FISH COMMUNITIES AND FISHING IN A FLOODPLAIN LAKE OF CENTRAL AMAZONIA*

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RÉSUMÉ

PEUPLEMENTS DE POISSONS ET PECHE DANS UN LAC DE PLAINE INONDÉE EN AMAZONIE CENTRALE.

L'analyse synthétique des résultats d'une étude multidisciplinaire menée sur une île de la plaine inondée d'Amazonie centrale et sur son lac intérieur débouche sur un certain nombre d'observations. La production piscicole actuelle est largement inférieure au potentiel estimé. La différence peut néanmoins varier amplement d'une année à l'autre. La composition des captures est sensiblement différente de la composition du peuplement. Outre qu'il existe dans le peuplement de nombreuses espèces de petite taille dont l'exploitation n'est pas pratiquée, il y a nettement un désintérêt de la pêche pour certaines espèces exploitables abondantes. Le régime de crue affecte, de manière prononcée les comportements de pêche. Il affecte aussi les captures par effort qui, du fait de larges changements de la densité des poissons dans le volume d'eau, ne sont pas proportionnelles à l'abondance en poisson. Lorsque la hauteur d'eau moyenne sur une année augmente, la biomasse totale de poisson augmente aussi, mais les captures par effort diminuent. Il est conclu que la production piscicole est soumise à un certain nombre de contraintes physiques, biologiques, écologiques, culturelles et économiques qui limitent l'activité de pêche. La situation étant complexe, des études minutieuses sont encore nécessaires avant de pouvoir proposer un aménagement adapté.

SUMMARY

The synthesizes analysis of the results of a multidisciplinary study, carried out on an island and its inner lake in a central Amazonian foodplain, leads to a certain number of observations. Current fishery production is below its estimated potential. The difference, however, can vary greatly from one year to another. The composition of the captures differs significantly from the composition of the fish population. Aside from the many species not captured because of their small size, there is a clear disinterest for certain exploitable and abundant species. Flooding markedly affects fishing habits. It also affects catch per unit of effort which, because of large changes in fish density in the volume of water, are not proportional to the actual abundance of fish. When the average yearly water level is high, the total fish biomass is also high, but catches per unit of effort are low. It is to be concluded that fishery production is subjected to a certain number of physical, biological, ecological, cultural and economic constraints which limit fishing activity. Because of the complex situation, exacting studies are still necessary before appropriate management can be proposed.

INTRODUCTION

Floodplains of tropical rivers are generally considered very productive environnements. For their aquatic component and its terminal production, the above assumption is supported by the observed higher fish yields in rivers with extensive floodplain than in the ones with a more de limited bed (WELCOMME,1974 ; 1979). The Amazon River belongs clearly to the first category with an extensive floodplain representing about 2.9% of the whole basin (about 210 000 km²). In the Brasilian Amazon, fish yield is based primarily on floodplain productivity (PETRERE, 1982 ; BAYLEY,1981 & 1982). With the increase in fishing pressure on the stocks, some indications of over-fishing have been detected for individual species (MERONA & BITTENCOURT, *in press*). However, BAYLEY (1981, 1982) suggests that there is a broad overall under-exploitation of the fish ressource in the Brazilian Amazon occurs. This paper is an attempt to resolve this contradiction based on a particular case : the « Lago do Rei », a floodplain lake in

central Amazonia. This study was part of a multidisciplinary project developed on the lake and the island which surrounds it, between 1985 and 1987 (ORSTOM-INPA-CEE, 1988).

METHODS

THE STUDY AREA

Careiro Island is a large alluvional island, located in front of the meeting of the waters of « Rio Negro » and « Rio Solimoes » (FIG. 1). The island is approximately 200 km² and includes a large lake named « Lago do Rei », as well as number of secondary water-bodies. This aquatic system is connected to the Amazon River by a canal, about 20 km long. The water level in the lake follows the water level fluctuations in the river.

DATA COLLECTION AND TREATMENT

Fish communities

The detailed methodology is described by MERONA et al. (1988). Experimental fishing with a battery of 13 gill nets of different mesh size was conducted every 2 months between February 1986 and June 1987. At each collection date, we sampled the different habitats which could be recognized in a predetermined zone (shown on FIG. 1). The specific and total capture was expressed in catch per unit of effort (CPUE = catch in number or weight per 1,300 m² during 24 h.). Biomass indices were calculated by correcting the CPUE of the samples by the estimated volume of the lake at the time of collection (see GUILLAUMET et al., 1988, for the detail of volume estimation).

Fishing

The study is based on daily fish landing data collections in two points : the central market of Manaus city and a traditional settlement on the north coast of Careiro

Island (« Terra Nova »). The detailed methodologies can be found in PETRERE (1978) for Manaus market and MERONA and THERY (1988) for the island. These data collections provide information on specific landings, gear used, local of fishing and effort.

Production estimates

Estimates of production are based on the work of BAYLEY (1982). It is assumed in this study that the potential yield lies between 0.3 and 0.5 times the biological production according to the model of GULLAND (1970) generalized to an exploited « multispecific stock ». The total fish yields of « Lago do Rei » are calculated from MERONA & THERY (1988). The surface and the volume of the lake are estimated from a simple model developed elsewhere (GUILLAUMET et al.,1988).

ACTUAL CATCH VERSUS POTENTIAL YIELD

The values of total yield observed for the two years of study are markedly lower than the potential yield (TABLE I). However the difference is much less pronounced in the 1985/1986 season where the yield represents 16.5% of the lowest estimation of the potential.

The way biomass and production were calculated implies a direct proportion between the production estimates and the mean surface area of the lake during the hydrological year. Some kind of relation may indeed exist. On one hand, the lower the level in the low water period, the higher the natural and fishing mortalities. On the other hand, a high water level favors the recruitement of the young in the community and a rapid growth. However, it is probable that biomass and production are also related to previous years hydrological regimes which could affect the abundance of age classes of two or more years. This effect is probably very important for the potential yield because fishing pressure is much more directed towards the older fish.
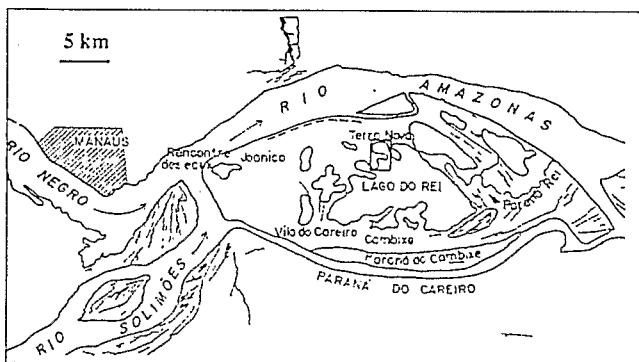

FIG. 1.- Map of the study area. Square shows the experimental fishing zone. *Description de la zone d'étude. L'encadré représente la zone de peche expérimentale.*

	1985/1986	1986/1987
Lake area (km²)	80.57	93.63
Biological Production (t/year)	22,560	26,216
Mean Biomass (t)	12,891	14,981
Potential Yield (t/year)	6,678-11,280	7,865-13,108
Actual Yield (t)	1,115	552

TABLE I.- Estimates of fish production, potential yield and actual yield for the « Lago do Rei ». *Estimations de la production biologique, du potentiel de peche et des débarquements actuels des poissons du « Lago do Rei ».*
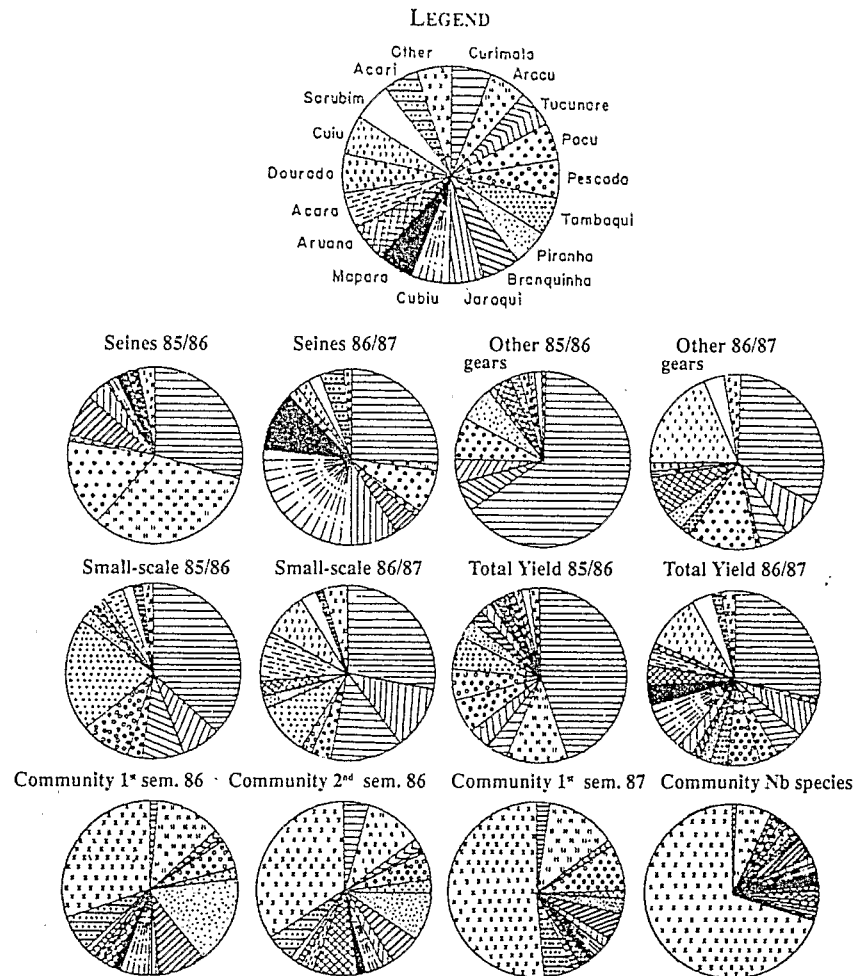
LEGEND

FIG. 2.— Catch composition and fish community composition for the 85/86 and 86/87 hydrological seasons in the « Lago do Rei ».

Composition des captures et composition de la communauté de poissons pour les saisons hydrologiques 85/86 et 86/87 dans le « Lago do Rei ».

Another consideration concerns how much of the biological production can be considered as potentially exploitable. BAYLEY (1982) estimates at 134 000 t the part of the production of fish greater than 25 cm in length which are basically those recruited by the fishery. This value represents 36.7 % of the total biological production and is comparable with the predictions given by the model of GULLAND (1970).

CATCH COMPOSITION VERSUS COMMUNITY COMPOSITION

Three types of fishing activities contribute to the total yield.

• A seine fishery in the canal between the lake and the river captures the migrating fishes.

• A « multi-gear » fishery using gill nets, fishing-rod, trident and harpoon, is developed in the lake itself.

• A small-scale local fishery with very low investment, takes place in the lake in areas near the settlements. In total captures, 17 fish products are significantly represented (FIG. 2). One of them, the « curimata » (*Prochilodus nigricans*) was clearly dominant during the two seasons studied. Some products appear sporadically like the « aracu » (Anostomidae *spp.*), the « cubiu » (*Anodus spp.* and *Eigenmannina spp.*) and the « mapara » (*Hypophtalmus spp.*). The seine fishery is responsible for these captures. In the lake itself, catch composition is somewhat constant from one year to the next although in 1986/87 a significant decrease of the contribution of « curimata » and a parallel increase in the relative importance of « cuiu » (*Pseudodoras niger*) are observed. The catch composition of the small-scale local fishery shows a great proportion of some very high priced species like the « tambaqui » (*Colossoma macropomum*), and the « tucunaré » (*Cichla monoculus*).

In the fish community, these 17 fishing products represented together always less than 75 % of the mean biomass estimated over 3 six-month periods. The exploited products correspond to approximately 41 species, which represents only 30 % of the total number of species captured in the lake. The difference between the relative importance of the fishing products in biomass and in number of

species suggests that a great number of non-exploited species are small-sized and could not be caught with the gears currently in use. Considering only the exploited products, it can be seen that some species are heavily exploited in spite of low representation in the community. It is especially true with the « curimata » whose distribution in the lake is limited to the marginal areas covered with floating meadows (MERONA *et al.*, 1988). On the contrary, the « aracu » and the « piranha » (*Serrasalmus spp.*) are poorly exploited despite their great abundance in the fish community.

FISHING BEHAVIOR AND HYDROLOGICAL REGIME

Global fishing intensity as well as the use of specific gear (both expressed by the number of trips to the lake) are very variable on a monthly basis (FIG. 3). The use of seine is irregular and seems to be opportunistic, taking advantage of local and time-limited fish concentrations. The frequency of the trips into the lake, using gillnet, fishing-rod, trident, harpoon or a mixture of these gears is cyclic and regular, showing a maximum during the low water period and a minimum during the high water period. There are two possible explanations for the low degree of acti-
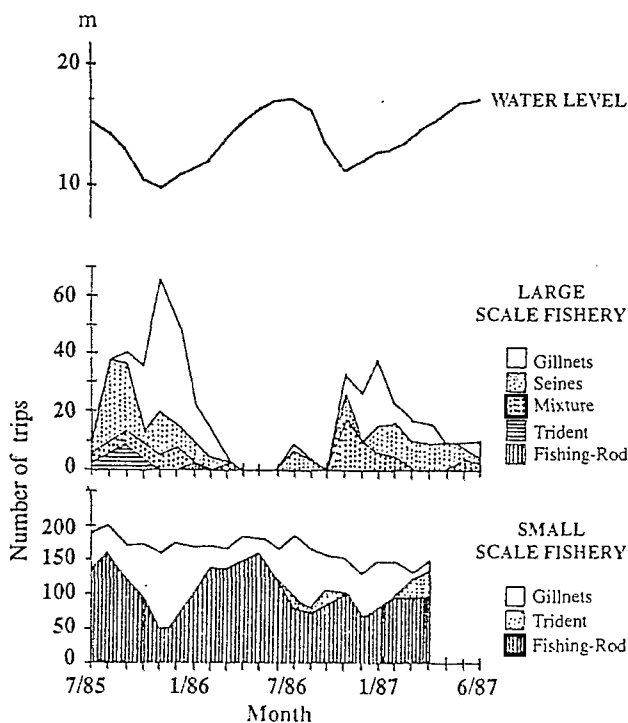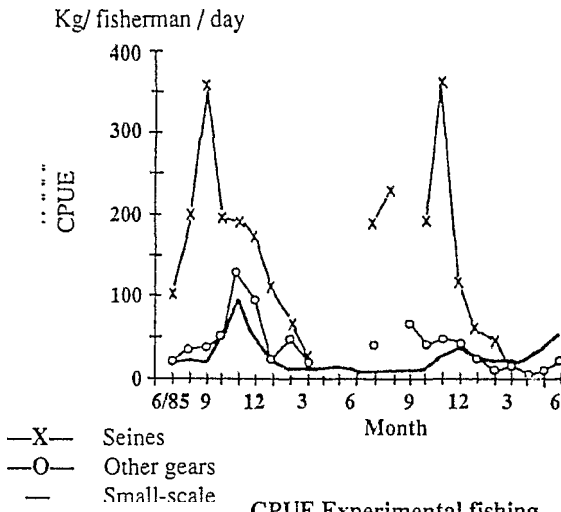

FIG. 3.- Changes in the water level of the Amazon River and in the number of trips in the fisheries of « Lago do Rei » for the 85/86 and 86/87 hydrological seasons. *Evolution de la hauteur d'eau dans l'Amazone et du nombre de voyages de pêche pour les pecheries du « Lago do Rei » pendant les saisons hydrologiques 85/86 et 86/87.*

vity in the high water season. On one hand, when the water rises in the river, it enters in the lake by the canal, carrying with it a great amount of trunks and other floating plant material which can eventually obstruct the channel and prevent the entry of the fishing boats. On an other hand, the increase in lake volume and the inundation of large marginal areas allows many commercial species to take refuge in the flooded forest or in the floating vegetation where fishing on a large scale is not possible. Because of its ability to reach to access the marginal areas, the small-scale local fishery is a much more constant activity.

TIME VARIATIONS OF CATCH BY EFFORT AND BIOMASS

The catch per unit of effort (CPUE) of the 3-different fisheries present large seasonal variations (FIG. 4). The CPUE of the seine fishery, which can attain high values of 350 kg by fisherman and by day, shows two maxima in the hydrological year, one during the falling of the waters and the other in the beginning of the flood. These changes correspond to the two types of lateral fish migration in the system described by COX FERNANDES & MERONA (*in press*). The variations of CPUE in the two other types of fisheries are almost parallel. The values are much lower than those of the seine fishery and there is a maximum during the low water period. For all fisheries, the mean value of CPUE is lower in 1986/1987 than in 1985/1986. The CPUE of the experimental fishing shows a very sharp increase in the period of low water, but is nearly the same in the two periods of rising water.

The variations of biomass appear very different compared to those of CPUE. A very rapid increase during the inundation was observed in the two years of this study. However, a parallel decrease did not occur during the falling waters in 1986 resulting in much higher biomass values in 1987.

These observations suggest that CPUE cannot be used as abundance indices in that particular case. They are, in fact, proportional to the density of fish in the environment which is in turn dependent on the volume of water present in the studied area. Because of the large interannual variations in the hydrological regime, this volume cannot be considered constant on a yearly basis.
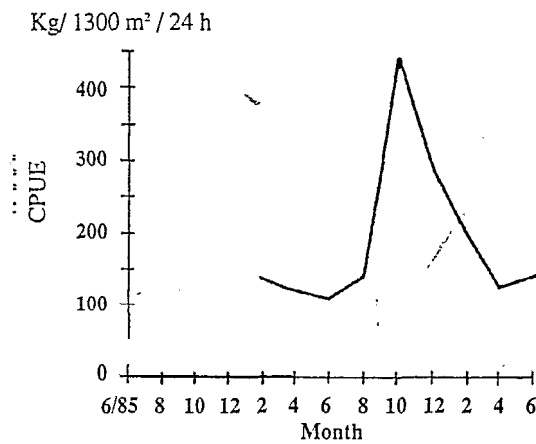
GENERAL CONCLUSIONS

The low value of the total yield from the « Lago do Rei » compared with the estimated potential yield, would suggest that the fisheries under-exploit this fishing ground. However, the great difference observed between the 2 years of this study demand caution in drawing this conclu-
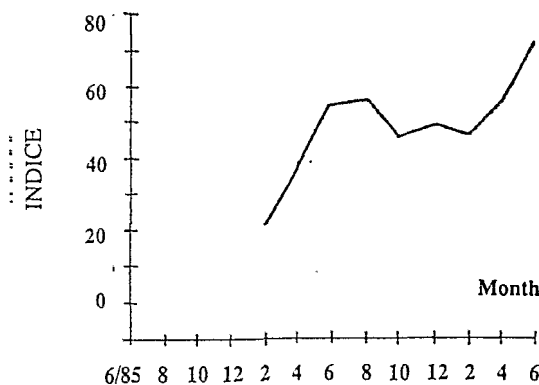
sion. A very dry year may provoke low production toge-ther with high natural mortality. The fishing itself, as has been shown, takes advantage of the low waters and fishing mortality may, in this hypothetical case, be catastrophic, even with unchanged fishing intensity.

Regardless of the degree of under-exploitation, it is obvious that the fishery has a very limited number of tar-get species although almost all the medium and large size species could eventually be caught. This observation can be explained by the existence of a great variety of constraints limiting the fishing activity. They are related to number of factors.

1) Hydrological characteristics : the vegetation carried by the ri-sing waters can prevent access to the fishing ground. In addi-tion, the great increase in the volume of the water during the high water season results in a reduction of gear efficiency. The use of certain categories of gear is also limited by the characteristics of the water-body.

2) Fish morphology : some very elongated fishes like the « aracu » or the « mapara » escape from the gillnets used by the fishery. Smaller mesh size cannot be used because they will capture small size fish which cannot be sold.

3) Fish behavior : some species (particularly piranhas) enter in direct competition with the fisherman, attacking the fish cap-tured in the gill net and causing heavy losses.

4) Fish ecology : a number of species take refuge in the marginal and inaccessible areas of the flood-plain. Lateral migration does not seem to be a regular phenomenon for some popula-tions.

5) Cultural and economical factors : in the region, there are many superstitions about fish. A number of species are not accep-table to the consumer or bring a low price in the market.

This situation lead the fisherman to concentrate his effort on a few species whose stocks could be threatened in the short or medium term. This appears to be the case of the « pescadas » (*Plagioscion spp.*) which were intensively fished in the period 1976-1979 (ANNIBAL, 1982) and are now quite scarce.

In these conditions management of the fishery is impossible on the base of too general data. The annual variation in production must be monitored over a long time period in order to determine a maximum value for the potential yield. There is also an urgent need for detailed' studies on the exploitable species in order to determine their contribution to community production and their relationships with other species.

CPUE Artesanal fishing

Kg/ fisherman / day

—X— Seines
—O— Other gears
—   Small-scale

CPUE Experimental fishing

Kg/ 1300 m² / 24 h

Biomass Indices

FIG. 4. — Changes in the catch per unit of effort in the fisheries and in the experimental fishing in the « Lago do Rei » for the 1985/86 and 1986/87 hydrological seasons.

Evolution des captures par effort de pêcheries artisanales et de la pêche expérimentale dans le « Lago do Rei » pendant les saisons hydrologiques 1985/86 et 1986/87

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