



HAL
open science

Fish Population Structure and its Relation to Fisheries Yield in Small Reservoirs in Côte d'Ivoire

Luis Tito de Morais

► **To cite this version:**

Luis Tito de Morais. Fish Population Structure and its Relation to Fisheries Yield in Small Reservoirs in Côte d'Ivoire. I. G. Cowx. Management and Ecology of Lake and Reservoir Fisheries, Blackwell Publishing Ltd, pp.112-122, 2002, 9780852382837. 10.1002/9780470995679.ch10 . hal-02495171

HAL Id: hal-02495171

<https://hal.science/hal-02495171>

Submitted on 1 May 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Tito de Morais, L. 2002. Fish Population Structure and its Relation to Fisheries Yield in Small Reservoirs in Côte d'Ivoire. *In* Management and Ecology of Lake and Reservoir Fisheries. *Edited by* I.G. Cowx. Blackwell Publishing Ltd. pp. 112–122.

Fish population structure and its relation to fisheries yield in small reservoirs in Côte d'Ivoire

L. TITO de MORAIS

Centre IRD de Bouaké, Bouaké, Côte d'Ivoire

Abstract

Lack of reliable data on the fisheries of northern Côte d'Ivoire reservoirs is a major limitation for management of the fish stocks. As individual reservoirs cannot be studied due to the high costs and lack of trained investigators, empirical and production models have to be used to evaluate exploitation rates and fisheries potential. Daily yield (DY, in kg fishing day⁻¹year⁻¹) and total catch (TC, in kg year⁻¹) appear to be better descriptors than annual yield (in kg ha⁻¹ year⁻¹). TC is related to variables linked to nutrient availability (watershed area, conductivity and Morphoedaphic Index). DY is related to fish species richness and to reservoir area, indicating that fish population structure could be a key to understanding the patterns observed. Correlation between fish population structure and yield was significant. It was hypothesised that overall catch, TC, is related to nutrient availability, but that catch per unit effort is related to the presence of given species in the reservoirs, and particularly to the presence of bottom feeding species.

Keywords: fish population structure, fisheries, reservoirs, yield models.

1 Introduction

At first glance, small-scale reservoir fisheries appear to be of marginal importance in the national fisheries statistics of southern countries. Côte d'Ivoire, for example, declares almost no yield from its small-scale reservoirs to FAO statistics. This is mostly related to a lack of knowledge of its importance rather than a true image of the fisheries situation in such water bodies. A preliminary study (Da Costa, Traore & Tito de Morais 1998) indicated that small-sized (< 10 ha) and medium-sized (10–100 ha) reservoirs may contribute between 16 % and 46 % of the 13 447 t year⁻¹ of total freshwater fisheries production in Côte d'Ivoire. The large variation in these estimates depends upon the variation in yield estimates in the reservoirs. Several models and relationships between annual fish yield and morphometric and biological data have been proposed for tropical reservoirs (see Amarasinghe 1996 for review). But to be operational, such models need to be adapted to local conditions, and plausible biological criteria for such relationships have to be tested (Amarasinghe 1996). The present chapter is the first attempt to adapt empirical and production models to Côte d'Ivoire small-reservoir fisheries.

2 Study area

The aim of this study was to test for different relationships between fisheries yield and lake and watershed morphology and fish community-related variables. Such variables are more easily obtained in the field than are catch and effort data. The collection of the latter requires more than 1 year of observation of daily catch in each reservoir. Conversely, morphometric data can be obtained by remote sensing, map observation, or by means of a single field trip. Fish assemblage data already exist or can be obtained with few (3–4) sampling sessions in each reservoir. The major applications of such relationships are in ecological monitoring and in fisheries management.

Southern countries lack funding and skilled investigators to efficiently monitor small-scale fisheries, which are numerous and scattered. It is essential to distinguish between myths and reality when it comes to discussing the fishing importance of small-scale reservoirs. Arguments related to the importance of fish as a by-product of water supply reservoirs are widespread. Yet, no one can really give accurate figures of fisheries yield for small- and medium-size reservoirs in the north of Côte d'Ivoire. The only regional study appears to be that of Baijot, Moreau & Bouda (1994) in Burkina Faso, where the reservoirs are larger (15–1500 ha) than in Côte d'Ivoire and the fisheries organisation is totally different due to a lack of marine fisheries.

3 Materials and methods

Over 300 reservoirs have been built in Côte d'Ivoire, mostly for water supply for cattle and irrigation (Table 1). Reservoirs for watering cattle are generally smaller than those devoted to other uses. Two hundred and sixty-nine of the 297 small reservoirs built for cattle are in the northern region. Nearby inhabitants have been using the reservoirs for other purposes such as fishing, hygiene and recreation.

As people living in the area are mostly from the Senoufo group, they consider themselves as cultivators and are reluctant to fish. Foreigners such as the Bozos from Mali do the fishing. The Bozos pay a levy in fish, money or other form, to exploit the reservoirs. Da Costa et al. (1998) showed that fishing is an important (with regard to local standards) source of income for local people. Fish is also important in nutritional terms in the northern region of the country, as other sources of protein are expensive or unavailable. The traditional fishing gears used in the small reservoirs in the north of the Côte d'Ivoire are mainly (by order of importance) gillnets, traps, hooked lines (baited or unbaited), and cast nets. Beach seines are seldom used. In most cases, at any given period, one single fisherman practises in each given reservoir. When a fisherman leaves a reservoir, another one rapidly replaces him. Fishermen may change from one reservoir to another, or travel back to Mali for a while. All fishermen use similar fishing gears and similar fishing strategies, allowing use of fishing day as a measure of fishing effort in the reservoirs. Due to staffing limitations, rather than collecting superficial data from many reservoirs, fishing activity at seven reservoirs was studied in detail.

These reservoirs (Table 2) are in the same area and belong to two of the largest river basins in Côte d'Ivoire : the Bandama (five dams) and the Comoé (two dams). Three are medium-sized reservoirs, and

four small-sized reservoirs. Overall species richness (SR) is similar in the two rivers (88 and 91 species) and fish SR varies from 10 to 24 in the reservoirs.

3.1 Fish catches

The study lasted 27 months from April 1996 to June 1998. One observer was appointed to each reservoir to record daily fish landings, registering : fisherman's name, number of fish by species, total weight by species and by sub-sample, gear used (when available), duration of fishing activity. Other information such as weather conditions, fish selling prices, activity of fishermen when not fishing, were also recorded but are not presented here. The data were enumerated as total catch per year (TC, kg year⁻¹), annual yield (AY, kg ha⁻¹ year⁻¹), unit effort (fishing days) and daily catch per unit effort (CPUE), i.e. daily yield (DY, kg day⁻¹ ha⁻¹). Unit effort was chosen to compare yield values between reservoirs. The only effort variable available in this context, fishing day, was used. This means that if nobody fishes in a given reservoir, the value for that day is 0. If only one person fishes the value is 1 for that day. If two persons fish the value is 2 and so on. So in the larger reservoirs (e.g. Katiali and Tiné) where there are several fishermen, it is possible to have more than 365 fishing days in 1 year. Even though this variable is not very precise, it has been used widely in the fisheries studies in Africa.

Fishermen generally combine their catch when they land. It is seldom possible to separate the catch according to the fishing gears used, although fishermen generally use the same fishing gears and strategies every day.

3.2 Fish population structure

SR and fish population structure were investigated using bimonthly beach seine and gillnet samples between January 1998 and September 1999. Gillnets were set over- night using two, 13-net gangs. Gillnets were monofilament nets, 25 m in length, 2 m in height. Mesh sizes were 10, 12.5, 15, 17.5, 20, 22.5, 25, 30, 40, 50, 60, 70, 80 mm, knot- to-knot. Beach seining (14-mm multifilament mesh size) was performed once a month, in the morning around 07.00 h.

3.3 Statistical analysis and tests

Significance of morphometric and production models was tested by correlation. Several paired combinations of both were tested : SR on reservoir area (RA, ha), SR on watershed area (WA, km²), SR on the ratio WA/RA, catch on SR, catch on RA, catch on WA, catch on the ratio WA/RA, catch on depth (D, m), catch on conductivity (C, μ S), catch on fishing intensity (FI, fishing days km²), and catch on morpho-edaphic index (MEI) (DxC). Catch was tested as TC per year (kg year⁻¹), AY (kg ha⁻¹year⁻¹) and as DY (kg day⁻¹ ha⁻¹). Correspondence analysis of the matrix of fish abundance per reservoir was used to investigate the relationship between yield and species composition. Reservoirs were plotted in the factorial space of the correspondence analysis on the matrix of species abundance per reservoir. The clustering of reservoirs according to their scores in the factorial space was compared to the grouping of reservoirs according to yield. The clustering distance used was the Euclidian distance. The clustering method used was average linkage for yield and Ward's method (Ward 1963) for scores. Mantel's test (Mantel 1967) was used to test for the similarity between the two distance matrices (yield and scores). Mantel's test is a permutation test (1000 random permutations) on the Z value (Manly 1994):

$$Z = \sum_{i=2}^n \sum_{j=2}^{i-1} m_{ij} e_{ij}$$

where m and e are the elements of two $n \times n$ distance matrices with i as the row index and j the column index ; m is the canonical distance matrix between reservoirs calculated on the DY ; e is the canonical distance matrix between reservoirs calculated on the scores of the reservoirs in the factorial space. Factorial space is that of the correspondence analysis on the matrix of fish species abundance per reservoir. To estimate the capability of fish to feed upon bottom living food items, mouth orientation was noted for each species. The percent of fish species with a downward oriented mouth was calculated in each reservoir.

The correlation tests were performed using the ‘R’ software and the multivariate and Mantel tests using the ‘ADE’ software (Thioulouse, Chessel, Dolédec & Olivier 1997).

4. Results

The most abundant fish species captured by the small-scale fisheries in the reservoirs were (by order of abundance in the artisanal catches): *Oreochromis niloticus* L., *Sarotherodon galilaeus* (L.), *Clarias* spp. (mostly *C. anguillaris* L.), *Chrysichthys* spp. (mostly *C. nigromarginatus* Lacepède), *Tilapia zillii* (Gervais), *Heterotis niloticus* Cuvier, and *Marcusenius* sp. (mostly *M. senegalensis* Steindachner) (Table 3).

A 27-month survey of the artisanal fisheries was performed, but in all reservoirs except Katiali, fishing activity stopped for several weeks during the survey. Only two continuous periods were available for analysis in all reservoirs : one lasting 1 year and one lasting only 6 months. Only those continuous surveys are taken into account here-after (Table 4). Only the 1-year survey was available in the Tiaplé reservoir whereas two 1-year periods were available in the Katiali reservoir.

It was apparent that fishing days is a reliable measure of the fishing effort (Table 4). Whenever two independent values of DY are available they are very similar (except in Korokara reservoir where fishing activity was very irregular).

SR exhibited no correlation with RA ($r^2 = 0.05$, $P = 0.641$), but it was correlated to WA ($r^2 = 0.64$, $P = 0.030$) and to the ratio WA/RA ($r^2 = 0.568$, $P = 0.050$).

Morphometric and production linear models showed a complex picture (Table 5). AY ($\text{kg ha}^{-1} \text{ year}^{-1}$) showed little or no correlation with the variables studied.

DY, which is a measure of CPUE, was correlated with SR, RA, WA/RA and MEI. The last was also correlated to TC, as were WA and C.

The clustering of reservoirs according to their scores in the factorial space of the correspondence analysis on the matrix of species abundance per reservoir, showed good agreement with the grouping obtained from DY values in each reservoir (Fig. 1). The two groupings were obtained independently

(fishing inquiries for yield, and survey net fishing for species abundance) and the Mantel test indicated a significant correlation ($P = 0.015$) between the two distance matrices. This indicates a relationship between fish population structure (presence and abundance) and fisheries yield.

Characteristic species of each reservoir were noted (Table 6). Species are considered characteristic of a given group of reservoirs when more than 90 % of the TC of the species came from that group of reservoirs. Gboyo and Sambakaha were the reservoirs with the highest per cent of bottom feeding fishes, 43 % and 48 % of the total species present respectively. Apart from Tiné (40 % bottom feeding species), reservoirs having a low per cent of benthic feeding species (Katiali – 39 %; Korokara – 30 %; Nambingué – 29 %) were also the reservoirs showing low yields (Tables 4 and 6).

5. Discussion

Annual fish yield does not appear to be a good descriptor for small-scale reservoir fisheries in the northern Côte d'Ivoire. The pattern of yield observed among reservoirs is complex and the AY ($\text{kg ha}^{-1} \text{ year}^{-1}$) does not reflect the variability of the system. DY, which is a measure of fishing effort, and TC (kg year^{-1}), which is a measure of the overall productivity of the system, appear to be better descriptors. Not surprisingly, TC was related to variables linked to nutrient availability (WA, C and MEI). DY was related to fish SR and to RA, indicating that fish community structure could be a key to understanding the patterns observed. Several authors (see Lévêque 1997 for review) have raised the question of the relationship between SR and productivity for which there appears to be no simple relationship. Some simple systems, both natural and artificial, appear to be more productive than heterogeneous, but similar levels of production can be observed in species-rich ecosystems and in ecosystems with a low level of diversity (Lévêque 1997). An alternative hypothesis could be that SR is not the relevant variable. Ecological processes may function perfectly well with very few fish species. Lake Nakuru (Vareschi & Jacobs 1984, cited by Lévêque 1997) is an extreme example of very high production (over $2000 \text{ kg ha}^{-1} \text{ year}^{-1}$) in a mono-specific lake. What may be of importance are the species biomass (relative abundance of species) and their capacity to ensure an efficient energy flow in any given environment. Indeed, in this study, correlation between fish population structure (presence and abundance) and yield ($\text{kg day}^{-1} \text{ year}^{-1}$) was significant. This hypothesised that overall catch, TC, is related to nutrient availability (approximated here by water conductivity), but that CPUE is related to the presence of given species in the reservoirs, and particularly to the presence of bottom feeding species. The most efficient fisheries in the small- and medium-sized reservoirs in the Côte d'Ivoire are those where bottom feeding fish species dominate. The dominance of bottom feeding species is an indicator of good physical conditions in the deeper zones of the reservoirs. Such reservoirs certainly experience a better use of the trophic resources than reservoirs where only a few bottom feeding fish species live. Benthic resources thus become available at any time to the upper levels through fish consumption. In reservoirs where bottom layers cannot be used by fish (due to low levels of oxygen, for instance), the utilisation of the energy locked on the bottom depends upon winds strong enough to induce an upward transfer of nutrients. The possibility of use of bottom resources by fish is thus expected to increase productivity in the reservoirs. The dominance of bottom feeding fish species is

thus an indicator of high fisheries yield. Turner (1996) discussed a similar pattern but relating the efficiencies of fisheries to primary productivity. He concluded that the presence of the predator *Lates niloticus* (L.) affected transfer efficiencies, leading to less efficient fisheries in lakes where *Lates* is present than in lakes where this predator is absent. Turner investigated very large African lakes where fisheries yield is mainly based upon pelagic species (like *Limnothrissa*) and primary productivity is expected to play a major role. In this study, in small reservoirs, the pelagic zone is reduced and the availability of bottom energy appears to account for the major differences in fisheries yield. Primary productivity (estimated by its surrogate-conductivity) of course plays a role in fixing the limits to the overall catch, but the fisheries efficiency and yield are determined by the availability of bottom energy. In this study, the presence of *Lates niloticus* can also be suspected of being responsible for the low efficiency of the fishery in Tiné reservoir. Tiné was the largest reservoir selected, but it had the lowest SR and the lowest yield. Any conclusion about this reservoir has thus to be tempered. Tiné reservoir is virtually emptied every 3 years by the rice cultivators who manage the reservoir. It is the only reservoir selected to be managed that way.

The low numbers of fish species observed in Tiné is therefore likely to be the result of events occurring when the reservoir almost dries up.

The SR of that fish community is drastically reduced and this situation may continue when the lake has been filled again. Its fish population can be considered to be in a permanent pioneering state and unable to support an efficient and stable fishery. This reservoir deserves a specific study, which is being undertaken.

Acknowledgements

Field data were obtained, thanks to several inquirers and to the technical and fishing teams of Idessa/CNRA in Bouaké (A. Daha, E. Koffi Koffi, J. N'Guessan and L. Kadja). Jean Raffray, A. Tito de Moraes and Y. Kerroux were of invaluable help in data processing. Kouassi S. Da Costa helped through several discussions and provided comments. Both 'R' (<http://lib.stat.cmu.edu/R/CRAN>) <<http://lib.stat.cmu.edu/R/CRAN>> and 'ADE' software (<http://www.plib.univ-lyon1/ADE-4>) <<http://www.plib.univ-lyon1/ADE-4>> are freely available on the web. I wish to express gratitude to their numerous developers for such impressive work in the benefit of the scientific community.

References

- Anonymous (1992) Direction et Contrôle des Grands Travaux. Inventaire des barrages hydro-agricoles et à autres vocations existant en Côte d'Ivoire. Report, DCGTx, Abidjan, Côte d'Ivoire, multigr, 57 pp.
- Amarasinghe U.S. (1996) Stock assessment in Sri Lankan reservoirs : a review. In I.G. Cowx (ed.) Stock Assessment in Inland Fisheries. Oxford : Fishing News Books, Blackwell Science, pp. 345–

- Baijot E., Moreau J. & Bouda S. (1994) Aspects hydrobiologiques et piscicoles des retenues d'eau en zone soudano-sahélienne. Centre Technique de Coopération Agricole et Rurale (CTA) ACP/CEE. Commission des Communautés Européennes (CCE), DG VIII D5, Bruxelles, 250 pp.
- Da Costa K.S., Traoré K. & Tito de Morais L. (1998) Effort de pêche et production exploitée dans les petites retenues du Nord de la Côte d'Ivoire. Bulletin Français de la Pêche et de la Pisciculture 71 , 65 –78.
- Gourdin F. (1999) Premiers éléments pour une caractérisation hydrologique à diverses échelles du Nord de la Côte d'Ivoire : du local au régional. Report IRD Bouaké, Côte d'Ivoire. Mult. Pag. (in French).
- Gulland J.A. (1983) Fish Stock Assessment . Chichester : Wiley, 223 pp.
- Lévêque C. (1997) Biodiversity, Dynamics and Conservation. The Freshwater Fish of Tropical Africa. Cambridge : Cambridge University Press, 438 pp.
- Manly B.F. (1994) Multivariate Statistical Methods. A Primer , second edition. London : Chapman & Hall, 215 pp.
- Mantel N. (1967) The detection of disease clustering and a generalized regression approach. Cancer Research 27 , 209 –220.
- Thioulouse J., Chessel D., Dolédec S. & Olivier J.M. (1997) ADE-4 : a multivariate analysis and graphical display software. Statistics and Computing 7 , 75–83.
- Turner G.F. (1996) Maximization of yields from African lakes. In I.G. Cowx (ed.) Stock Assessment in Inland Fisheries . Oxford : Fishing News Books, Blackwell Science, pp. 465–481.
- Vareschi E. & Jacobs J. (1984) The ecology of lake Nakuru (Kenia). Production and consumption of consumer organisms. Oecologia (Berlin) 61 , 83–98.
- Ward J.H. (1963) Hierarchical grouping to optimize an objective function. Journal of the American Statistical Association 58 , 238–244.

Tables and figures

Table 1

Number of reservoirs in Côte d'Ivoire according to river basin and main use.

River basin	Main use			Total
	Irrigation	Drinking water	Cattle watering	
Agnébi	3	4	5	12
Bandama	33	6	115	154
Bia	0	0	2	2
Comoé	3	5	57	65
Marahoué	3	1	8	12
N'zi	29	9	22	60
Niger	2	4	60	66
San Pedro	1	5	2	8
Sassandra	5	0	3	8
Black Volta	0	0	23	23
Total	79	34	297	410

Only small-size (area <10 ha) and medium-size (area 10 –100 km²) reservoirs are listed. Sources: Anonymous 1992 and Gourdin 1999.

Table 2

Characteristics of river and reservoir used in this study

River or reservoir name	Area (km ²) ^b	Maximum <i>D</i> (m) ^b	Type	Main river basin	SR	WA (km ²)
Bandama	–	–	River	Bandama	88 ^a	97 000 ^a
Comoé	–	–	River	Comoé	91 ^a	78 000 ^a
Tiné	0.45	10.0	Medium dam	Bandama	18 ^c	9.4 ^b
Katiali	0.24	2.5	Medium dam	Bandama	33 ^c	16.8 ^b
Sambakaha	0.15	4.2	Medium dam	Bandama	31 ^c	21.2 ^b
Gboyo	0.07	2.9	Small dam	Bandama	29 ^c	10.2 ^b
Korokara T	0.07	3.8	Small dam	Bandama	22 ^c	1.1 ^b
Nambingué	0.10	2.9	Small dam	Comoé	23 ^c	11 ^b
Tiaplé	0.07	3.3	Small dam	Comoé	20 ^c	6 ^b

After: ^a Lévêque 1997. ^b Gourdin 1999. ^c This study.

Table 3

TCs (all fishing gears combined) (during 27 months) of the eight main fish groups in the small-scale fisheries in seven reservoirs from northern Côte d'Ivoire.

Fish taxa	TC (seven reservoirs) (kg)
<i>Oreochromis niloticus</i>	11 207
<i>Sarotherodon galilaeus</i>	8983
<i>Clarias</i> sp. (<i>anguillaris</i>)	6530
<i>Chrysichtys</i> sp. (<i>nigromarginatus</i>)	7215
<i>Tilapia zillii</i>	4746
<i>Heterotis niloticus</i>	2463
Other tilapines	1236
<i>Marcusenius</i> sp. (<i>senegalensis</i>)	779

Table 4

Artisanal fisheries data from the seven studied reservoirs.

Reservoir	Area (ha)	Duration of study	Total yield (kg)	AY (kg ha ⁻¹ year ⁻¹)	Effort (fishing days)	DY (kg day ⁻¹ ha ⁻¹)
Gboyo	7	1	4442	635	213	3.0
		0.5	1926	550	103	2.7
Korokara T	7	1	384	55	81	0.7
		0.5	1925	550	196	1.4
Tiaplé	7	1	1069	153	93	1.6
		0.5	No data	No data	No data	No data
Nambingué	10	1	1825	183	238	0.8
		0.5	1480	296	219	0.7
Sambakaha	15	1	7572	505	195	2.6
		0.5	3555	474	94	2.5
Katiali	24	1	4082	170	472	0.4
		1	2434	101	250	0.4
Tiné	45	1	5811	129	538	0.2
		0.5	1726	77	243	0.2

Table 5

Correlation (r^2) and ANOVA results (probability of F) in linear models between different pairs of variables.

	AY (kg ha ⁻¹ year ⁻¹)		DY (kg day ⁻¹ ha ⁻¹)		TC (kg year ⁻¹)	
	$P > F$	r^2	$P > F$	r^2	$P > F$	r^2
SR	0.157	0.173	0.049	0.308	0.120	0.205
RA (ha)	0.079	0.254	0.036	0.340	0.358	0.077
WA (km ²)	0.577	0.029	0.429	0.058	0.014	0.433
WA/RA	0.023	0.389	0.002	0.586	0.205	0.141
D (m)	0.267	0.110	0.198	0.145	0.371	0.073
C (μ S)	0.237	0.124	0.131	0.194	0.006	0.508
FI	0.107	0.218	0.500	0.042	0.665	0.018
MEI	0.116	0.350	0.030	0.505	0.028	0.509

Significant values are marked in **bold**.

Table 6

Dominant fish species and trophic status in reservoirs grouped by yield level and SR level.

Reservoirs	Dominant species	Trophic status	Yield level	SR level
Gboyo and Sambakaha	<i>Chrysichthys nigrodigitatus</i>	Bottom feeder		
	<i>Chrysichthys maurus</i>	Bottom feeder		
	<i>Hepsetus odoe</i>	Pelagic feeder	High	High
	<i>Marcusenius senegalensis</i>	Bottom feeder		
	<i>Mormyrus hasselquisti</i>	Bottom feeder		
	<i>Synodontis schall</i>	Bottom feeder		
	<i>Synodontis bastiani</i>	Bottom feeder		
Tiaplé	<i>Barbus sublineatus</i>	Pelagic feeder	Intermediate	Intermediate
	<i>Auchenoglanis occidentalis</i>	Pelagic feeder		
Katiali	<i>Chromidotilapia guentheri</i>	Pelagic feeder	Low	High
	<i>Polypterus endlicheri</i>	Pelagic feeder		
Nambingué	<i>Labeo coubie</i>	Pelagic feeder	Low	Low
Korokara	<i>Hemichromis bimaculatus</i>	Pelagic feeder		
Tiné	<i>Lates niloticus</i>	Pelagic feeder	Low	Low

Figure 1

(a) Clustering of reservoirs according to their scores in the factorial space of the correspondence analysis on the matrix of species abundance per reservoir; (b) clustering of reservoirs according to yield.

