consider that besides their lower material and effort costs, gillnetting is important in inventory research because the catches contain species not caught by other methods. This conclusion supports the suggestion by Casselman et al. (1990) that there is no single, universal method of investigating the ichthyofauna of large rivers.

Table 6. Probability levels for differences in abundances of taxa collected by electric fishing at given segment (S) in the Ivai River sites. Probability values < 0.05 are in bold. *p* is the probability corrected by the Bonferroni criterion. Parentheses = number of comparisons

Site 1, number of differences = 4 (15), *p*=0.003

	S1L	S2L	S3L	S4R	S5R	S6R
S1L	1.000					
S2L	0.623	1.000				
S3L	0.286	0.817	1.000			
S4R	0.705	0.455	0.239	1.000		
S5R	**0.026**	**0.007**	**0.026**	**0.016**	1.000	
S6R	0.299	0.284	0.524	0.216	0.085	1.000

Site 2, number of differences = 15 (45), *p*=0.001

	S1R	S2R	S3R	S4R	S5R	S6R	S7L	S8L	S9L	S10L
S1R	1.000									
S2R	0.974	1.000								
S3R	0.287	0.193	1.000							
S4R	**0.013**	**0.014**	0.138	1.000						
S5R	**0.022**	**0.018**	**0.023**	0.820	1.000					
S6R	0.169	0.228	0.094	**0.014**	**0.014**	1.000				
S7L	**0.035**	**0.034**	0.092	0.741	0.860	**0.021**	1.000			
S8L	**0.012**	**0.011**	**0.031**	0.322	0.417	**0.006**	0.513	1.000		
S9L	0.117	0.103	0.352	0.650	0.457	**0.036**	0.472	0.180	1.000	
S10L	0.586	0.540	0.918	0.356	0.323	0.089	0.261	0.157	0.550	1.000

Site 3, number of differences = 3 (15), *p*=0.003

	S1L	S2L	S3L	S4R	S5R	S6R
S1L	1.000					
S2L	0.344	1.000				
S3L	0.312	0.090	1.000			
S4R	0.934	0.302	0.219	1.000		
S5R	0.087	**0.024**	0.546	**0.018**	1.000	
S6R	0.151	**0.042**	0.645	0.085	0.977	1.000

Rarified taxon richness was assessed as the expected number of taxa in the Ivai River if the number of individuals caught at a segment had been 300–325 fish. At site 3 the sample of 160 individuals contained the same number of species as these with 220 fish, which indicates a weakness of the rarefraction method (Magurran, 1988) as well as some environmental differences between sections and selectivity of the electric fishing technique (Casselman et al., 1990; Knight & Bain, 1996). It is a rather raw richness estimate (Vinson & Hawkins, 1996) and for increasing accuracy a minimum of six contiguous sections are recommended for assessing site taxon richness.

The higher number of differences between samples captured in given sections recorded for log-transformed data showed the lack of accuracy in our density indexes and further investigations are required. Differences between left and right bank sections were always statistically significant, which is why the number of differences between sections considered together increased in our first comparison. For us the ecotone zones of both banks of the three sites in the Ivai were similar; for fish they were not. However, this does not diminish the usefulness of this research, because the overall aim of the study was to obtain the richest possible list of species of this uninvestigated river. Attempts at critical analysis of the CPUE data were also probably useful because, owing to calculated density indices, it is possible to estimate the impact of various human impacts on fish populations, now and in the future. Knight & Bain (1996) also recommended 'qualitative pilot studies' using similar gears and stated that they should be done prior to initiating more detailed studies on fish communities in relatively uninvestigated environments where sampling conditions are different, such as exist in tropical rivers.

Acknowledgements

The authors are very obliged to R. H. K. Mann and an anonymous reviewer for extensive, merit comments on the manuscript, English improvement and valuable suggestions for future research. The authors thank Ł. Głowacki for his help in preparing the English version of the manuscript, Sidinei M. Thomaz for chemical water analysis and J. D. Latini, S. Rodrigues, Claudiane L. M. Ferreti, Luiz A. M. Ludwig and Geraldo A. Stumm for assistance in field research. The study was financially supported by COPEL.

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Appendix 1. Explanations: p – pelagic; b – benthic, and pg – pelagic–benthic species

No.	Latin name	Abbreviation
1	*Acestrorhynchus lacustris*	A. lacust **p**
2	*Apareiodon affinis*	A. affinis **b**
3	*Apareiodon piracicabae*	A. piracic **b**
4	*Aphyocharax nasutus*	A. nasutus **p**
5	*Apteronotus albifrons*	A. albifro **pb**
6	*Apteronotus* sp.	Apteronot **pb**
7	*Astyanax bimaculatus*	A. bimacul **pb**
8	*Auchenipterus nuchalis*	A. nuchali **p**
9	*Bryconamericus iheringi*	B. ihering **b**
10	*Bryconamericus* sp.	Brycm sp **b**
11	*Bryconamericus stramineus*	B. strami **b**
12	*Characidium zebra*	C. zebra **b**
13	*Cheirodon notomelas*	C. notomel **pb**
14	*Cichlasoma paranaense*	C. paranae **b**
15	*Crenicichla britski*	C. britski **b**
16	*Crenicichla haroldoi*	C. haroldo **b**
17	*Eigenmannia trilineata*	E. triline **p**
18	*Eigenmannia virescens*	E. virescens **p**
19	*Farlowella hahni*	F. hahni **b**
20	*Galeocharax knerii*	G. knerii **p**
21	*Geophagus brasiliensis*	G. brasili **b**
22	*Gymnotus carapo*	G. carapo **b**
23	*Hemigrammus marginatus*	H. margina **p**
24	*Hemigrammus* sp.	Hemigramu **p**
25	*Hoplerythrinus unitaeniatus*	H. unitaen **pb**
26	*Hoplias lacerdae*	H. lacerda **pb**
27	*Hoplias malabaricus*	H. malabar **pb**
28	*Hoplosternum littorale*	H. littora **b**
29	*Hyphessobrycon* sp.	Hyphessob **p**
30	*Hypoptopomus* sp.	Hypoptopo **p**
31	*Hypostomus albopunctatus*	H. albopun **b**
32	*Hypostomus derbyi*	H. derbyi **b**
33	*Hypostomus regani*	H. regani **b**

Appendix 1. Cont'd

No.	Latin name	Abbreviation
34	*Hypostomus* sp.	Hypost sp **b**
35	*Hypostomus* sp. b.	Hypos spb **b**
36	*Iheringichthys labrosus*	I. labrosu **b**
37	*Leporinus amblirhynchus*	L. amblirh **b**
38	*Leporinus obtusidens*	L. obtusid **pb**
39	*Leporinus octofasciatus*	L. octofas **pb**
40	*Leporinus striatus*	L. striatu **pb**
41	*Loricaria* sp.	Loricaria sp **b**
42	*Loricarichthys* sp.	Loricarich **b**
43	*Megalonema platana*	M. platana **p**
44	*Moenkhausia intermedia*	M. interme **p**
45	*Myloplus levis*	M. levis **pb**
46	*Nannorhamdia* sp.	Nannorha **pb**
47	*Odontostilbe* sp.	Odontosti **pb**
48	*Oligosarcus* sp.	Oligosarc **p**
49	*Parodon tortuosus*	P. tortuosus **b**
50	*Pimelodella gracilis*	P. gracilis **b**
51	*Pimelodus maculatus*	P. maculat **pb**
52	*Pimelodus ornatus*	P. ornatus **pb**
53	*Potamotrygon* sp.	Potamotry **b**
54	*Prochilodus lineatus*	P. lineatu **pb**
55	*Pseudocetopsis gobiodes*	P. gobioid **pb**
56	*Raphiodon vulpinus*	R. vulpinu **p**
57	*Rhamdia hilarii*	R. hilarii **pb**
58	*Roeboides paranensis*	R. paranen **p**
59	*Schizodon altoparanae*	S. altopar **p**
60	*Schizodon nasutus*	S. nasutus **p**
61	*Schizodon* sp.	Schizodon **pb**
62	*Serrasalmus marginatus*	S. margina **pb**
63	*Steindachnerina insculpta*	S. insculp **b**
64	*Sternopygus macrurus*	S. macruru **pb**
65	*Synbranchus marmoratus*	S. marmora **b**
66	*Tatia neivai*	T. neivai **pb**
67	*Trachydoras paraguayensis*	T. paragua **b**