

THE PILCOMAYO FISHERY SYSTEM: A SOCIO-ECONOMIC PERSPECTIVE IN A CHANGING RIVER

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Introduction

The Pilcomayo River basin extends from the Andean highlands to the Chaco plains shared between Bolivia, Argentina and Paraguay (Figure 1). One of its main features is the transport of large amounts of suspended sediments (around 100 million tons per year), which particularly produce noticeable geomorphologic and hydrological changes in its middle sector. The Pilcomayo River is also well known for its fishery, one of the most important artisanal fisheries from South America. It is characterized by multiple users distributed across the middle and upper basin, with different cultural and socioeconomic profiles. The sabalo (*Prochilodus lineatus*) is the main target species providing important economic revenues and food resources for a large percentage of the population. Its importance for Villamontes city is paramount, as this area supplies nearly 70 % of the fish sold in Bolivian markets.

The aim of this study is to describe the fishery system in the Middle and Upper Pilcomayo basin, considering its social and economic characteristics together with an analysis of factors regulating fish yield. We present the Pilcomayo fishery as a paradigmatic case of a seasonal productive small scale system that represents a critical resource for several riverine communities.

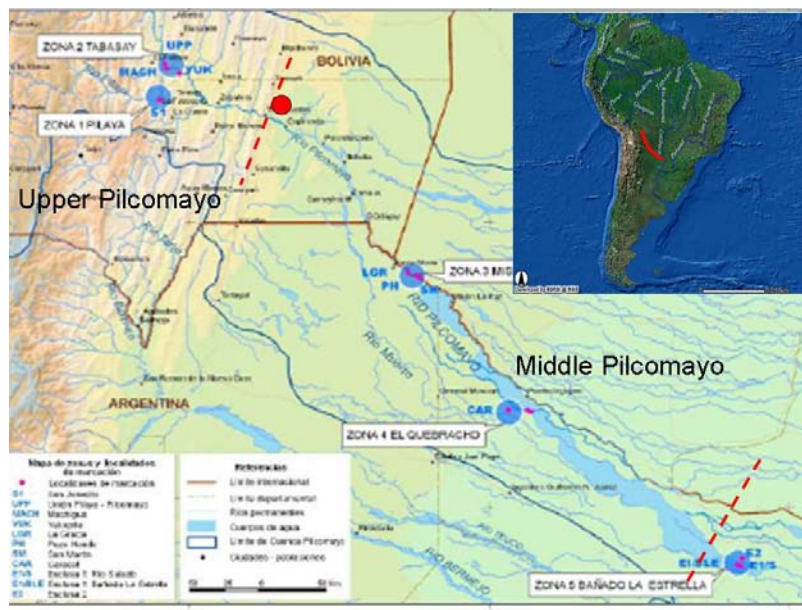


Figure 1: The Pilcomayo basin location. Dashed red lines represent the limits between upper, middle and lower basin. Red dot indicates the location of Villamontes city.

Fishery cycle, capture trends and gear selectivity

The fishery is highly seasonal since it starts in the middle of the southern hemisphere fall (usually May), and lasts till middle winter depending on the hydrological conditions. Sabalo is the main target species (95%), which by this time of the year is distributed across the whole basin. The traps and seines used can also retain valuable species such as *Pseudoplatystoma corruscans* (surubi) and *Salminus brasiliensis* (dorado) as bycatch. The sabalo starts migrating upstream as water level decreases, thus providing the catch for all the fisheries distributed along the medium and upper basin (Bayley 1973; Sverlij et al 1993; Smolders et al 2000 a,b).

The sabalo is an iteroparous species thus makes several migratory movements through its life span. Whereas the upper basin has been recognized as a spawning area, the middle basin, which encompasses a large wetland complex, is considered a critical nursery habitat. The fishery is strongly related to hydrological period. The river exhibits strong flash floods during the summer with flow decreases during fall and winter, allowing the development of an intensive fishing season. Historical catch records show a decreasing trend which could be indicative of sustainability problems (e.g. Bayley 1970; Payne 1986, 1987; Payne 1993; Guerrero Hiza 1993; Huntington 1998) (Figure 2).

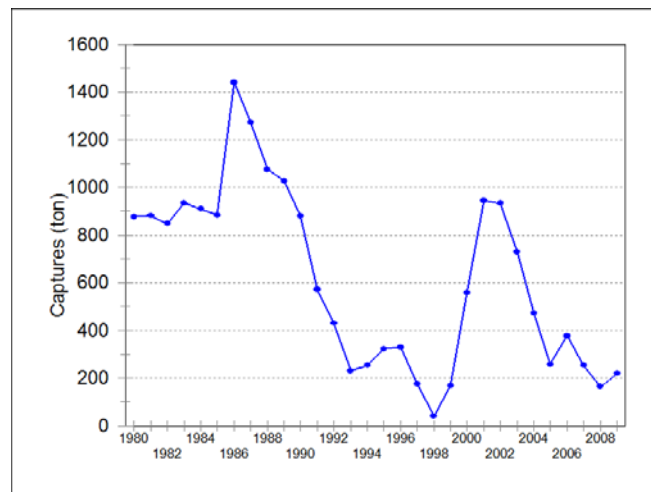


Figure 2: Historical captures of sabalo from the middle and upper Pilcomayo

Capture efficiency and selectivity vary strongly among different gears. Scoop, cast nets and clap nests are used by individual fishermen, whereas seines are group operated. Both seines and traps exhibit higher catch per unit effort than other gears and support 60% and 30% of fish catch respectively, despite cast nets and clap nests are the most used gears in the upper and middle basin respectively. Catch composition also differs in length structure, since gears used in the middle of the channel tend to capture larger fish (Figure 3). These issues need to be considered when defining regulations and management guidelines.

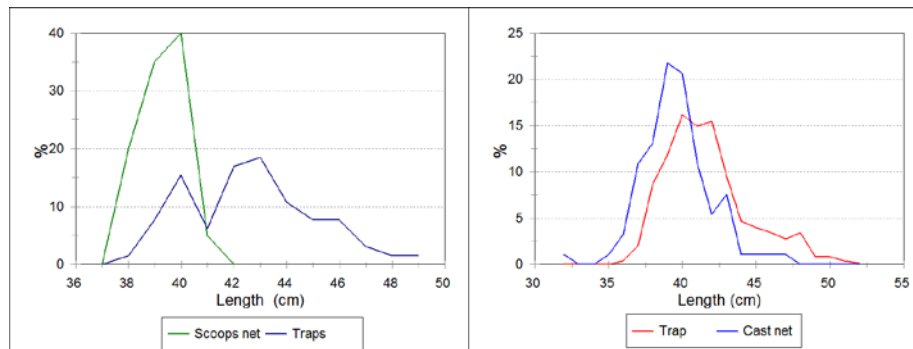


Figure 3. Length structure comparisons between traps and other gears used by individual fishermen

Fishermen profile, gear types and commercial activity

The Pilcomayo fishery is highly diverse comprising people of different ethnical origin which use a variety of gears, adapted to cope with variable hydro-geomorphologic conditions along the river course. Selected fishing grounds are granted to different social groups (concessions), which in turn use different gears to obtain their catch. In the upper basin fish traps are used by “mestizo” fishermen who take care of the full production chain, from catching to transporting and retailing (Figure 4). Traps are usually installed in a narrow confined zone, where high water velocity limit fish movements. The “Angosto” canyon is the most famous area supporting the largest fishing effort. People who work in trap concessions arrive from different geographical areas as soon as the fishery is opened in early May.



Figure 4: View of a trap catching fish in a narrow river reach

Native people (Weenhayek, Guarani and Wichi ethnical groups) who live in small communities and small towns in the middle basin use large seines towed by boats and as cast nets, clap nets and scoop nets. They also have fishing rights on several river reaches

so no overlap exists between concession systems. Table 1 summarizes the fishing characteristics within the Pilcomayo basin.

Table 1: Main fishery grounds, gears and fishermen characteristics in the upper and middle Pilcomayo basin.

COUNTRY	BASIN ZONE	GEAR	FISHERMAN PROFILE
Bolivia	Mountain (Upper Pilcomayo and tributaries)	Cast nets	Native
	“Angosto” zone	Traps	Mestizo
	Piedmont area	Cast nets	Mestizo, native
		Seines Scoop nets	Native Mestizo, native
Chaco plain	Clap nets	Native	
Argentina	Chaco plain	Clap nets	Native
	La Estrella wetland	Spear	Native
Paraguay	Chaco plain	Clap nets	Native

A main difference between mestizo and native concessions is that the first have a commercial goal, thus hiring native and not native people, whereas the second put more emphasis on social and cultural goals based on a family structure. Currently there are between 40 to 50 concessions reflecting an overall increasing trend (Figure 5).

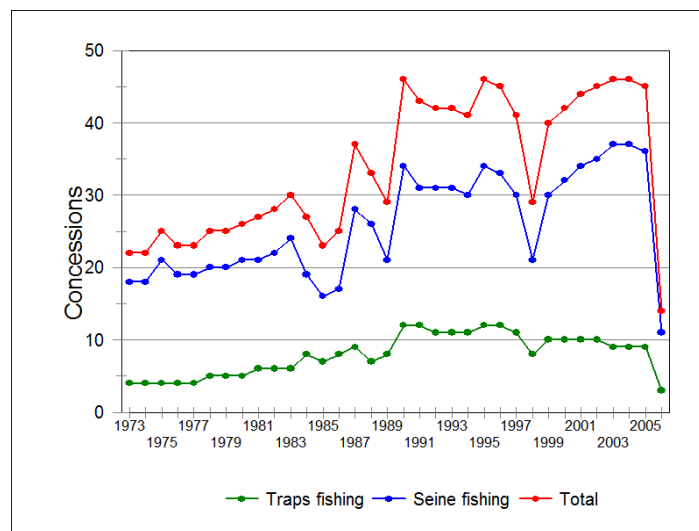


Figure 5: Temporal variation of fishery concessions in the middle and upper Pilcomayo River (during year 2006 the fishery was almost inactive due to flash floods).

Catch is managed in several ways. Big and medium trucks park for one to two weeks near the concessions, buying and conserving the fish in ice. This is the main circuit by which fish are transported to and distributed in the big city markets. However several fishermen who fish on their own, using cast nets and scoop nets, sell the fish to local markets and restaurants contributing to sustain an important small scale economic

circuit (Figure 6). Fish price varies according to size, fishing period, market demands and natural abundance.



Figure 6: Villamontes market during fishing season

Factors governing fishery yield

The exploited sabalo stock is mainly composed by 2-3 years old fish which recruit to the fishery as they migrate for the first time. Age and length structure vary yearly, as mean length and growth performance appear be related to flow (Figures 7-8)

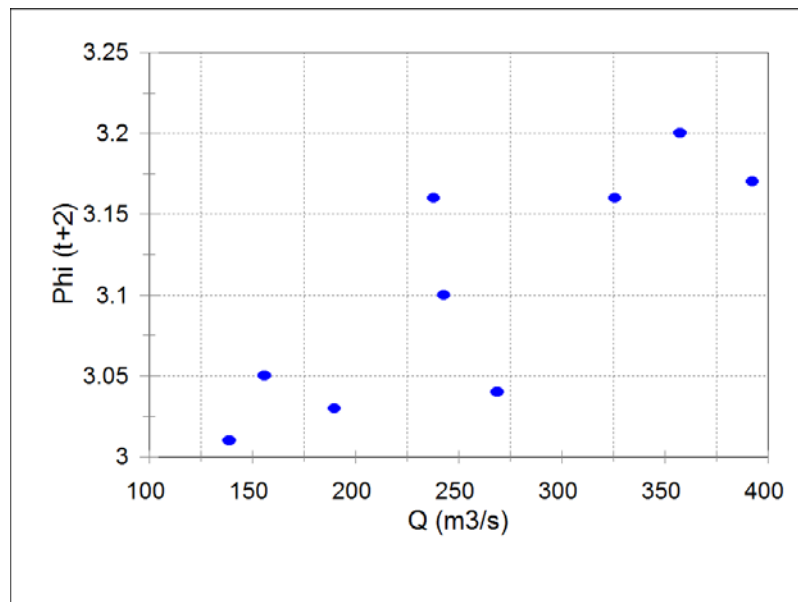


Figure 7: Relationship between mean annual flow and sabalo performance growth (phi index)

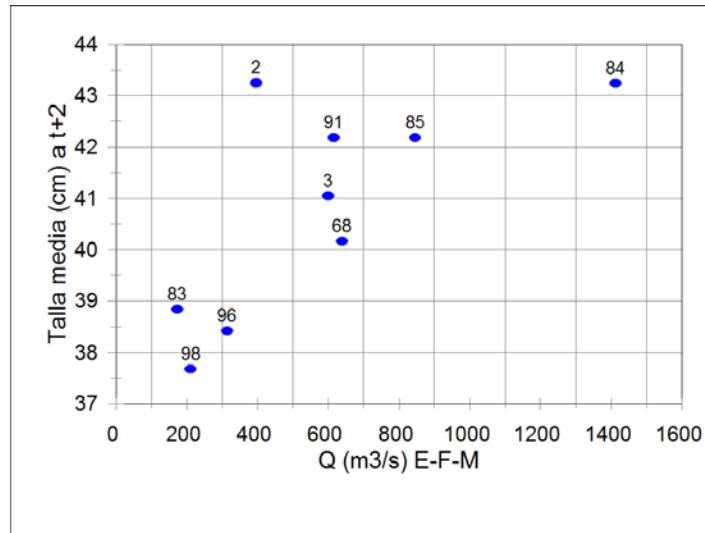


Figure 8: Relationship between flow during January-February and March and mean length of sabalo captures

On the other hand, a strong relationship was noted between catch and mean flow for the previous five years, implying that flow plays a critical role in regulating fish yield and therefore can be used for forecasting (Figure 9).

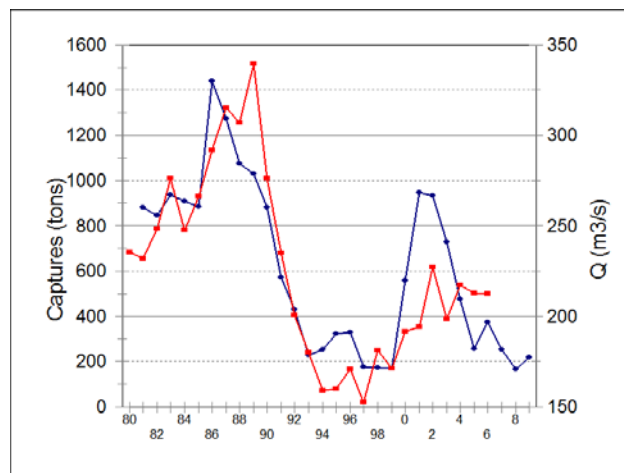


Figure 9: Temporal variation of catch (red line) and average flow (blue lines) for previous five years

Such relationship is even exacerbated during extraordinary climatic events produced by ENSO. During El Niño years rain generally decreases in the upper basin whereas the opposite trend is noticed for La Niña years (Figure 10). These macroclimatic events have a noticeable impact on hydrological cycles and thus are main factors affecting fishery behavior.

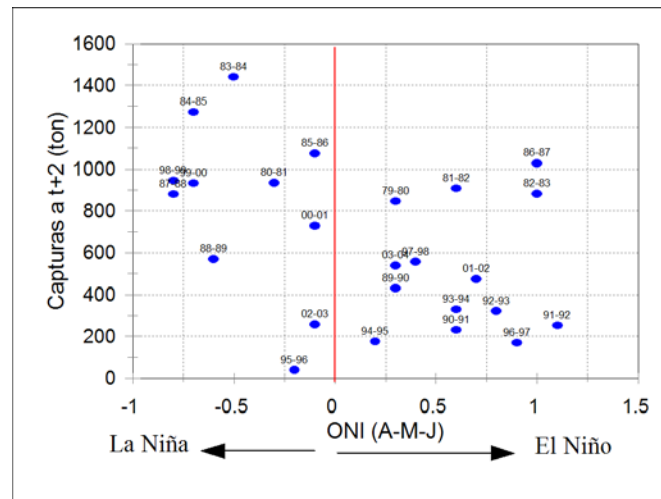


Figure 10: Relationship between El Niño and La Niña intensities (based on Oceanic Niño Index) and sabalo captures in the Pilcomayo basin.

Conclusions

The sabalo fishery of the Pilcomayo River supports the livelihood of high number of people living along the middle and upper basin. Despite it is based on a single species, the fishery is complex since it is shared by different countries, involving different fishermen profiles, diverse gears and lack of appropriate management guidelines. Fish yield has decreased in the last decades favored by adverse hydrological conditions and increase of fishing effort. Since fishery success depends of sabalo migratory movements which are strongly related to hydrological pulses and availability of nursery habitats in the middle basin, an integrated socio-economic and environmental management framework should be applied to maintain the fishery at sustainable levels and preserve fishermen communities.

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