Fish fauna of Floresta Nacional de Ipanema, São Paulo State, Brazil

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Abstract: The Floresta Nacional de Ipanema is located on the southeast of the state of São Paulo, Brazil, and belongs to the cities of Araçoiaba da Serra, Iperó and Capela do Alto. It extends over an area of 5,069 ha surrounded by several streams, small lakes, the Ipanema river and the Hedberg dam. The fish species in this area were sampled between 1993 and 2012 in several isolated studies, with the use of gill nets and sieves. Fifty species of fish were registered, 43 native and 7 non-native (*Cyprinus carpio*, *Piaractus mesopotamicus, Brycon cephalus, Triportheus nematurus, Clarias gariepinus*, *Tilapia rendalli* and *Poecilia vivipara*), distributed in seven Orders, 21 Families and 41 Genera. The present study aimed at cataloguing the fish species in the Ipanema National Forest. Handling and preservation actions will be based on the information obtained.
Keywords: *Floresta Nacional de Ipanema, ichthyofauna, inventory, fish, conservation unit.*

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Resumo: A Floresta Nacional de Ipanema está localizada no sudoeste do estado de São Paulo, Brasil e pertence às cidades de Araçoiaba da Serra, Iperó e Capela do Alto. Estende-se por uma área de 5, 069 ha, onde ocorrem diversos riachos, pequenos lagos, o rio Ipanema e a represa de Hedberg. As espécies de peixes dessa unidade de conservação foram amostradas entre 1993 e 2012 em vários estudos realizados, com o uso de redes de espera e peneiras. Foram registradas 50 espécies de peixes, 43 nativas e 7 não-nativas (*Cyprinus carpio, Piaractus mesopotamicus, Brycon cephalus, Triportheus nematurus, Clarias gariepinus, Tilapia rendalli* e *Poecilia vivipara*), distribuídas em sete ordens, 21 famílias e 41 gêneros. O estudo teve como objetivo catalogar as espécies de peixes da Floresta Nacional de Ipanema. Ações de manejo e preservação deverão ser baseadas nas informações obtidas.
Palavras-chave: *Floresta Nacional de Ipanema, ictiofauna, inventário, peixe, unidade de conservação.*

Introduction

Currently, there are 391 species described for São Paulo state, representing about 15% of freshwater fish species of the Brazil (Oyakawa & Menezes 2011). Recently Smith et al. 2007 registered 71 species of fishes in the Sorocaba river basin, where it is located the Floresta Nacional de Ipanema.

The Floresta Nacional de Ipanema (FLONA de Ipanema) is a national conservation unit created in 1992, which is maintained by the Instituto Nacional do Meio Ambiente e Recursos Naturais Renováveis (IBAMA). It extends over an area of 5,069 ha, with 1,388 ha being covered with vegetation (Smith & Regalado 2008).

The three main watercourses that run across the area are the Ipanema, Verde and Ribeirão do Ferro streams. Ipanema and Verde streams make up the basin of Ipanema River, and Ribeirão do Ferro and other streams located within the conservation unit make up the microbasin of Ribeirão do Ferro. Besides these watercourses, there is the hydrographic basin of the Iperó River, located in the western portion of the Araçoiaba Mount.

Significant environmental impacts were identified in the microbasins comprised in the present study. The replacement of natural vegetation with pasture fields is noticeable in the Iperó River, which causes erosion and silting of watercourses. This is also found in the Ipanema River, where effluent discharge and use of pesticides are frequent. The microbasin of Ribeirão do Ferro, in turn, is in better conditions since it is located in the Araçoiaba Mount. However, this small stream is also affected by adverse conditions, such as the many dams in its bed and the silting resulting from a landslide of waste on its left edge next to the area of limestone mining, and the suppression of riparian vegetation in the lowest areas of the Araçoiaba Mount (downstream).

The above finding deserves attention, because the little-known fish species of the region may be endangered. The ichthyofauna of the basins located in the Floresta Nacional de Ipanema was first registred by Georg Heinrich von Langsdorff, who visited the region, in 1825, and identified the following fish species: "jundiá" (*Rhamdia quelen*), "mandiuva" (*Pimelodus maculatus*), "traíra" (*Hoplias malabaricus*) and "tuvira" (*Gymnotus carapo*) (Expedição… 1821-1829).

The knowledge of the fish fauna of this region is mainly due to the work of Bernardo & Barrella (1999), Smith (1999), Smith & Marciano (2000) well as studies for the preparation of the Management Plan in 2003 (Brasil 2003). More recently, the studies of Smith (2003), Smith et al. (2007), Smith & Regalado (2008), and Smith et al. (2009) were conducted. Being conservation areas considered place of survival within a larger unit changed (Sarmento-Soares & Martins-Pinheiro, 2007), knowledge of existing species is critical. So, the present study aimed at cataloguing the fish species in the conservation unit based on the above mentioned studies and on the sampling of species to provide information as a basis for handling and preservation actions.

Material and Methods

The Floresta Nacional de Ipanema is located between latitudes 23° 25' and 23° 28' S and longitudes 47° 33' and 47° 40' W in an area of 5,180 ha belonging the municipalities of Iperó, Araçoiaba da Serra and Capela do Alto, on the southeast of the state of São Paulo, 125 km far from the capital, São Paulo.

Various streams emerge from the Araçoiaba Mount (Figure 1), and the largest one is called Ribeirão do Ferro (Salazar 1998). This stream is formed by three small irregular streams of water, in which confluence is the "Cobra" Lagoon, a reservoir of Ribeirão do Ferro, constructed in the beginning of 1970. There are other lagoons besides the Cobra Lagoon. The Ipanema River, a major tributary of the Sorocaba River, flows east of the Araçoiaba Mount, forming the Hedberg Dam, constructed in 1818 (Salazar 1998). All these waterways make up the hydrographic basin of the Sorocaba River, main tributary of the left bank of the Tietê River.

Fish were collected in some stretches of Ribeirão do Ferro and Verde rivers, in one stretch of the Ipanema River (dam and downstream the dam), in the Hedberg Dam, in the Limão and Cobra lagoons and in other lagoons that occur in the FLONA (Table 1). The fish were captured with sieves and nets with meshes of 3, 4, 6, 7, 8, 10 and 12 cm between opposing knots. The organisms collected were stored in the fish collection of the biology museum of the Universidade Paulista – Campus Sorocaba.

Results

A total of 50 species distributed in seven orders, 21 families and 41 genera were identified. The taxonomic list of identified species is shown in Table 2. Most of these species belonged to the Characiformes order (25 species) and the Siluriformes (18 species). The most represented families are: Characidae, Loricariidae, Heptapteridae and Callichthyidae with 15, 6, 3 and 3 species, respectively. Of the total identified species, 43 are native and seven are considered non-native. Regarding the distribution of the fish fauna, 27 species are widely distributed throughout the conservation area while 23 were recorded to a particular habitat (Table 3). Besides, non-native species present in the area are concentrated in lentic environment as the Hedberg reservoir and Cobra lagoon, except *Tilapia rendalli* which is widely

Table 1. Sampling stations sampled in the Floresta Nacional de Ipanema with their ecological status and geographic location.

Sampling stations	Ecological status	Geographical coordinates
Ipa01 – Ipanema River	class 2 river, lotic, high current	23K 239172 UTM 7399430
Ipa02 – Ipanema River	class 2 river, lotic, high current	23K 0234693 UTM 7407007
Ipa03 – Verde River	stream, lotic, low current	23K 236768 UTM 7404492
Ipa04 – Verde River	stream, lotic, low current	23K 235202 UTM 7403739
Ipa05 – Hedberg Dam	reservoir, lentic	23K 235171 UTM 7406740
Ipa06 – Hedberg Dam	reservoir, lentic	23K 0234518 UTM 7406543
Ipa07 – Hedberg Dam	reservoir, lentic	23K 0234859 UTM 7406967
Ipa08 – Ribeirão do Ferro Stream	stream, lotic, moderate current	23K 0232070 UTM 7406301
Ipa 09 – Ribeirão do Ferro Stream	stream, lotic, moderate current	23K 0231146 UTM 7405348
Ipa10 – Cobra Lagoon	lentic environment	23K 2330394 UTM 7404885
Ipa11 – Limão Lagoon	lentic environment	23K 233765 UTM 7407117
Ipa 12 – Lagoon	lentic environment	23k 0234479 UTM 7406472
Ipa 13 – Lagoon	lentic environment	23k 0234284 UTM 7406554
Ipa 14 – Lagoon	lentic environment	23k0234681 UTM 7404199

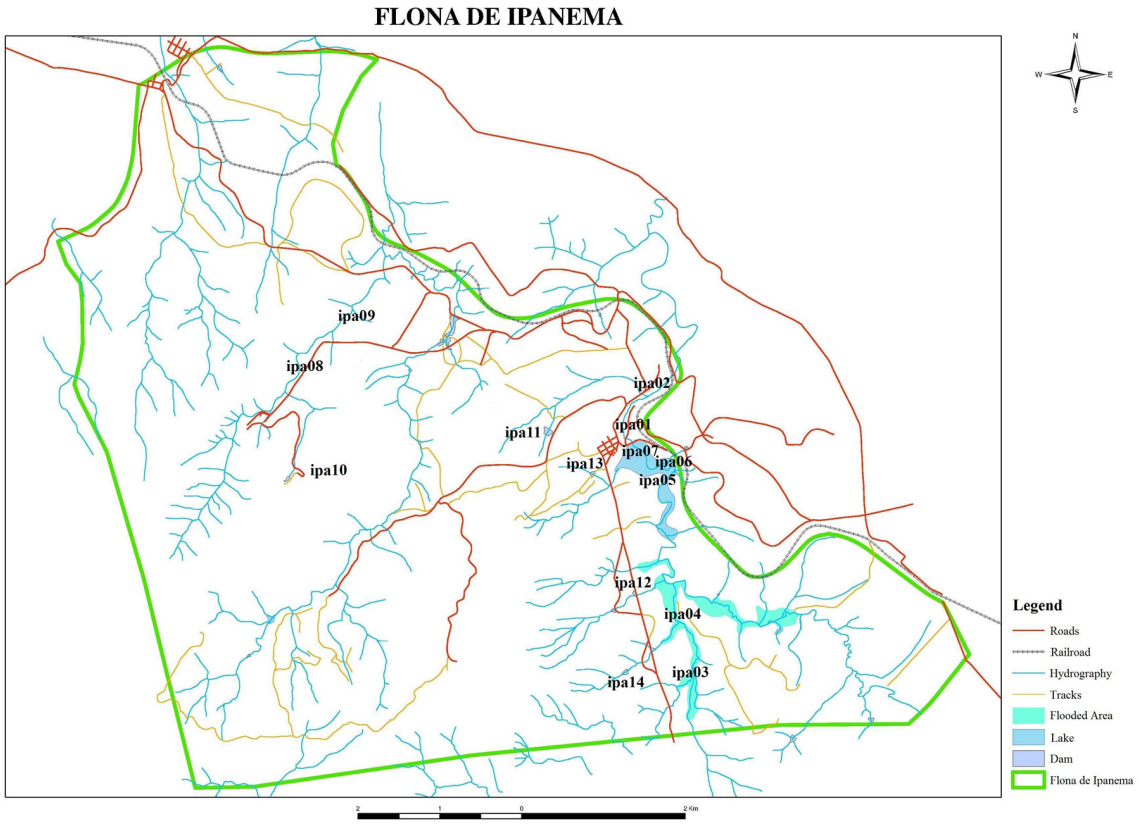

Figure 1. Hidrographic system of the Floresta Nacional de Ipanema.

Table 2. Taxonomic list of fish species from the Floresta Nacional de Ipanema.

	Species
Characiformes	
Characidae	*Astyanax fasciatus* (Cuvier, 1819)
	Astyanax altiparanae Garutti and Britski, 2000
	Astyanax eigenmanniorum (Cope, 1894)
	Astyanax paranae Eigenmann, 1914
	Astyanax scabripinnis (Jenyns, 1842)
	Hyphessobrycon anisitsi (Eigenmann, 1907)
	Hemigrammus marginatus Ellis, 1911
	Serrapinnus notomelas (Eigenmann, 1915)
	Odontostilbe microcephala Eigenmann, 1907
	Bryconamericus stramineus Eigenmann, 1908
	*Brycon cephalus** (Günther, 1869)
	Oligosarcus pintoi Campos, 1945
	Acestrorhynchus lacustris (Lütken, 1875)
	Salminus hilarii Valenciennes, 1850
	Triportheus nematurus * (Kner, 1858)
Crenuchidae	
	Characidium zebra Eigenmann, 1909
Serrasalmidae	
	Piaractus mesopotamicus * (Holmberg, 1887)
Erythrinidae	
	Hoplias malabaricus (Block, 1794)
Prochilodontidae	*Prochilodus lineatus* (Valenciennes,1836)
	Prochilodus vimboides Kner, 1859
Curimatidae	*Steindachnerina insculpta* (Fernández-Yépez, 1948)

* non-native specie

Table 2. Continued...

	Species
	Cyphocharax modestus (Fernández-Yépez, 1948)
Anostomidae	*Leporinus obtusidens* (Valenciennes, 1836)
Parodontidae	
	Parodon nasus Kner, 1859
	Apareiodon affinis (Steindachner, 1879)
CYPRINIFORMES	
Cyprinidae	*Cyprinus carpio** Linnaeus, 1758
SILURIFORMES	
Callichthyidae	
	Corydoras aeneus (Gill, 1858)
	Corydoras flaveolus Ihering, 1911
	Hoplosternum littorale (Hancock, 1828)
Cetopsidae	
	Cetopsis gobioides Kner, 1857
Clariidae	
	*Clarias gariepinus** (Burchell, 1822)
Pimelodidae	
	Pimelodus maculatus La Cèpede, 1803
	Iheringichthys syi Azpelicueta & Britski, 2012
Heptapteridae	
	Imparfinis mirini Haseman, 1911
	Pimelodella rudolphi (Miranda-Ribeiro, 1918)
	Rhamdia quelen (Quoy and Gaimard, 1824)
Pseudopimelodidae	
	Microglanis garavelloi Shibatta and Benine, 2005
Trichomycteridae	
Loricariidae	*Trichomycterus iheringi*
	Hisonotus depressicauda (Miranda-Ribeiro, 1918)
	Hypostomus ancistroides (Ihering, 1911)
	Hypostomus margaritifer (Regan, 1908)
	Hypostomus sp.
	Rineloricaria latirostris (Boulenger, 1900)
	Rineloricaria sp.
GYMNOTIFORMES	
Gymnotidae	*Gymnotus carapo* Linnaeus, 1758
PERCIFORMES	
Cichlidae	
	Geophagus brasiliensis (Quoy and Gaimard, 1824)
	*Tilapia rendalli** (Boulenger, 1897)
Cyprinodontiformes	
Poeciliidae	*Phalloceros reisi* Lucinda, 2008
	Poecilia vivipara Block and Schneider, 1801
SYNBRANCHIFORMES	
Synbranchidae	*Synbranchus marmoratus* Bloch, 1795

* non-native specie

distributed by the numerous water bodies of the area. According to Table 3 is possible to see eight species that exhibit migratory habit, eight exhibit parental care and two, both Poeciliidae, have internal fertilization. Regarding the feeding habits of the species found in the Floresta Nacional de Ipanema, predominated omnivorous and insectivorous species (14 and 13 species respectively). One of the identified species (*Prochilodus vimboides*) is considered vulnerable in the state according to the book of threatened fauna in the State of São Paulo (Bressan et al. 2009). Other features and details of the distribution of species are included in Table 3.

Discussion

The ichthyofauna composition is the one expected for non estuarine waters of the neotropical region (Lowe-McConell 1987, Castro & Menezes 1998). Among the various water ecosystems in this conservation unit, we can cite the streams with moderate to high flows, waterfall stretches, gravelly soil, in some cases consolidated substratum, great concentration of allochthonous and autochthonous insects and the typical herbaceous and shrubby vegetation, which

Table 3. Fish species occurring in the Floresta Nacional de Ipanema, with their characteristics and distribution.

Species	Vulgar names	Feeding habit	Preferred habitats	Reproduction	Distribution
Astyanax altiparanae	lambari do rabo amarelo	omnivorous	backwaters, near the margin	external fertilization, without parental care, not migratory	wide
Astyanax fasciatus	lambari do rabo vermelho	omnivorous	vegetation on the margins	external fertilization, without parental care	wide
Astyanax scabripinnis	lambari	insectivorous	backwaters of streams	external fertilization, without parental care, not migratory	restricted
Astyanax eigenmanniorum	lambari	insectivorous	benthopelagic	external fertilization, without parental care, not migratory	restricted
Astyanax paranae	lambari	insectivorous	benthopelagic	external fertilization, without parental care, not migratory	restricted
Hemigrammus marginatus	piaba	omnivorouss	vegetation on the margins	external fertilization, without parental care, not migratory	restricted
Hyphessobrycon anisitsi	tetra	insectivorous herbivore	benthopelagic	external fertilization, without parental care	restricted
Serrapinnus notomelas	piaba	omnivorous	vegetation on the margins	external fertilization, without parental care, not migratory	wide
Odontostilbe microcephala	pequira	omnivorous	benthopelagic	external fertilization, without parental care, not migratory	restricted
Bryconamericus stramineus	pequira	omnivorous	backwaters or currents between the grass, benthopelagic	external fertilization, without parental care, not migratory	restricted
Brycon cephalus [1]	matrinxã	omnivorous	benthopelagic	external fertilization, with parental care migratory	wide
Oligosarcus pintoi	peixe-cachorro	carnivorous	roots of the marginal vegetation	external fertilization, without parental care, not migratory	wide
Characidium zebra	canivete	insectivorous	rocky substrate, benthopelagic,	external fertilization, without parental care, not migratory	restricted
Acestrorhynchus lacustris	cadela	piscivore	backwaters	external fertilization, without parental care, not migratory	wide
Salminus hilarii	tabarana	carnivorous	currents	external fertilization, migratory, without parental care	wide
Triportheus nematurus [1]	sardinha	insectivorous	currents	external fertilization, migratory, without parental care	restricted
Piaractus mesopotamicus [1]	pacu	herbivore	demersal	external fertilization, migratory, without parental care	restricted
Steindachnerina insculptaSaguirú	saguirú	iliophagous	backwaters, background	external fertilization, without parental care, not migratory	wide
Cyphocharax modestus	saguirú	iliophagous	backwaters, background	external fertilization, without parental care, not migratory	wide
Prochilodus lineatus	curimbatá	iliophagous	current	external fertilization, migratory, without parental care	restricted
Prochilodus vimboides [2]	curimbatá	iliophagous	current	external fertilization, migratory, without parental care	restricted
Hoplias malabaricus	traíra	carnivorous	backwaters, lagoons	external fertilization, with parental care, not migratory	wide
Leporinus obtusidens	piava	herbivore	lotic environments	external fertilization, without parental care, migratory	wide
Parodon nasus	canivete	iliophagous	marginal areas, current, gritty background	external fertilization, without parental care, not migratory	wide
Apareiodon affinis	canivete	detritivore	benthopelagic, lotic and lentic environment	external fertilization, without parental care, not migratory	restricted
Cyprinus carpio [1]	carpa	herbivore-detritivore and zoobenthos	benthopelagic	external fertilization, without parental care, not migratory	restricted
Corydoras aeneus	ronquinha	omnivorous	clear water, backwaters or currents	external fertilization, without parental care, not migratory	wide

[1] Introduced species / non-native. [2] Specie in vulnerable state according to Bressan et al. (2009).

Table 3. Continued...

Species	Vulgar names	Feeding habit	Preferred habitats	Reproduction	Distribution
Corydoras flaveolus	ronquinha	omnivorous	clear water, backwaters or currents	external fertilization, without parental care, not migratory	restricted
Cetopsis gobioides	candiru	insectivorous	current and demersal	external fertilization, without parental care, not migratory	restricted
Clarias gariepinus [1]	bagre africano	omnivorous	benthopelagic	external fertilization, without parental care, with lateral migration	restricted
Hypostomus ancistroides	cascudo	herbivore-detritivore	river rapids, background	external fertilization, with parental care, not migratory	wide
Hypostomus margaritifer	cascudo	herbivore-detritivore	river rapids, background	external fertilization, without parental care, not migratory	wide
Hypostomus sp.	cascudo	herbivore-detritivore	river rapids, background	external fertilization, without parental care, not migratory	wide
Rineloricaria latirostris	cascudo	detritivore	current, rocks and trunk	external fertilization, without parental care, not migratory	restricted
Rineloricaria sp.	cascudo	detritivore	current, rocks and trunk	external fertilization, without parental care, not migratory	restricted
Hisonotus depressicauda	limpa-vidro	detritivore	vegetation on the margins	external fertilization, without parental care, not migratory	restricted
Hoplosternum litoralle	caborja	iliophagous	backwaters, background	external fertilization with parental care	wide
Imparfinis mirini	bagrinho	insectivorous	current, pebble, gravel and grit background	not migratory, external fertilization with parental care	wide
Microglanis garavelloi	bagrinho	insectivorous	vegetation on the margins	not migratory external fertilization	restricted
Pimelodella rudolphi	mandizinho	insectivorous	Current, pebble background and demersal	external fertilization, without parental care, not migratory	restricted
Pimelodus maculatus	mandi-pintado	insectivorous	current, background	external fertilization, without parental care, not migratory	wide
Iheringichthys syi	mandi	carnivorous, insectivorous	rivers, background	external fertilization, without parental care, not migratory	wide
Rhamdia quelen	bagre	omnivorous	low current, background	external fertilization, with parental care, not migratory	wide
Trichomycterus sp.	sobe-serra	insectivorous	current, grit and gravel background	external fertilization, without parental care, not migratory	restricted
Gymnotus carapo	tuvira	carnivorous	vegetation on the margins	external fertilization, without parental care, not migratory	wide
Geophagus brasiliensis	cará	omnivorous	margins	external fertilization, with parental care, not migratory	wide
Tilapia rendalli [1]	tilápia	herbivore	margins	external fertilization, with parental care, not migratory	wide
Phaloceros reisi Barrigudinho,	barrigudinho	omnivorous	margins, shallow water	internal fertilization, not migratory	wide
Poecilia vivipara [1]	barrigudinho	omnivorous	margins, shallow water	internal fertilization, not migratory	wide
Synbranchus marmoratus	mussum	carnivorous	lentic environment, cleft in the margins	external fertilization, not migratory	wide

[1] Introduced species / non-native. [2] Specie in vulnerable state according to Bressan et al. (2009).

favors the presence of small characids ("lambaris"), loricariids ("cascudos"), and catfish.

The ichthyofauna of the region consists of small-sized fish, such as "carás", "lambaris", "cascudos" and small catfish, which depend on the riparian vegetation for their food source of allochthonous material. The presences of *Astyanax scabripinnis*, a species typically found in streams, was registered (Castro & Casatti 1997). The streams located in the conservation unit are ecosystems with a little known ichthyofauna (Castro & Menezes 1998, Menezes et al. 2007). According Oyakawa et al. (2006), this lack of knowledge is related to the fact that the fish are small and uninteresting streams for fishing, besides their cryptic habits and occur in aquatic environments quite restricted. The author also highlights the difficulty in sampling all species present in a given stretch of river.

According to Bressan et al. (2009) the species *Prochilodus vimboides* and *Bunocephalus larai* occur in vulnerable state in the area of the Floresta Nacional de Ipanema. However, no individual from *Bunocephalus larai* was collected during this work.

The predominant species in these rivers, including Verde and Ipanema rivers, are the "cará" (*Geophagus brasiliensis*), the "lambaris" (*Astyanax altiparanae* and *A. fasciatus*), the "saguirú" (*Cyphocharax modestus* and *Steindachnerina insculpta*), the lacustris catfish (*Rhamdia quelen*, *Pimelodus maculatus* and *Iheringichthys labrosus*), the "cascudo" (*Hypostomus ancistroides*), the "peixe-cadela" (*Acestrorhynchus lacustris*) and the "guarú" (*Phalloceros reisi*).

In addition to rivers and streams there are several lagoons as the Cobra and the Limão lagoons with several fish species. Fish of five species were identified there, as follows: "cará" (*Geophagus brasiliensis*), "lambari" (*Astyanax altiparanae*), "tilapia" (*Tilapia rendalli*), "barrigudinho" (*Phalloceros reisi*) and "cascudo" (*Hypostomus ancistroides*). Because these lagoons are located in the headwater of rivers they have reduced diversity of species.

The Hedberg Dam, constructed in 1818, showed an ichthyofauna typical of lentic environment mainly formed by "saguirus" (*Cyphocharax modestus* and *Steindachnerina insculpta*), "carás" (*Geophagus brasiliensis*) and "lambaris" (*Astyanax fasciatus* and *A. altiparanae*). Moreover, species from typical lotic environments have been captured, such as the "curimbatá" (rheophilic species) and the "cascudo" (*Hypostomus ancistroides*), that are supposed to reproduce in the upstream stretches or in tributaries such as the Verde River. Being an old dam, the Hedberg Dam has a highly structured fish community. According to Lowe-McConnell (1987), it takes around 5 to 15 years for a fish community to reach stability.

This dam has been transformed into a pay to fish lake, and several species were added to this environment, such as the *Tilapia rendalli, Piaractus mesopotamicus*, *Brycon cephalus* and *Cyprinus carpio* (Smith 2003), which may contribute to the decreased stability of this fish community. Currently, although the fishing has been disabled, in addition to these species, it is also possible to verify the presence of the "catfish", *Clarias gariepinus*. This is because aquatic environments located in conservation areas, although legally protected, are subject to threats of a species is introduced elsewhere in the basin, because a water system tends to be virtually connected with all parts and subsystems, from the source to the mouth, the main channel of the lagoons (Agostinho et al. 2006).

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