Composition and structure of fish community in a stretch of the Santa Bárbara River influenced by Nova Avanhandava Reservoir (low Tietê River, São Paulo State, Brazil).

VIDOTTO[1], A.P. & CARVALHO[1], E.D.

[1] UNESP, Instituto de Biociências, Departamento de Morfologia, Laboratório de Biologia e Ecologia de Peixes, CEP 18.618-000, Botucatu, São Paulo, Brazil e-mail: vidotto@ibb.unesp.br.

ABSTRACT: Composition and structure of fish community in a stretch of the Santa Bárbara River influenced by Nova Avanhandava Reservoir (low Tietê River, São Paulo State, Brazil). The purpose of this study is to characterize the fish species in Santa Bárbara River, the major tributary of Nova Avanhandava Reservoir, and the structure of this fish community. Fishes were collected in fourteen samplings, with gill and sieving nets (used in littoral areas), in six sites with different physiographical characteristics. The physical and chemical parameters of the water at each site were also recorded: water temperature, dissolved oxygen, conductivity, pH, water transparency and depth were measured. The two fishing gears captured fourteen species, 4,010 specimens, comprising a biomass of 308.5Kg. Introduced species represented 30% of ichthyofauna (12 species), and 38% in number and 50% of the biomass in the gill net captures. The Ponderal index showed that P. squamosissimus is the dominant species at most sites, a finding not related to the site's characteristics, while at two sites, A. altiparanae was dominant. Characiformes were the most abundant species, followed by Perciformes and Siluriformes, different of expected for South-American rivers. This finding may be due to the introduction of Perciformes (8 species), indicating drastic changes in the composition of this reservoir after species introduction. Despite similarity in the physical and chemical parameters of water between sites, the Shannon-Wiener diversity index (T test, $p > 0.05$), as well as the CPUE (ANOVA, $p<0.05$), were significantly different for the majority of sites. The shallowest sites presented higher species number as well as greater diversity, species richness, constant species and CPUE, indicating that littoral zones are the most diverse and productive zones of reservoirs and important for the maintenance of fish abundance and diversity of fish community.
Key-words: freshwater fish, reservoir, Tietê River, introduced species, littoral zones.

RESUMO: Composição e estrutura da comunidade de peixes de um trecho do rio Santa Bárbara sob influência do reservatório de Nova Avanhandava (baixo rio Tietê, São Paulo, Brasil). O objetivo deste trabalho foi caracterizar as espécies de peixes do rio Santa Bárbara, maior tributário do reservatório de Nova Avanhandava, e ainda a estrutura desta comunidade de peixes. Foram realizadas 14 coletas com redes de espera e arrasto marginal, em seis trechos com diferentes características fisiográficas. Também foram obtidos dados abióticos de cada um dos trechos: temperatura da água, oxigênio dissolvido, condutividade, pH, transparência e profundidade. As duas metodologias de captura amostraram 40 espécies de peixes, compreendendo 4,010 exemplares e uma biomassa de 308.35Kg. As espécies introduzidas representam 30% da ictiofauna (12 espécies), 38% da abundância numérica e 50% da biomassa das capturas com rede de espera. O índice Ponderal mostrou que P. squamosissimus foi dominante na maioria dos trechos, independente de suas características, enquanto que nos outros dois trechos a espécie dominante foi A. altiparanae. Os Characiformes foram mais abundantes, seguidos pelos Perciformes e Siluriformes, neste último, diferente do esperado para os rios sul-americanos. Este fato está relacionado ao número de espécies introduzidas que pertencem a esta ordem (8 espécies), indicando modificações severas na composição de espécies deste reservatório decorrentes das introduções. Apesar da semelhança dos fatores abióticos entre os trechos, o índice de diversidade de Shannon-Wiener foi significativamente diferente entre a maioria dos trechos (T test, $p>0.05$), bem como a CPUE (Anova, $p<0.05$). Os trechos mais rasos apresentaram maior número de espécies, diversidade, riqueza, número de espécies constantes e CPUE. Isto indica que as zonas litorâneas dos reservatórios são as mais diversas e produti-

vas, e importantes na manutenção da abundância e diversidade das comunidades de peixes de reservatórios.

Palavras chave: peixes de água doce, reservatório, rio Tietê, espécies introduzidas, áreas litorâneas.

Introduction

River damming represents one of the greatest human interferences in natural river flow, leading to several effects on the river basin (Gore, 1996). Many Brazilian impoundments have been built for hydroelectric generation during the last 40 years, especially in the Southeastern, Midwest and South regions of the country. In the upper Paraná River basin, a chain of dams and artificial lakes has been built along its large tributaries, including the Grande, Paranaíba, Tietê, Paranapanema and Iguaçu rivers, and the main channel of Paraná River (Araújo-Lima et al., 1995), particularly in response to the growing demand for electric energy in southeastern Brazil, the most inhabited area of the country.

Numerous consecutive dams create a group of reservoirs that receive and accumulate organic and inorganic matter from adjacent systems (Rodgher et al., 2005). The main channel of Tietê River comprises a cascade of six reservoirs: Barra Bonita, Bariri, Ibitinga, Promissão, Nova Avanhandava and Três Irmãos. The river also receives great discharges of organic matter, toxic substances and domestic sewage from metropolitan regions, but the cascade system is capable of increasing water quality, due to the sedimentation of suspended matter in the system's upper portion (Fracácio et al., 2002, Rodgher et al., 2005).

Characterizing the spatial and temporal patterns of the fish community from these heterogeneous and complex environments helps to evaluate the factors (human and natural) that regulate community structure (Gido & Matthews, 2000; Oliveira et al., 2005). Fish communities of reservoirs are the result of ecological reorganization process of the communities that previously occupied the dammed fluvial segments. Many drastic changes in composition and abundance of species can occur, such as excessive proliferation of some opportunistic species, and decline or local extinction of others that cannot complete their life cycle, such as migratory species (Araújo-Lima et al., 1995; Agostinho et al., 2004). In addition to damming, other impacts contribute to changes in fish communities of many Brazilian rivers, like water contamination by domestic and industrial effluent discharges and use of agrotoxics in the vicinity of reservoirs (Rodgher et al., 2005), loss of ciliary forest (Alvim & Peret, 2004), and introduction of exotic species (Agostinho & Júlio Jr., 1996), producing damage and unpredictable effects to the aquatic biota.

The aim of this study is to characterize the composition, structure and ecological attributes of the fish community from Santa Bárbara River, in a stretch strongly influenced by the Nova Avanhandava Reservoir (low Tietê River, São Paulo, Brazil).

Material and methods

Nova Avanhandava Reservoir is the fifth of Tietê cascade. Its dam is at an elevation of 358m and has a surface area of 210 km^2, total water volume of 2,720 x 10^6 m^3, mean discharge rate of 688m^3.s^{-1}, maximum depth of 30m and water permanence time of 46 days (Torloni et al., 1993; Rodgher et al., 2002). According to the energy company AES Tietê, variation in the altimetric level of the dam is almost insignificant (357.9 to 358.3m).

Santa Bárbara River (S 21^o 05' 25" W 050^o 07' 18") is the most important tributary of Nova Avanhandava Reservoir, flowing into the right margin of reservoir's main channel. Six sampling sites (A, B, C, D, E and F) were selected for this study; all of them receive strong influence of the lentic compartment of the reservoir. The first site (A) is shallow and has extensive pasture and farming areas in the vicinity; sites B and C have a small secondary forest on the margin, and aquatic macrophytes; the edges of sites D and F are also widely used for pasturing and farming, although the former is shallow and the latter is deeper; site E is very deep (max. 12.5m) and, here, nets were set in open water (Fig. 1).

The physical and chemical parameters of water were recorded at each site, except for sites C and D, where only one measurement was made, due to the proximity between them. The following parameters were recorded: water depth using a Secchi disc, water temperature and dissolved oxygen (with oximeter), conductivity (with electronic conductomer) and pH (with pHmeter).

Samplings were made monthly from September 2002 to August 2003, and also in October and December 2003, and March 2004 (14 samples). Fishes were caught using gill nets with mesh sizes from 3 to 14 cm (opposite knots length), comprising 1,200 m² of nets per month. Gill nets were placed late in the afternoon and removed the following morning (14 hours exposure) in the six sampling sites (Fig. 1, Tab. I).

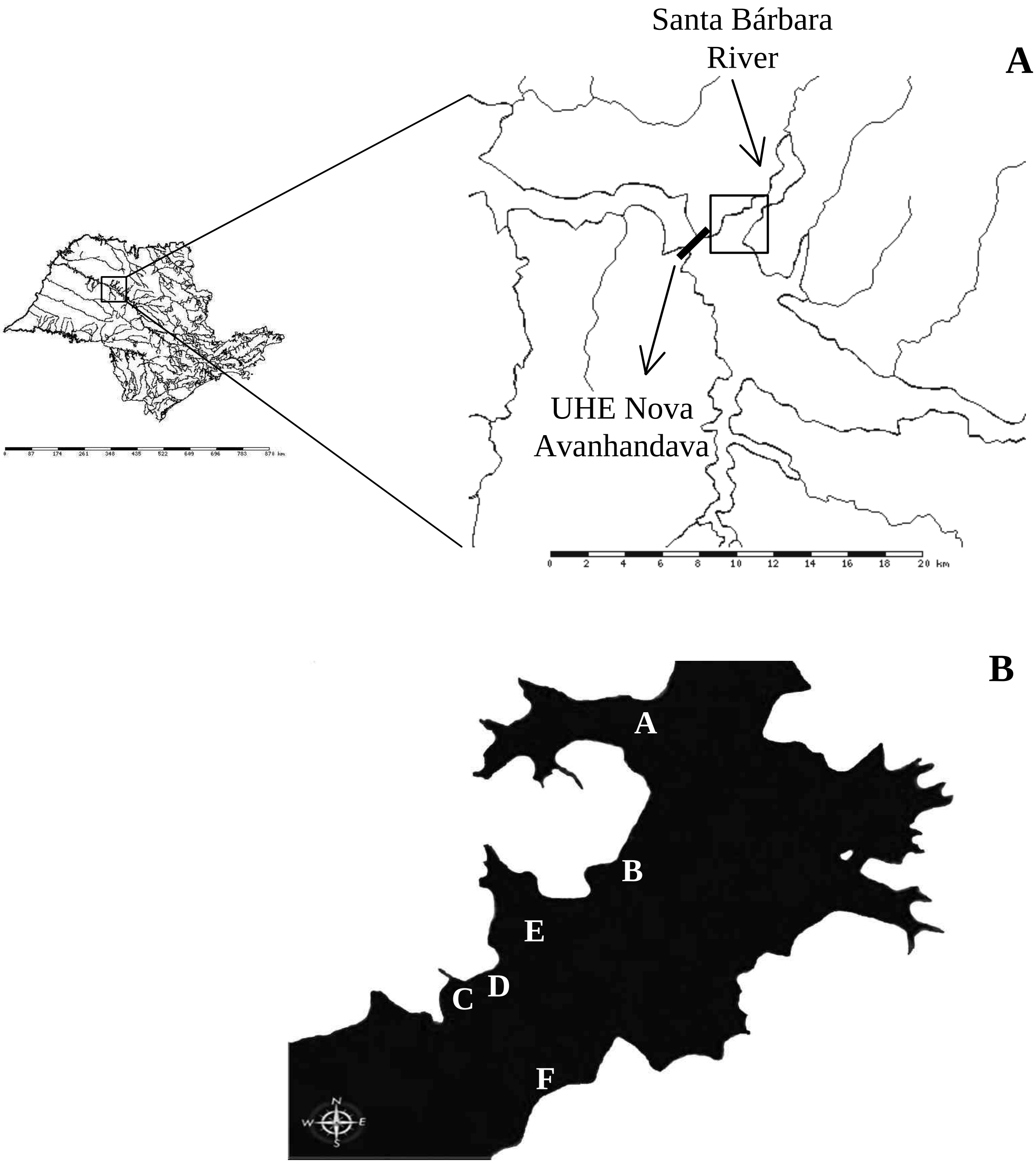

Figure 1: São Paulo State and the Nova Avanhandava Reservoir (Low Tietê River), indicating the Santa Bárbara River (A); localization of six sampling sites at Santa Bárbara River (B).

Table I: Mean values (and standard errors in parentheses) of physical and chemical parameters of water, and depth amplitude of sampling sites in Santa Bárbara River, Nova Avanhandava Reservoir, low Tietê River, Brazil.

Sites	Water Temperature (°C)	Water transparency (m)	Dissolved oxygen ($mgO_2.L^{-1}$)	pH	Conductivity (mS.cm^{-1})	Depth (m)
A	25.5 (2.92)	1.58 (0.38)	7.51 (1.02)	7.41 (0.51)	155.8 (17,67)	0.65 - 1.0
B	25.9 (2.73)	1.49 (0.38)	7.71 (0.74)	7.40 (0.60)	155.0 (15.27)	0.60 - 1.7
C-D	25.4 (2.76)	1.49 (0.32)	7.49 (0.72)	7.42 (0.52)	157.7 (16.39)	1.5 - 3.8
E	25.7 (2.92)	1.44 (0.33)	7.87 (0.91)	7.42 (0.50)	154.2 (13.98)	6.8 - 12.5
F	25.2 (2.65)	1.34 (0.25)	7.76 (1.19)	7.38 (0.61)	158.7 (11.96)	1.1 - 7.5

We also used a seining net (10 x 1.5 m, 5mm mesh) in some months (Oct/2002, Feb, May, Jun, Oct and Dec/2003), to capture small-sized fish and thus, minimize the selectivity of gill nets. Nets were handled by two individuals and were thrown three times into aquatic vegetation and margin of the river. The results obtained with this fishing gear were not included in the statistical analysis.

Fish collected were identified to species, preserved in 10% formalin and, conserved in 70° GL alcohol. Voucher specimens were deposited in the Museu de Zoologia da Universidade Estadual de Londrina (MZUEL n. 4,729 to MZUEL 4,760).

Abundance was calculated in number and biomass according to catch frequency (%) of each species and taxonomic group, and also by a double criteria method based on the Ponderal index (PI), expressed as a percentage: [(Ni.Wi)/ å (Ni.Pi)].100, where Ni and Wi are the total number and weight of individuals of ith species (Nataragam & Jhingian, 1961 (in Beaumord & Petrere Jr., 1994). Catch per unit effort (CPUE) was estimated for number (CPUEn) and biomass (CPUEb). This standardizing indicates how much would be collected if 1000 m² gill nets had been used during 14h of exposure. For statistical analysis, we performed a natural log (ln) transformation on CPUE data. A Kolmogorov-Smirnov test was performed to verify Gaussian distribution, and one-way analysis of variance (ANOVA) was carried out for significant differences between CPUE data at each site.

The frequency of sampling constancy (Dajoz, 1978) was calculated for each site, and the following categories were established: constant (³50%), accessory (25% ³ C ‹ 50%) and accidental (‹ 25%). Two diversity indexes were used, that are not affected by sample size: Shannon-Wiener (H') and Simpson (1/D), which is also considered as a dominance measure (Krebs, 1989). T test was performed on Shannon-Wiener index data, using PAST program (Hammer et al., 2003). Eveness index (E) and species richness (S) were also performed (Odum, 1988). Similarities between sites were estimated by Morisita-Horn and Jaccard indexes (Krebs, 1989).

Results

The physical and chemical parameters of water indicate high similarity between sites (Tab. I). The two fishing gears (gill and seining nets) captured 4,010 fish specimens, representing six taxonomic orders, 17 families and 40 species, and a biomass of 308.5Kg. With just the gill nets, 3,750 specimens, with 306.1Kg were caught. The most important species in number were Astyanax altiparanae (35.7%) and Serrasalmus maculatus (13.0%), while in terms of biomass the most significant were Plagioscion squamosissimus (38.1%) and Schizodon nasutus (20.8%) (Tab. II).

Seining nets captured 16 species, 260 specimens and 2.2Kg of biomass. Seven species were only captured with this fishing gear (Tab. II). The most important species in number were Oreochromis niloticus (33.1%) and Serrasalmus maculatus (18.1%) and in biomass Satanoperca pappaterra (32.3%) and Tilapia rendalli (22.8%) .

Twelve introduced species (30% of ichthyofauna) were recorded: Poecilia reticulata, Pterygoplichthys anisitsi, Astronotus crassipinnis, Oreochromis niloticus, Tilapia rendalli, Geophagus proximus, Cichla sp., Cichla kelberi, Metynnis lippincotianus, Triportheus nematurus, Satanoperca pappaterra and Plagioscion squamosissimus (Tab. II).

Table II: Taxonomic position (according to REIS et al., 2003), abundance and biomass (g) (absolute = N/Wt and relative = %) of fish collected with gill and seining nets in Santa Bárbara River, Nova Avanhandava Reservoir. *: introduced species.

Taxonomic Group	Gill nets				Seining net			
	Abundance		Biomass		Abundance		Biomass	
	N	%	Wt	%	N	%	Wt	%
CHARACIFORMES								
Parodontidae								
Apareiodon affinis	44	1.17	1,160.6	0.4	13	5	100.5	4.5
Curimatidae								
Steindachnerina insculpta	16	0.43	318.7	0.1	-	-	-	-
Anostomidae								
Leporinus friderici	33	0.88	9,314.1	3.0	-	-	-	-
Leporinus obtusidens	1	0.03	1,787.4	0.6	-	-	-	-
Leporinus octofasciatus	1	0.03	54.5	0.02	-	-	-	-
Schizodon intermedius	1	0.03	196	0.06	-	-	-	-
Schizodon nasutus	259	6.91	63,675.7	20.8	-	-	-	-
Characidae								
Astyanax altiparanae	1,341	35.76	29,539.6	9.7	2	0.8	9.9	0.4
Astyanax fasciatus	2	0.05	28.9	0.01	-	-	-	-
Astyanax shubarti	3	0.08	140,0	0.05	-	-	-	-
Brycon orbignyanus	1	0.03	41.4	0.01	-	-	-	-
Hemigrammus marginatus	-	-	-	-	22	8.5	5.4	0.2
Moenkhausia intermedia	90	2.40	1,147.9	0.4	2	0.8	19.0	0.8
Metynnis lippincottianus*	196	5.23	11,067.2	3.6	4	1.5	51.2	2.3
Piaractus mesopotamicus	1	0.03	1,023.8	0.3	-	-	-	-
Serrasalmus maculatus	487	12.99	35,126.7	11.5	47	18.1	88.5	4.0
Triportheus nematurus *	47	1.25	3,921.7	1.3				
Acestrorhynchidae								
Acestrorhynchus lacustris	1	0.03	60	0.02	-	-	-	-
Erythrinidae								
Hoplias malabaricus	7	0.19	1,452.6	0.5	6	2.3	267.1	12.0
Erythrinus erythrinus	1	0.03	22.2	0.01	-	-	-	-
SILURIFORMES								
Callichthyidae								
Hoplosternum littorale	3	0.08	431.9	0.1	-	-	-	-
Loricariidae								
Hypstomus sp.	4	0.11	792	0.3	-	-	-	-
Pterygoplichthys anisitsi *	1	0.03	908.9	0.3	-	-	-	-
Heptapteridae								
Rhamdia quelen	23	0.61	4,856.4	1.6	-	-	-	-
Pimelodidae								
Pimelodus maculatus	2	0.05	1,083	0.4	-	-	-	-
Auchenipteridae								
Tatia neivai	1	0.03	12.1	0.004	-	-	-	-
GYMNOTIFORMES								
Gymnotidae								
Gymnotus carapo	4	0.11	320.1	0.1	-	-	-	-
Gymnotus cf. inaequilabiatus	-	-	-	-	3	1.2	28.5	1.3
Sternopygidae								
Sternopygus macrurus	-	-	-	-	1	0.4	6.5	0.3

Table II: Cont.

CYPRINODONTIFORMES								
Poeciliidae								
Poecilia reticulata *	-	-	-	-	23	8.9	2.3	0.1
SYNBRANCHIFORMES								
Synbranchidae								
Synbranchus marmoratus	-	-	-	-	1	0.4	94.1	4.2
PERCIFORMES								
Sciaenidae								
Plagioscion squamosissimus *	981	26.16	116,567	38.1	-	-	-	-
Cichlidae								
Astronotus crassipinnis *	2	0.05	241.4	0.1	-	-	-	-
Cichla kelberi *	59	1.57	5,565.3	1.8	8	3.1	164.4	7.4
Cichla sp.*	1	0.03	100.1	0.03	-	-	-	-
Cichlasoma paranaense	-	-	-	-	2	0.77	87.3	3.9
Oreochromis niloticus *	-	-	-	-	86	33.1	78.5	3.5
Geophagus proximus *	5	0.13	329.4	0.1	-	-	-	-
Satanoperca pappaterra *	122	3.25	13,620.4	4.5	30	11.5	722.7	32.3
Tilapia rendalli *	10	0.27	1,210.2	0.4	10	3.9	509.9	22.8
TOTAL	**3,750**	**100**	**306,117.0**	**100**	**260**	**100**	**2,235.7**	**100**

Characiformes represented 19 species, followed by Perciformes (nine species) and Siluriformes (six species) (Tab. II). Abundance in number and biomass of fish caught with gill nets was dominated by Characiformes (67.5 and 52.3%, respectively) and Perciformes (31.5 and 45.0%, respectively). However, an inverse pattern was observed with seining nets, where Perciformes dominated over Characiformes (Fig. 2).

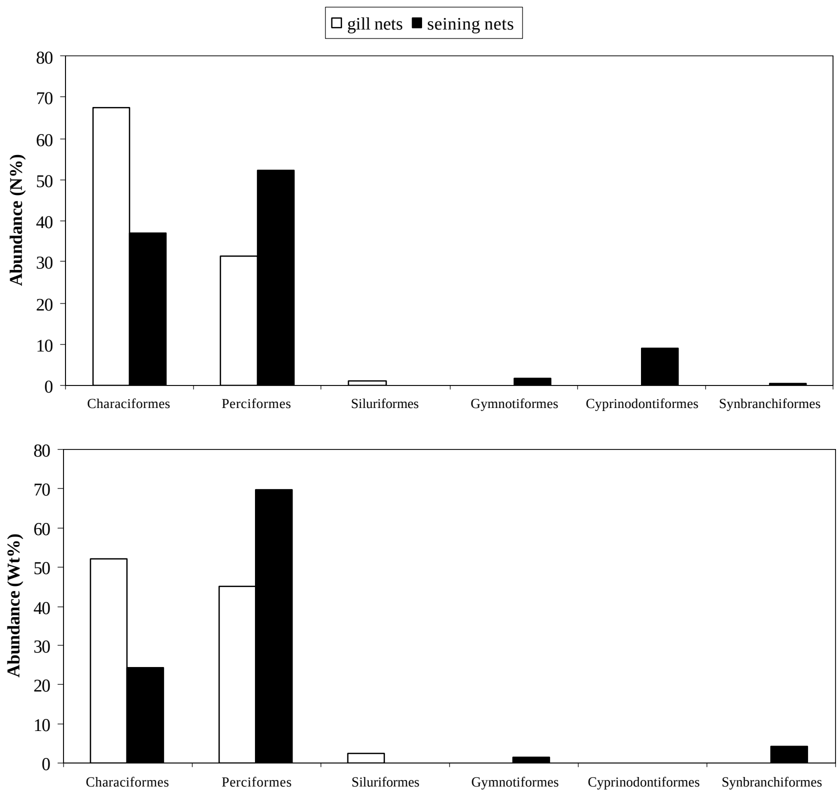

Figure 2: Relative abundance (%) in number (A) and biomass (B) for each taxonomic group

Six species were constant at least in four sampling sites: A. altiparanae, C. kelberi, S. pappaterra, S. nasutus, S. maculatus and P. squamosissimus, the latter was the only constant species in all sampling sites. Sites A and D had the most constant species (8), followed by site B (7). A higher number of accessory species was observed in site C (4) and accidental in sites B and E (12 and 11, respectively) (Fig. 3).

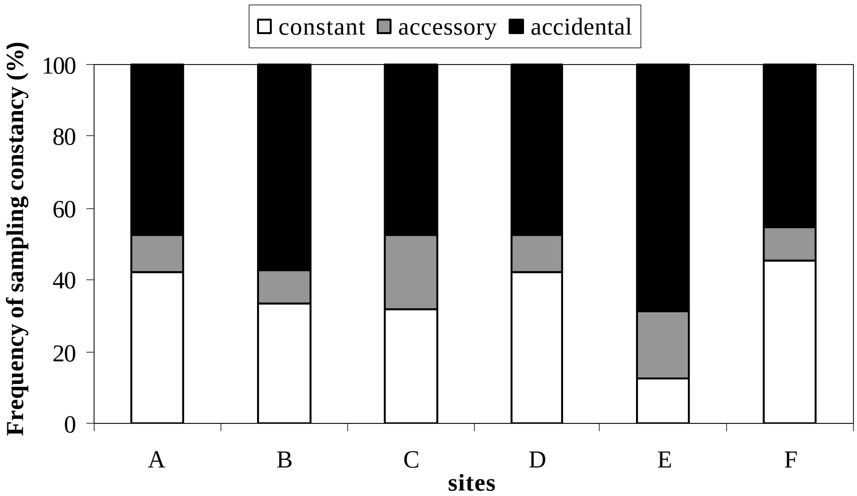

Figure 3: Frequency of sampling constancy (%) with gill nets in all sampling sites of Santa Bárbara River.

Site B revealed a higher species number (21), followed by sites A, C and D (19 species each), and sites E and F had the lowest species number (16 and 11, respectively). The T Test revealed that Shannon-Wiener diversity was significantly different between all sites (p›0.05), except among sites E and A, B, C, D, C and D, and B and F (Tab. IV). Site A had the highest values for Shannon-Wiener (H': 1.89) and Simpson's diversity index (1/D: 4.51). Maximum diversity (H max) and species richness (S) was observed at site B (H max: 3.04; S: 7.41); this site also presented the lowest scores for Simpson's diversity index (1/D: 2.83) and evenness (E: 0.51); the highest value for this last index was observed in site E (E: 0.66) (Tab. III).

Table III: Number of species, Shannon-Wiener diversity index (H'), Evenness index (E), species richness (S) and Simpson's diversity index (1/D) for the six sample sites of Nova Avanhandava Reservoir.

	A	**B**	**C**	**D**	**E**	**F**
Number of species	19	21	19	19	16	11
Shannon-Wiener diversity index (H')	1.89	1.56	1.73	1.73	1.83	1.40
Maximum diversity (H max)	2.95	3.04	2.95	2.94	2.77	2.40
Evenness (E)	0.64	0.51	0.59	0.59	0.66	0.58
Simpson's diversity index (1/D)	4.51	2.83	3.90	3.73	3.99	3.27
Species Richness (S)	6.36	7.41	6.21	6.13	6.90	3.76

Table IV: T test values for Shannon-Wiener index data. Significant values are in bold (p›0.05).

	B	**C**	**D**	**E**	**F**
A	**5.0284**	**2.7082**	**2.7572**	0.9436	**8.0966**
B		**-2.8791**	**-2.6267**	-1.3271	1.0149
C			0.2807	0.4208	**4.5834**
D				0.2701	**4.2705**
E					**1.0464**

Significant values (‹0.60) for Jaccard's similarity (Tab. Va) were observed between sites D and A, C, and also B and C. The Morisita-Horn index showed that all sites were very similar (most of them with values higher than 0.89), except when site E was compared with sites B, C, D, and site F with A, B, C, D (Tab. Vb).

Table V: Jaccard (a) and Morisita-Horn (b) similarity indexes between the six sampling sites of Nova Avanhandava Reservoir. Significant values are in bold.

a)	**Jaccard Index**	**B**	**C**	**D**	**E**	**F**
	A	0.519	0.583	**0.652**	0.400	0.429
	B		**0.640**	0.577	0.357	0.320
	C			**0.810**	0.591	0.304
	D				0.522	0.304
	E					0.350

b)	**Morisita-Horn Index**	**B**	**C**	**D**	**E**	**F**
	A	**0.890**	**0.952**	**0.934**	**0.646**	0.519
	B		**0.943**	**0.968**	0.379	0.300
	C			**0.989**	0.592	0.521
	D				0.489	0.417
	E					**0.915**

Ponderal index (Fig. 4) was calculated for three dominant species (›90%) from each site. P. squamosissimus was dominant in four sites (A, C, E and F), with A. altiparanae in second place at sites A and C and S. maculatus in E and F. Site B was dominated by A. altiparanae and P. squamosissimus, since a small difference between them was found. S. nasutus occurred in third position in sites A, B, C, D and M. lippincottianus in sites E and F.

The highest mean values of CPUE in number and biomass were observed in sites D (CPUEn: 469.10; CPUEb: 34.15) and C (CPUEn: 369.32; CPUEb: 29.81), and the lowest in site E (CPUEn: 47.30; CPUEb: 10.01) (Tab. VI). The CPUEn demonstrated significant differences between sites A, B, C, D when compared with sites E and F, and also within these two sites (ANOVA, F = 10.870; p‹0.0001). CPUEb showed that differences between sites E and B, C, D were significant (ANOVA, F = 5.869; p = 0.0001) (Tab. VII).

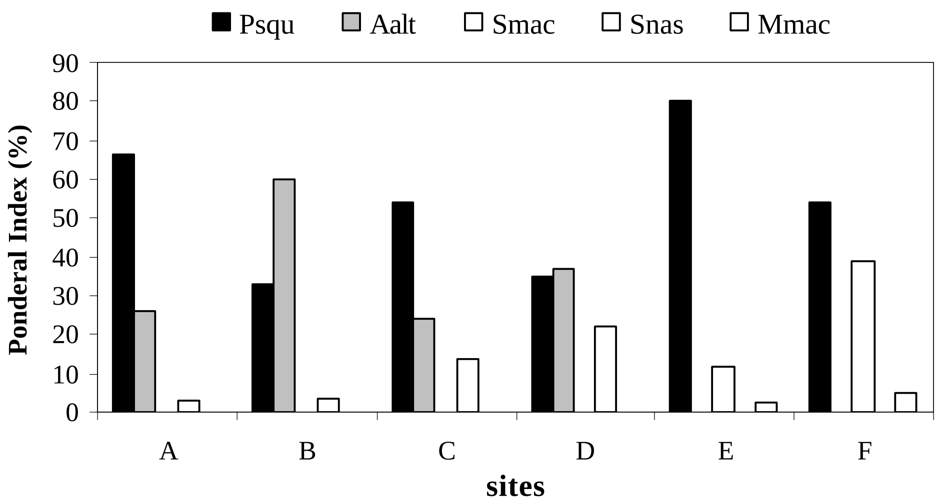

Figure 4: Ponderal index (%) for the most abundant species from each of the six sites. Species acronyms: Psqu = Plagioscion squamosissimus; Aalt = Astyanax altiparanae; Snas = Schizodon nasutus; Smac = Serrasalmus maculatus; Mlip = Metynnis lippincottianus.

Table VI: Mean values of capture per unit effort in number (CPUEn) and biomass (CPUEb) for sampling sites of Santa Bárbara River, Nova Avanhandava Reservoir. Standard errors are in parentheses.

Sites	Mean CPUEn	Mean CPUEb
A	371.6 (273.7)	21.2 (17.5)
B	338.7 (169.2)	18.4 (9.2)
C	369.3 (146.3)	29.8 (13.1)
D	469.1 (226.0)	34.2 (16.3)
E	47.3 (39.9)	10.0 (7.8)
F	132.9 (72.0)	18.0 (10.8)

Table VII: Results from the two-way ANOVA performed on CPUE data from all sampling sites.

	CPUEn				CPUEb			
Source of variation	Mean Square	DF	F	P	Mean Square	DF	F	P
Between groups	11.118	5	30.51	‹0.0001	3.232	5	8.32	0.0001
Within groups	0.3644	67			0.3886	67		

Discussion

Few surveys of fish community have been made in Nova Avanhandava Reservoir, and none specifically on the Santa Bárbara River. Torloni et al. (1993) registered 42 species in the main channel of this reservoir and in some tributaries, while Smith et al. (2002), reviewing old and recent data, described an ichthyofauna composed of 46 species. In contrast, we captured 18 species that were not reported by Smith et al. (2002), thus, raising the species number to 64 in Nova Avanhandava Reservoir.

Many authors emphasize that river damming can change the structure and abundance of riverine fish (Wooton, 1990; Santos & Formagio, 2000; Barrella & Petrere Jr., 2003). It is known that reservoirs support less species than rivers before damming, due to changes in many factors, such as temperature, turbidy, flow, nutrients input and food resources availability (Araújo & Santos, 2001). The restructuring that follows involves the excessive proliferation of some opportunistic species, that are small to medium sized with low commercial importance, and decline or local extinction of others that cannot complete their life cycle (like migratory species). A survey made by CESP between 1971 and 1973 on the Tietê River (before Nova Avanhandava damming) indicates the occurrence of 70 taxons (R. B. C. Almeida, unpublished data), including representative specimens of great migratory species (Zungaro zungaro, Pseudoplatystoma corruscans, Hemisorubim platyrhynchos, Megalonema platanum, and "dourado" Salminus brasiliensis), that are decreasing or disappearing from all great tributaries of the Paraná River basin.

However, the occurrence of some migratory species (Leporinus friderici and L. obtusidens) indicates that these species use reservoir tributaries for spawning. The presence and conservation of tributaries is important to support original fish diversity and riverine populations (Hoffmann et al., 2005).

Perciformes demonstrated a higher species number than Siluriformes, when the opposite would be expected, as proposed by Lowe-McConnell (1999) for South-American rivers, and observed in several reservoirs (Dias & Garavello, 1998; Carvalho et al., 1998b; Hoffmann et al., 2005). We found a new distribution pattern, where six Siluriformes were registered against nine Perciformes species. Furthermore, all Perciformes species were introduced, with the exception of Cichlasoma paranaense, the only native of this basin (Kullander, 2003). Perciformes were also more abundant (number and biomass) than Siluriformes in Santa Bárbara River. However, the survey made before damming (R. B. C. Almeida, unpublished data) shows that this community was dominated by

Characiformes followed by Siluriformes, indicating that after damming and species introduction, drastic modifications occurred in the structure and composition of native fish community.

The twelve introduced species represent 30% of the fish species, 38% in number and 50% in biomass, and P. squamosissimus is responsible for almost all the abundance of introduced species, indicating its complete establishment in the Nova Avanhandava Reservoir. Despite of low captures have been recorded for many introduced species, an increase in Geophagus proximus captures has been documented in this tributary, during the following year, around the cage fish farm systems (Paes, 2006).

Environmental conditions, such as the abundance of food resources and lack of natural predators has a great influence on introduced species colonization (Townsend, 1996; Orsi, 2005), however, reproductive strategy is known as the most important factor for introduced species colonization, as seen for P. squamosissimus in Itaipu Reservoir (Carnelós & Benedito-Cecílio, 2002) and C. monoculus in Capivara Reservoir (Orsi, 2005). The low capture of Cichla species in this study may be related to the gill nets selectivity, which are not very efficient for cichlids capture (Lowe-McConnell, 1999); however, high catches in commercial and sportive fisheries are observed in all medium and low Tietê basin, indicating its successful establishment (CESP, 1996).

Introduced species can compete for food and spatial resources with native species (Marchetti, 1999) and increase predation pressure in native populations (Hahn et al., 1997). In Nova Avanhandava, as in many Brazilian reservoirs, the dominant predator is P. squamosissimus (Gomes & Miranda, 2001). The low capture of native predators, such as Acestrorhynchus lacustris and Hoplias malabaricus, as well as indicating competition among these species, also suggests that P. squamosissimus and C. kelberi may exert high predation pressure on native species. Fish, however, are not the main item in the diet of these two species, especially P. squamosissimus, which preferentially feed on crustaceans and insects in the same sites of this reservoir (Vidotto, 2005).

An important factor for fish predation is the low habitat complexity (macrophytes and ciliary forest) in all sampling sites. This structure provides shelter against predators, and food resources for small sized species and juveniles (Casatti et al., 2003), possibly explaining the low abundance of the species group in this reservoir. The only exception is Astyanax altiparanae, the most abundant species in number, and dominant in two sites. This species, widespread in several Brazilian reservoirs (Agostinho et al., 1995), has a great feeding plasticity and reproductive potential, occurring in lotic and lentic environments, even in degraded rivers (Bennemann et al., 2000; Orsi et al., 2004).

Ecological attributes of this ichthyofauna, such as Simpson's diversity index, Evenness and Ponderal index indicates that few species represent a great part of the abundance (number and biomass), while the species majority have a low abundance. This pattern is usual in tropical communities with defined dry - rainy seasons (Odum, 1988), as observed in other reservoirs (Agostinho et al., 1997; Carvalho et al., 1998b; Castro et al., 2003).

In all sampling sites, a greater number of accidental species occurred, as observed in other reservoirs (Carvalho et al., 1998a; Dias & Garavello, 1998) and streams (Pavanelli & Caramaschi, 2003). These species are considered migrants that join the resident community occasionally for feeding or reproduction (Uieda, 1984). In addition, Matthews (1998) reported that, even in high diversity environments, many species are represented by few individuals.

In addition to the proximity of sampling sites, especially C and D, and the small difference among physical and chemical parameters of the water, we observed significant differences in diversity, CPUE and abundance of main species between sites. These findings agree with the assumption of Matthews (1998) that each sampling site can be considered a locality or fish assemblage, which is defined as a place where fish have a greater chance of meeting during daily activities (feeding, resting and sheltering) than with individuals of other localities.

The shallower sites (A, B, C and D) had the highest captures in number and biomass, species number, constant species, diversity, species richness and similarity indexes. As observed in other reservoirs (Carvalho et al., 2003; Pelicice et al., 2005), the littoral zones are often most productive, providing a feeding area, spawning habitat and shelter against predation for fish (Agostinho et al., 1999). In such shallow sites, the woody debris favors the colonization of a diversified associated fauna, especially insects, increasing fish diversity in these habitats, since they are potential sources of food (Oliveira et al., 2005). Conversely, deep zones are colonized for less species, usually medium and large sized.

The Nova Avanhandava Reservoir may be considered a model for studies of species introduction impacts, since they compose a great part of the fish community, as well as in abundance. In addition, we confirm the importance of littoral areas, places that offer shelter and food resources for fish species, especially in this case, where there are no marginal lakes for fish protection.

Acknowledgements

The authors would like to thank The Nature Conservancy do Brasil (TNC) for financial support and São Paulo State Research Foundation (FAPESP) for scholarship granted to first author (proc. nº 02/11113-6); we thank Dr. Oscar A. Shibatta for identification of fish specimens and Ricardo A. S. Teixeira and Renato Devidé (Depto. Morfologia, IB, UNESP-Botucatu) for helping in field works.

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Received: 16 April 2007
Accepted: 06 August 2007