

Angling sport fishing in Lobo-Broa reservoir (Itirapina, SP, Brazil)

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(With 9 figures)

Abstract

The objective of this paper was to study angling from September, 2002 to September, 2004 in the Lobo-Broa Reservoir, Itirapina, SP (22° 15' S and 47° 49' W). Interviews (total 1,027) with sport fishers were accomplished in the three main fishing sites (Horto, Pier and Praia). This fishing was practiced with a simple fishing rod and reel, mainly in Horto, where the catches and fishing effort were higher. The catches were mainly composed of Cichlidae (*Geophagus brasiliensis*, *Oreochromis niloticus*, *Tilapia rendalli* and *Cichla monoculus*). We tried to determine which factors (fishing sites, type of baits and season) and the covariate fishing effort, expressed in number of fishing rods multiplied by fishing time, would affect catches, using a 3 way-ANCOVA. The final model showed that only fishing sites and effort determined the captures of sporting fishing in the reservoir. Some measures for managing fishing practices are discussed.

Keywords: sport fishing, cpue, ANCOVA, reservoir fishing management.

As pescarias esportivas no reservatório Lobo-Broa (Itirapina, SP, Brasil)

Resumo

O objetivo deste trabalho foi estudar as pescarias esportivas, entre setembro de 2002 e setembro de 2004 na Represa do Lobo-Broa, Itirapina, SP (22° 15' S e 47° 49' W). Foram realizadas 1.027 entrevistas junto aos pescadores esportivos nos três principais locais (Horto, Pier e Praia). Estas pescarias foram praticadas com vara de pescar simples e com molinete, principalmente no Horto, onde as capturas e esforço pesqueiro foram maiores. A captura foi composta principalmente de Ciclídeos (*Geophagus brasiliensis*, *Oreochromis niloticus*, *Tilapia rendalli* e *Cichla monoculus*). Buscou-se detectar que fatores (locais de pescarias, tipos de isca e sazonalidade) e se a covariável esforço de pesca, expresso em termos de número de varas de pesca multiplicado pelo tempo de pesca, afetavam as capturas, usando uma ANCOVA trifatorial. O modelo final mostrou que apenas os locais de pesca e o esforço de pesca determinaram as capturas das pescarias esportivas na represa. Algumas medidas de manejo para as pescarias foram discutidas.

Palavras-chave: pescarias esportivas, cpue, ANCOVA, manejo de recursos pesqueiros.

1. Introduction

Fishing management is not related just to the fish stock, but should also address the human community in the social, economical and cultural aspects (King, 1995; Lucena, 2000). In the case of sports fishers, there is the need to consider the generated impact on the ecosystem (Kerkvliet and Nowell, 2000).

There is a world tendency in recognizing the economical and social importance of the worldwide increase in the sport, and specially in Australia, since Murray-Jones and Steffe (2000) estimated that sporting fishing is practiced by about 4.5 million people. In Germany,

the carp *Cyprinus carpio* stocks have been maintained stable mainly due to sports fishers, whose techniques are selective and related to bait size (Arlinghaus and Mehner, 2003). It is also one of the main leisure activities in Finland (Sipponen and Muotka, 1996), and the importance of the activity increased with the number of fishers, catches and profit that the activity has been generating (Sipponen, 2001). In the United States, in the beginning of the 90's, there were about 60 million sport fishers (Kendall, 1991). A great number of them are directed to catfishes in 282 of the 349 reservoirs examined

by Miranda (1999). O'Connel (2003) points out the importance of sport fishing data on the Canadian Atlantic coast to estimate the salmon stock in the area.

Arlinghaus et al. (2003) consider fishing anagement and conservation strategies of industrialized countries focused almost exclusively on sport fishing, while developing countries still prioritize professional small-scale fishing for food safety. However, even in those countries, the emphasis on sport fishing and conservation is increasing as a consequence of globalization. The evolution of sport fishing in Europe is still small when compared to the United States, where there are more studies on the theme, and consequently, a more efficient management of its fishing resources.

Sport fishing, when badly planned may cause negative impacts to local society and to its surrounding habitat (Beni, 1998). So the activity, previously considered inoffensive, is now seen as potentially harmful: the presence of fishers can cause erosion to the river banks and reservoir margins, water pollution, inappropriate rubbish disposal, etc. Bell (1997) considered the wetlands suitable places for high catches and profits, associated to their high productivity.

In Brazil, studies on sport fishing are scarce. Catella (2005) verified a decline in the activity in the south Pantanal (59 thousand sport fishers registered in 1999, 43 thousand in 2000, 35 thousand in 2001 and 30 thousand in 2002) and this reduction has been causing economic difficulties for the fishing tourist industry in the area. In the National Park of Ilha Grande (state of Paraná), by means of personal interviews with sport fishers, the main factors which lead them to take up this leisure-time activity were identified: closer contact with nature, stress relief and wish to visit new places (Zacarkim et al., 2005). Agostinho and Gomes (2005) say that about 10 tournaments of sport fishing were realized in the reservoir of Itaipu and some tournaments involved more than 800 people; in spite of the capture per unit of effort being low in these tournaments, the total catches of most people involved in the activity became highly relevant for the landing statistics of the reservoir.

This paper describes the angling sport fishing in Lobo-Broa reservoir and determines the factors, together with the fishing effort, that determines the catches.

1.1. Study area

The Lobo-Broa reservoir (Figure 1 – 22° 15' S and 47° 49' W), located between the municipal districts of Itirapina and Brotas, SP, was built in 1936 when damming the Lobo stream, Itaqueri and Geraldo rivers and other smaller streams (Argenton, 2004) with the initial objective of generating hydroelectric energy (Tundisi, 1986). Since then, its basin has been affected by unavoidable impacts, such as the discharge of untreated residential sewage, deforestation, sand mining, tourism and intense sport fishing (Tundisi et al., 2003; Jørgensen and Vollenweider, 2000). The climate of the area is of the type Cwa, according to Köppen; in other words, sub-

tropical mesothermic, with a wet summer and dry winter, under the influence of cold fronts arriving from the south, mainly in the winter and autumn. The average annual pluviosity is of 1,300 mm, and the dry season extends from April to September (Tundisi, 1986). Table 1 shows its main characteristics.

The hydrographic basin of the Lobo-Broa reservoir has been studied thoroughly over time, for its physical characterization (Nishiyama, 1991; Lorandi et al., 1983; Freire et al., 1980), riparian vegetation (Giampietro et al., 2004; Souza, 1977) limnology and primary production (Argenton, 2004; Milk and Espíndola, 2002; Abe et al., 2000; Angelini, 1995; Tundisi and Matsumura-Tundisi, 1995; Calijuri and Tundisi, 1990; Whitaker, 1987; Calijuri, 1985; Tundisi, 1977; Moraes, 1978; Rocha, 1978) and sediments (Dornfeld et al., 2002; Trinity, 1980; Strixino, 1973). In the 70's, some fish studies were accomplished, mainly on the biology of the main species, such as the growth of *Geophagus brasiliensis* (Barbieri, 1975; 1974) and of *Gymnotus carapo* (Barbieri and Barbieri, 1984); growth and reproduction of *Leporinus friderici* (Barbieri and Santos, 1988); reproduction of *Leporinus octofasciatus* (Barbieri and Barbieri, 1991), reproduction of *G. carapo* (Barbieri and Barbieri, 1984); reproduction of *Astyanax bimaculatus* and of *A. fasciatus* (Barbieri and Barbieri, 1988); reproduction and nutrition of *L. friderici* (Barbieri and Garavelo, 1981), reproduction of *Cichla ocellaris* (Souza et al., 2005) and the feeding of *C. ocellaris* (Velludo et al., 2005).

Surveys of the fish fauna were carried out by Albino (1987), who listed 15 fish species, belonging to 12 genera, 8 families and 5 orders and by Marinelli (2002), who listed 22 species distributed in 7 orders and 12 families. Fragoso et al. (2005) caught 23 species, 12 families and 7 orders. Pereira (2005), in experimental fishing carried out between 2002 and 2004, caught 7479 individuals distributed in five orders and 11 families and registered the presence of exotic species. The differences among these

Table 1. Characteristics of the Lobo-Broa reservoir.

Altitude	770 m
Lake area	6.8 km ²
Basin area	227.7 km ²
Volume	22,106 m ³
Maximum depth	12 m
Medium depth	3 m
Length	8 km
Annual water level fluctuation	2 m
Average water retention time	20 days
Trophic state	Oligo/mesotrophic
Köppen climate classification	Cwa
Average annual pluviosity	1,300 mm
Current uses	Water abstraction, leisure, sportfishing

Source: Modified from Straškraba and Tundisi (2000).

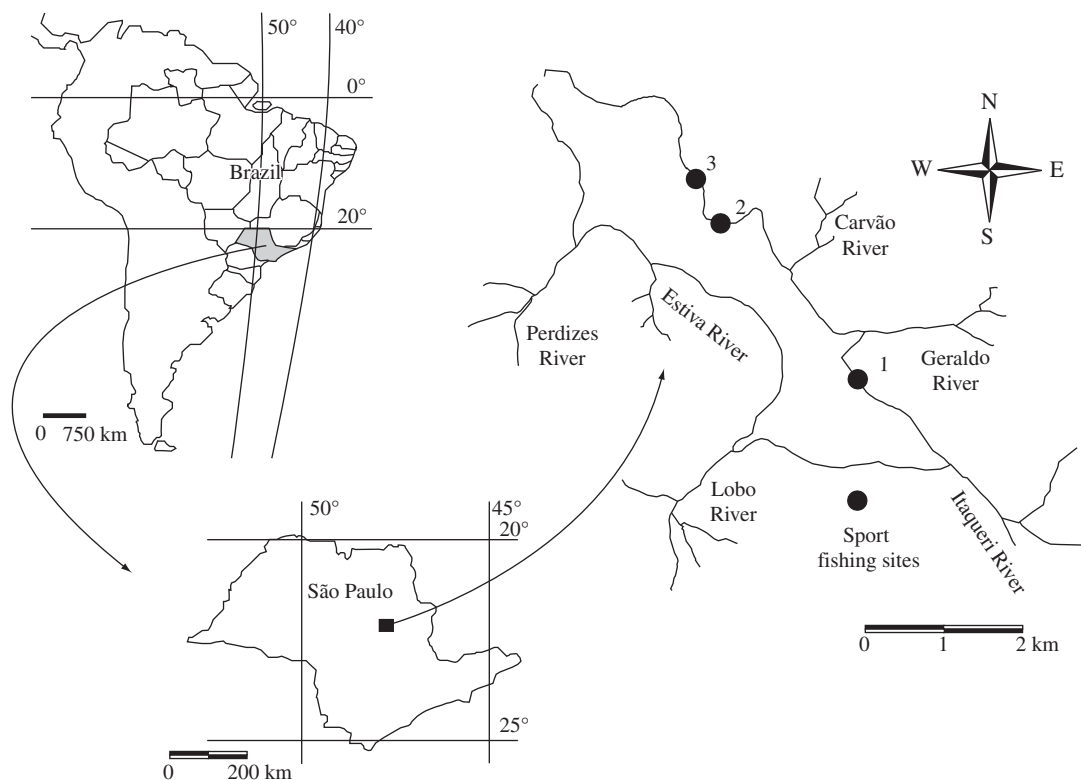


Figure 1. Main fishing sites where fishers were interviewed (1 = Horto, 2 = Pier, 3 = Praia) (Source: TUNDISI et al., 2004, modified).

figures may be attributed to the different methods and fishing arts used in the study above (Table 2).

2. Material and Methods

From September to November of 2002, February to December of 2003 and January to September of 2004, 254 visits were carried out to the three main sites of sport fishing: Horto, Pier and Praia (Figure 1). We registered 1,027 fishers, some interviewed more than once during the field research. The visits to the fishing sites were accomplished in the morning (between 8:00 and 11:00 AM), as well in the afternoon (between 1:00 and 4:00 PM).

For each fisher we noted the date, fishing site, effective fishing time, fishing gear, baits used and species caught. Due to the high number of fishers, mainly in the hottest months, catch sampling at different fishing sites was alternated in each period. Fish were also weighed (individual total weight) and measured (TL, cm). In the other places, only the number of fishers present was counted. Data were further grouped in the dry and rainy seasons (dry: April-September; rainy: October-March).

The main gear employed was the simple rod with or without a reel. Sport fishing in the Lobo-Broa reservoir is practiced at three main places: 1) Horto: with access

by means of fee paying; fishing by standing up or seated on *palaffite* benches. Some fishers use boats; 2) Praia: accessed via the Santo Antônio condominium; and 3) Pier: a structure built close to the Praia, also accessed via the Santo Antônio condominium.

2.1. Catch and effort analysis

Fishing effort was evaluated in two ways. In the fishing sites where fishers were just tallied, the effort was estimated only by number of fishers. At the other sites, where we had detailed data on catch and effort, the number of fishing poles (simple fishing rods) used by each fisher was multiplied by the effective fishing time (in hours). So for each fishing site, for the dry and rainy stations, both fishing efforts were calculated:

$$f_{\text{fishers}} = \sum n_{\text{fishers}} \quad (1)$$

where $\sum n_{\text{fishers}}$ is the total number of fishers.

$$f_{\text{fishing}} = \sum (n_{\text{poles}} \times t) \quad (2)$$

where n_{poles} is the number of simple fishing rods employed by each fisher and t is the fishing time for each rod.

Table 2. Taxa numeric comparison among the fish caught by Albino (1987), Marinelli (2002), Pereira (2005) e Fragoso et al (2005).

	Albino (1987)	Marinelli (2002)	Fragoso et al. (2005)	Pereira (2005)
Order	5	7	7	5
Family	8	12	12	11
Species	15	24	23	17

The cpue was compared between the fishing sites and in the year (in the dry and rainy seasons) computed through:

$$cpue_{site} = \frac{\sum cw_{site}}{f_{fishing}} \quad (3)$$

where $\sum cw_{site}$ is the capture of fishes in weight (g) for each fishing site, and:

$$cpue_{season} = \frac{\sum cw_{season}}{f_{fishing}} \quad (4)$$

where is the capture of fishes in weight (g) for each fishing season.

2.2. Statistical analysis

Initially we produced a scatterplot between catch X effort in order to examine a possible linear relationship.

We tried to set up an ANCOVA on the catch (response variable) and effort data looking for possible factors which would affect the catches (Huitema, 1980). In order to balance the model and decreasing environmental noise (Petrere, 1978), data were grouped by seasons, fishing sites and type of baits (factors) (Murray-Jones and Steffe, 2000; Wudneh, 1988; Pet et al., 1995; Okada et al., 1996; Paiva et al., 1994; Ribeiro and Petrere, 1990). Tests of normality (g_1 - coefficient of asymmetry and g_2 - coefficient of kurtosis) and residual analyses were carried out in order to validate the model. The model components were:

a) Factors:

S: season (1 = rainy; 2 = dry); FS: fishing site (1 = Horto; 2 = Píer; 3 = Praia); BU: bait use (1 = just bait; 2 = bait + ceva; 3 = just ceva); S * FS, S * BU, FS * BU: first order interactions; S * FS * BU: second order interaction.

b) Covariates:

ln f: natural logarithm of the fishing effort, expressed as the number of fishing rods multiplied by their fishing time.

The initial model was described by:

$$\ln cw = \mu + S + FS + BU + \ln f + \text{interactions} + \epsilon \quad (5)$$

where μ was overall mean and ϵ random variable.

Furthermore, a multiple comparison test a posteriori following Fisher LSD t distribution was employed in

order to detect significant differences between pairs of adjusted means (Huitema, 1980).

3. Results

3.1. Fishing effort

Figure 2 shows that the largest number of fishers/day (24.1) occurred in the rainy season of 2002-2003, and the second largest (14.0) was in the dry season of 2002. The distribution of number of sporting fishers per visiting day, by fishing site and season showed that the main fisher concentration occurred in the first rainy season (2002-2003), mainly in Horto. In the first dry season, the number of fishers/day was quite high, although there is not a preferred fishing site, when comparing with the following dry seasons, when fishers equally exploit the three fishing sites.

Fishing effort per season (Figure 3) shows that the largest fishing effort occurred in Horto in all seasons. The largest number of interviews was accomplished in the rainy season of 2002-2003 in Horto and in Píer, when there was also a larger number of fishers exploiting these sites (Horto: 58 interviews and effort 1155.76; Píer: 64 interviews and effort 887.99). Moreover, the largest relationship of fishing effort/ interview - was greater in Horto, in the dry season of 2003 (31.0) (Table 3).

The largest densities (fishers/km²) were registered in the rainy season. The largest catch/fisher was registered in the 2002/2003 rainy season. In the dry season of 2004, the smallest fish production was registered, despite the number of fisher/ density being the second value of our study (Table 4).

3.2. Use of baits

The baits used by the sport fishers were earthworm, dough (prepared with flour and water), orange bug, live bait (characins or other small fish captured in the reservoir) and artificial bait. Fishers using only one bait type were 45.7%, two types, 35.9% and three or more types, 6.7%.

Some fishers use an oakum sac (ceva) full of ration with ground corn (quirera) and corn in grain which attracts fish for easing catches. The exclusive use of cevas (11.7%) or associated to the bait (64.1%) was also mentioned. In the first case, they practice lambada fishing which is done with two or more treble hooks (a set of two or more welded hooks), baitless hooks attached to the main line. The fish, when touched by the hook, may be caught, being hooked not only by the mouth, but by any other part of its body. When the fish escapes, it may be severely injured. Table 5 indicates that some fishers preferred the use of bait in association with the cevas.

3.3. Description of the catches

The captured species and their relative abundance, in number of individuals and in weight, are presented in Table 6. The largest relative catches (in number and in weight) were due to *O. niloticus* in all seasons, ex-

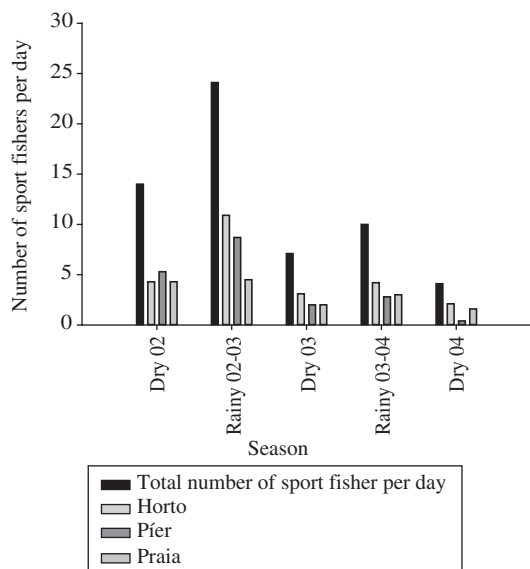


Figure 2. Distribution of number of sport fishers per visit, by fishing site and season, from 2002 to 2004.

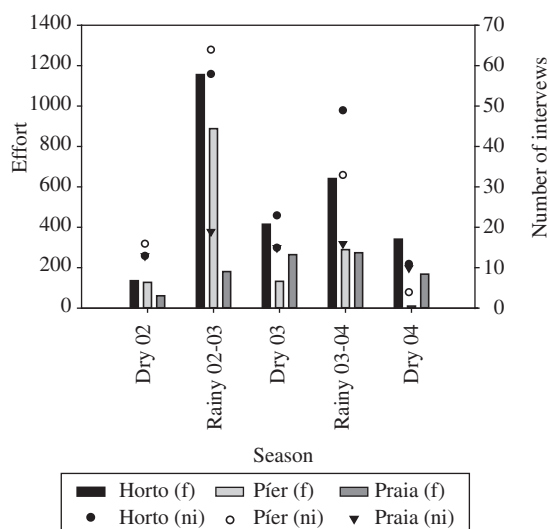


Figure 3. Distribution of fishing effort (f, in terms of number of fishing rods X fishing time) and number of interviews (ni) accomplished with the sport fishers by season.

Table 3. Relationship between fishing effort (number of rods x fishing time) divided by the number of accomplished interviews, for the dry and rainy seasons at three fishing sites (Horto, Píer and Praia).

Seasons	Horto	Píer	Praia
Dry season 2002	10.4	8.0	4.7
Rainy season 2002-2003	19.9	13.9	9.5
Dry season 2003	18.0	8.8	17.6
Rainy season 2003-2004	13.1	8.8	17.1
Dry season 2004	31.0	2.5	16.8

Table 4. Comparison between the yield (kg/fisher) and fisher density (fisher/km²) for the Lobo-Broa Reservoir.

Season	Yield (kg/fisher)	Fisher/km ²
Dry 2002	0.11	6.2
Rainy 2002/2003	0.22	74.6
Dry 2003	0.10	25.1
Rainy 2003/2004	0.10	36.8
Dry 2004	<0.001	8.4

Table 5. Use of bait types by season and fishing site.

Season	Fishing site	Exclusive use of baits (%)	Use of bait + ceva (%)	Exclusive use of bait (%)
Dry	Horto	17.7	72.6	9.7
	Píer	22.5	50.0	22.5
	Praia	21.4	61.9	16.7
Rainy	Horto	30.4	65.2	4.3
	Píer	26.1	66.3	7.6
	Praia	19.4	51.6	29.0

cept in the 2004 dry season, where just one individual of *Pimelodella cf. gracilis* weighing 200 g was caught. The catch and effort evaluation are shown in Figure 4. Higher catches and effort occurred in Horto. The largest values of catch per season occurred in the 2003-2004 rainy season (Figure 5).

The catch structure per season indicates that *G. brasiliensis*, *O. niloticus* and *C. monoculus* were caught in almost all seasons (Figure 6).

3.4. Statistical analyses

Figure 7 displays the linear and positive relationship between the natural logarithms of catch (ln_{cw}) and effort (ln_f) with some scatter along the tendency line which is usual in this sort of observational data.

We test the full model (Equation 5). These analyses have a rather exploratory character when trying to understand the correlation structure among the variables and factors in the model, looking for a minimum model. So the interactions not significant at 5% level (we were quite restrictive here) were successively dropped. The final ANCOVA model (Equation 6) indicated the effect of the fishing site and (as usual) the fishing effort determining the catches:

$$\ln c_w = \mu + FS + \ln f + \epsilon \tag{6}$$

The scatterplot between the studentized residuals x estimated values is presented in Figure 8, and the histogram of the residual, where the g_1 and g_2 tests are highly significant

($g_1 = -0.7211^{**}$, $g_2 = 2.0753^{**}$) is shown in Figure 9. Although the distribution of the residuals is not normal,

Table 6. Percentage in number (N) and weight (Wt-g) of the individuals caught by sport fishing during the study period.

Scientific name	Dry season		Rainy season		Dry season		Rainy season		Dry season	
	2002 (%)		2003/2004 (%)		2003 (%)		2003/2004 (%)		2004 (%)	
	N	Wt	N	Wt	N	Wt	N	Wt	N	Wt
<i>Astyanax altiparanae</i> (Garutti and Britski)	4.2	1.20	1.8	0.20	-	-	8.0	0.4	-	-
<i>Hoplias malabaricus</i> (Bloch)	-	-	0.4	0.30	-	-	-	-	-	-
<i>Hoplerithrynus unitaeniatus</i> (Spix and Agassiz)	-	-	0.5	0.30	-	-	-	-	-	-
<i>Leporinus fridericii</i> (Bloch)	-	-	0.4	0.60	-	-	-	-	-	-
<i>Pimelodella cf. gracilis</i> (Valenciennes)	-	-	-	-	-	-	-	-	100.0	100.00
<i>Cyphocharax modesta</i> (Fernández-Yépez)	-	-	0.2	0.10	-	-	3.0	0.7	-	-
<i>Tilapia rendalli</i> (Boulenger)	-	-	1.9	0.80	2.8	2.5	22.0	10.6	-	-
<i>Oreochromis niloticus</i> (Linnaeus)	54.2	47.40	77.5	86.7	80.6	85.8	57.0	80.6	-	-
<i>Geophagus brasiliensis</i> (Quoy and Gaimard)	33.3	40.90	16.7	9.60	11.1	3.2	8.0	5.5	-	-
<i>Cichla monoculus</i> (Spix and Agassiz)	8.3	10.50	0.7	1.30	5.6	8.5	2.0	2.2	-	-
Total (N/Wt-g)	48.0	4.52	569.0	111.69	36.0	16.7	100.0	25.0	1.0	0.02

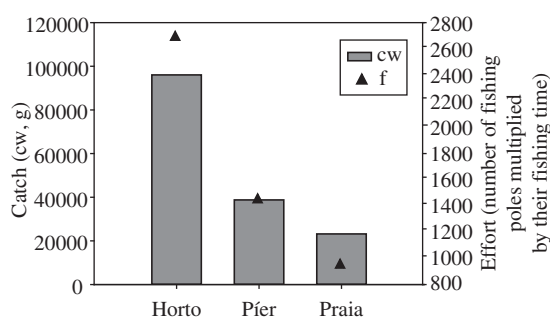


Figure 4. Catch (cw, g) and effort (f, number of fishing rods multiplied by their fishing time) at the fishing sites (Horto, Píer and Praia) in the Lobo Broa Reservoir.

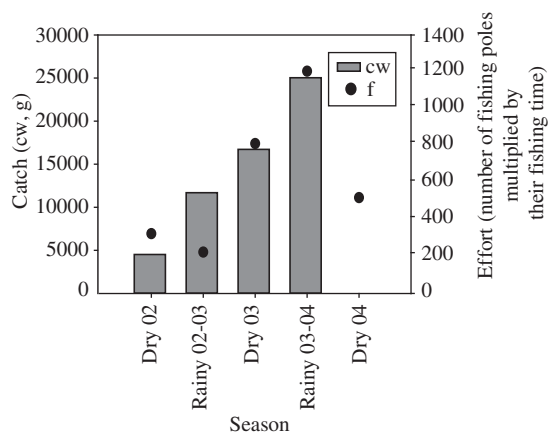


Figure 5. Catch (cw, g) and effort (f, number of fishing rods multiplied by their fishing time), for the dry and rainy stations during the study period at Lobo Broa Reservoir.

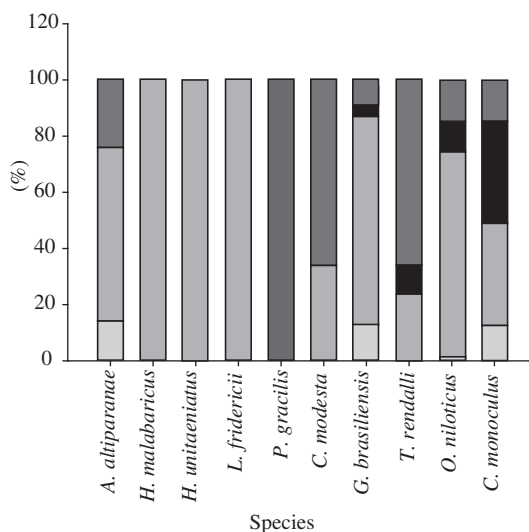


Figure 6. Distribution of the catches (% weight) per season per species.

we still stick with Equation 6, because the design is balanced, rendering robust F tests (Huitema, 1980).

Only one significant difference between the adjusted means was detected between Horto and Píer (Table 7).

4. Discussion

Petreire et al. (2002) affirmed that in smaller reservoirs like Ibitinga and Bariri (Tietê River) and Salto Grande (Parapanema River), small-scale fishing is practiced more than sport fishing. In larger dams, like

Table 7. Multiple comparison tests a posteriori between the adjusted means of \ln_{cw} (natural logarithm of the catches, g) by the ANCOVA final model in the three fishing sites. The numbers between brackets indicate the antilogarithms of the adjusted means.

Fishing sites	Adjusted mean catches (g) \pm se	Comparisons	t-test
Horto (1)	6.9928 (1088.77) \pm 0.1708	1 e 2	4.1672*
Pier (2)	6.0700 (432.68) \pm 0.1816	2 e 3	1.3633 ns
Praia (3)	6.4832 (654.06) \pm 0.3650	1 e 3	1.6846 ns

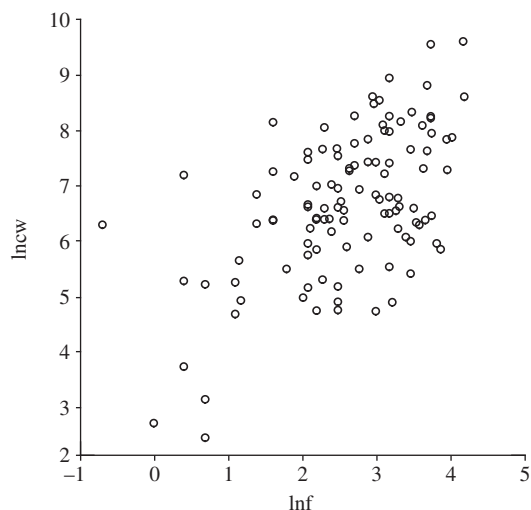


Figure 7. Relationship between \ln_{cw} (natural logarithms of catch, g) and \ln_f (natural logarithm of the fishing effort, number of fishing rods multiplied by their fishing time) for sport fishing in Lobo Broa Reservoir.

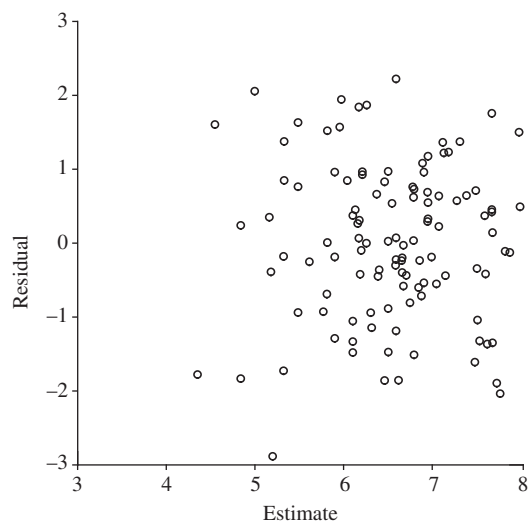


Figure 8. Studentized residuals versus the \ln_{cw} estimated values.

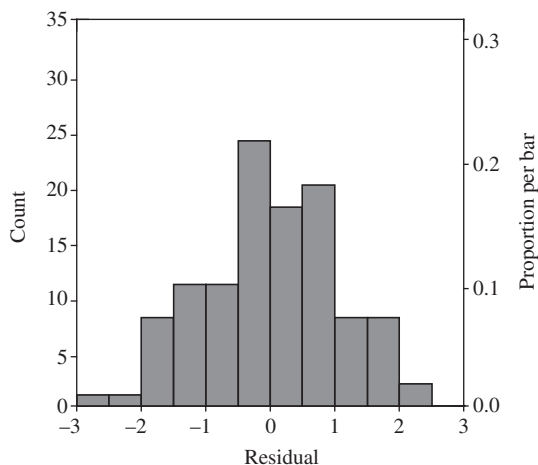


Figure 9. Histogram of the residuals of the final ANCOVA model ($g_1 = -0,7211^{**}$; $g_2 = 2,0753^{**}$).

Jupiá, Itaipu (Paraná River), Barra Bonita, Promissão (Tietê River), professional fishing prevails, in spite of the presence of sport fishers just at weekends. In the Lobo-Broa reservoir, only one professional fisher was interviewed.

According to Argenton (2004), the Horto area of Lobo-Broa reservoir is classified as meso-oligotrophic with higher nutrient concentrations and conductivity and the smallest oxygen concentrations were caused by the effluents brought by Itaqueri River and high turbidity due to sand mining. Such conditions can favour fish catches (Walter, 2000). Arcifa et al. (1988) associated increased turbidity to higher catches in the reservoir of Americana (SP). The eutrophication process can still contribute to the establishment of species such as the tilapia, which does not demand clean water (Ribeiro-Filho, 2002).

In Horto, the presence of wood stakes in the water for the fixing of chairs or benches, would also improve catches. Such stakes could act as artificial reefs supplying substratum for periphyton and benthos, refuge for fish and lessening marginal erosion (Agostinho et al., 2000).

The Praia area has high fish yield, statistically similar to the Horto area, due to higher fishing effort and the particular water circulation pattern and the higher temperatures, enhancing secondary productivity (A. Saggio, 2004, personal communication to JMAP).

Fish production (kg/ha/year) is low when compared to the data of Petrere et al. (2002), as seen in Table 8. The low catches in Lobo-Broa reservoir can be associated to the presence of more than two predators (*Hoplias malabaricus* and *C. monoculus*, macro carnivorous; *Hoplerithrynus unitaeniatus* a small sized facultative predator; *Rhamdia quelen* small sized predator; *Astyanax altiparanae*, *A. scabripinnis paranae* micro carnivores), due to the increased competition for resources (Paiva et al., 1994). Fernando et al. (1998) considered

Table 8. Comparison among the fish production (kg/ha/year) and flooded area for seven reservoirs of the Paraná River basin (Petrere et al., 2002) and this study.

Reservoir	Flooded area (ha)	Production (kg/ha/year)
Jupiá (Grande River)	35,200	4.7
Água Vermelha (Grande River)	64,400	2.9
Barra Bonita (Tietê River)	33,430	6.0
Ibitinga (Tietê River)	11,400	3.2
Promissão (Tietê River)	53,000	3.7
Nova Avanhandava (Rio Tietê)	21,700	2.5
Itaipu (Paraná River)	135,000	13.3
Lobo Broa Reservoir (this study)	680	<1.0

that reservoirs mainly fished for recreation present lower catches than the ones mostly exploited by commercial fishing. They also mentioned that the introduction of tilapia in the tropics and of sardines in Lake Tanganyika is responsible for higher catches.

The high *O. niloticus* catches, predominant in almost all of the fishing sites in Lobo-Broa reservoir can be attributed to species of omnivorous habits, when exploiting coastal habitats becomes more vulnerable to be caught by the sport fishers, who usually fish at the reservoir margin (Ribeiro-Filho, 2002). Fernando and Holcík (1985) and Paiva et al. (1994) reported that the introduction of *O. niloticus* in the reservoirs of NE Brazil has become dominant in commercial catches. The success of the introduction of tilapias in the Billings reservoir (SP), is due to some biological characteristics of this fish such as its high reproductive potential, capacity to ingest plankton, resistance to low concentrations of dissolved oxygen, and to its tolerance of chemical contaminations (Minte-Vera and Petrere, 2000).

The catches in weight in sports fishing were shown to be dependent on the fishing site and fishing effort as described by the ANCOVA model. Cetra (1998) and Petrere (1986) observed that increase in effort significantly increases catches in professional fishing in the middle river Tocantins (MA) and in the Amazon, respectively.

Seasonality was not shown to be significant in the final model. In other words, the temperature and pluviosity effects in the reservoir area did not affect fish catches. The small difference between mean temperature for the summer and for the winter and the low pluviosity in this last period, contrasting with abundant rains in the summer during the study period, behaved like the data described by Argenton (2004), Marinelli (2002), Queirós (2000) and Tundisi (1986). The rainy period seems not to affect the captures because during the rains, the flood-

gates were open to release the excess of water, so reducing fluctuation level. On the other hand, the study of Wudneh (1998) in Lake Tana, Ethiopia, showed that seasonality is an important factor in the capture of *Barbus tsanensis* and for the largest *Oreochromis niloticus* and *B. platydorsus*, in trawl fishing.

Anyway seasonality seems to be a more strong influence in floodplain rivers than in lakes and reservoirs. It is now well accepted, and as Cetra (1998) mentioned, in floodplain rivers, the periodic variation in river level is essential to the maintenance of fish diversity and biomass. The largest catches in his study occurred between May and August not only due to decrease in the river level, but also to the fish migration period, with the consequent fishing effort increasing upon shoals and the use of trawling. Seasonality also had an effect on the cpue values for the captures of *Clarias gariepinus* and on the other three fish species studied (Cetra op.cit.). Ribeiro and Petrere (1990) point out that water level fluctuation of the Negro River, associated with different fishing habitats, are important factors determining catches. In the Itaipu reservoir Okada et al. (1996) observed the largest catches in spring - summer. The dry season is not well marked in South Brazil and according to Julio-Jr. et al. (1997), the landings in Itaipu reservoir were more related to the kind of gear employed associated to more intense fish activity in the summer due to higher temperatures.

In this study, the fishing sites were shown to be statistically significant in determining catches. So the mean catches between Horto and Píer were statistically different, but the comparisons between Horto and Praia and between the Praia and Píer were not. This may be explained by the proximity of Horto to the mouth of Itaqueri River which carries untreated sewage (Argenton, 2004). In Praia, the second mean catch was registered due to the absence of vegetal covering, which would contribute with nutrients. The similarity between the catches in Praia and Píer can be justified due to the proximity of the two sites.

The type of bait used was shown to be not significant. In other words, unlike many fishers believed, the association between bait and ceva, or just the use ceva, does not increase the captures. So our advice is that the discontinuity of this practice could improve the water quality of the reservoir in Horto, principally because the water presented high phosphorus concentrations, which is above the recommended level by Brazilian legislation (resolution 20/86 of CONAMA, Conselho Nacional do Meio Ambiente) (Argenton, 2004). Despite the fishing of carp being selective due to bait size, Arlinghaus and Mehner (2003) in Germany credited the increase of water eutrophication to the discarded bait, when no fish is hooked.

Templeton (1984) considered rod fishing appropriate for large or small lakes, to rivers and others water bodies. The captures depend on the spatial the fishing effort and the techniques used. Arlinghaus et al. (2003) believed in the sociocultural and socioeconomic benefits generated

by sport fishing in Europe, in spite of the negative impacts in the aquatic ecosystems.

Agostinho and Gomes (2005) mentioned that in Brazil, fishing management can be addressed for the preservation of biological diversity and/or to sustain stock density in two ways: 1) management with a conservationist purpose: to be adopted in order to maintain the population density above critical demographic and genetic thresholds important for reproduction and evolutionary processes, and 2) exploitation management: to maintain a maximum income from the fishing activity, adopting measures that increase recruitment, improving the environment biogenic capacity, so reducing natural mortality and then monitoring fishing.

Little has been done in relation to the management of the stocks of Lobo-Broa reservoir involving the fishers. The more productive Horto area does not have any sheltering facilities for the fishers. Some haphazard fish introductions are accomplished by fishers, without any previous studies. In Broa reservoir and in Ilha Grande Park (Zacarkim et al., 2005) the interviewed sport fishers agreed that professional fishing (cast nets and gillnets) should be prohibited in order to keep the fishing resource just for themselves. However, in this study, there were several sport fishers who fished with nets, but didn't trade the fishes, and are not considered professional fishers.

Investments in sport fishing tourism would promote local development in a sustainable way. Appropriate stock management and maintenance of water quality in Lobo-Broa reservoir could guarantee that the native stock was not overexploited, as well as controlling the alien species stocks.

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