ALLOCATION POLICIES AND ITS IMPLICATIONS FOR RECREATIONAL FISHERIES MANAGEMENT IN INLAND WATERS OF ARGENTINA

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Abstract

The Northeast, Central, Western and Northwestern, and Patagonia and Tierra del Fuego regions dominate Argentina inland recreational fishing. Being each unique in terms of environmental context, fish fauna and fishery types. High species diversity, extractive fishing and highly priced fly-fishing catch and release fisheries characterizes the Northeast. The Central Western and Northwestern fisheries are extractive, targeting few species. Patagonia and Tierra del Fuego have extractive and catch and release salmonid fisheries on the Andes. There are extractive fisheries of native species on Atlantic drainages of northern Patagonia, and anadromous rainbow and brown trout fisheries on southern Patagonia and Tierra del Fuego.

In the Northeast, Central, Western and Northwestern regions conflicts between fisheries sectors (e.g. recreational vs. commercial) exist. In Patagonia and Tierra del Fuego conflicts within the recreational sector associated to fishery types and fisher philosophies (e.g. extractive vs. catch and release, highly price lodges vs. free access) predominate. Allocation, where implemented is set by specific interest groups not as part of an official strategy. This is part of a broader problem namely: lack of awareness of the fragility of the resource, which in term results in lack of integrated approaches towards the sustainability of Argentina's inland recreational fisheries.

Inland Recreational Fisheries of Argentina. An Overview

Recreational fishing in Argentina is an expanding activity suspected of a high economic turnover at the local, regional and national levels (Urzua Vergara, 1992, Vigliano & Alonso, 2000, Cleminson, 2000). The Northeast, Central, Western and Northwestern and Patagonia and Tierra del Fuego regions (Figure 1) dominate the scene of Argentina's inland recreational fishing. Each region has unique characteristics in terms of environmental and socio-economic context, fish fauna fishery types and conflicts, defining a complex scenario, where base line studies and management programs are still insufficiently developed to provide guidance to interested parties. In general terms in all three regions based on target species sought for, their characteristics, the type of fishing gear and fishers socio-economic level, five types of inland recreational fisheries can be recognized (Table 1).

World-class fisheries: characterized by fishers of very high socio-economic level, highly specialized in terms of gear used and services required, making use of exclusive fishing lodges and outfitters mainly from outside Argentina and

some nationals. Their fishing experience targets mainly top predators of trophy size and pristine environments with little human presence, being usually catch and release advocates. In some cases, the lack of trophy size fish may be replaced by a high daily capture of very hard to catch fish such as dorado (*Salminus brasiliensis*) in the Iberá wetlands (Northeast).

Recreational 1: characterized by high socio-economic level fishers mainly nationals that use lower priced lodges and outfitters than the previous group, they also favour top predators and big size fish, being less specialized in terms of gear and uniqueness of the fishing experience, mostly advocates of catch and release.

Recreational 2: upper middle-to-middle class socio-economic level national and international fishers from foreign countries. Generalist with regards to gear and services required targeting a wider range of species, which include predators, planktivorous, and omnivorous fishes, and seeking not only sizes but also numbers of fish, conformed by both catch and release and extractive advocates.

Recreational 3: lower middle_class-to-middle_class local and regional extractive fishers that do not hire specialized services. The fishing experience is not necessarily centred on catching fish and may be more related to the possibilities of outdoor activities with family or friends. In terms of fish they seek numbers, targeting carnivorous, planktivorous, and omnivorous fishes.

Recreational 4. This fourth category has to be considered carefully because it is actually an extractive fishery, characteristic of highly populated areas where poor people target mainly detritivorous as well as omnivorous species, seeking numbers for consumption even though fish species caught are usually banned for consumption due to environmental problems such as contaminants in fish flesh. Even though this type of fishery could be considered subsistence we have chosen to include it as recreational because it has no commercial value and people engaged in it have a mixed recreational subsistence view of it.

Preservation, recovery and improvement of natural resources are guarantee through the Argentine Constitution, the National Environmental Policy Law # 25.675, the National Parks Law # 22.351, the Wild Fauna Conservation Law # 22.421, Provincial constitutions, Provincial laws and regulations. Basically these body of norms state that natural resources must be managed as to preserve, recover or improve the quality of both natural and cultural resources promoting their rational and sustainable use. The provinces mostly regulate recreational fishing in Argentina, national law having precedence over provincial ones . Where interprovincial or international jurisdictions apply joint commissions are established to deal with conflicts and resource management.

Figure 1. Inland Recreational Fishing Regions of Argentina. 1. Northeastern region, 2. Central, Western and Northwestern regions. 3. Patagonia and Tierra del Fuego regions.

Table 1. General characteristics for Argentinean inland recreational fisheries

FISHERY TYPE	RESOURCE CHARACTERISTIC SOUGHT FOR	TYPE OF TARGET SPECIES	MAIN TARGET FISH SPECIES OR SPORT FISHERIES	FISHERS SOCIO ECONOMIC LEVEL	COMPETITION WITH COMMERCIAL AND SUBSISTENCE FISHERIES	ARGENTINEAN REGION	REGIONAL HUMAN DENSITY
WORLD CLASS FISHING LODGES	TROPHY SIZE HIGH NUMBERS OF FISH PER DAY	TOP PREDATORS, CARNIVOROUS	SALMONIDS *Salminus*	VERY HIGH, INTERNATIONAL CLIENTELE AND SOME NATIONALS OF HIGH SOCIO ECONOMIC LEVEL	NULE	TIERRA DEL FUEGO SOUTHERN PATAGONIA IBERA SWAMPS (NE)	VERY LOW
RECREATIONAL 1. FISHING LODGES	LARGE SIZE FISH	TOP PREDATORS, CARNIVOROUS, LARGE OMNIVOROUS	SALMONIDS *Salminus* *Pseudoplatystoma* *Piractus* *Brycon*	HIGH, NATIONAL CLIENTELE OF HIGH SOCIOECONOMIC LEVEL	VERY LOW	NORTHERN PATAGONIA PARANA-PARAGUAY CONFLUENCE UPPER BERMEJO AND UPPER PARANA RIVERS BELOW YACYRETA DAM	LOW
RECREATIONAL 2	SIZE AND NUMBERS OF FISH CAUGHT	PREDATORS, PLANKTIVOROUS AND OMNIVOROUS	SALMONIDS *Odontesthes hatcheri* *Odontesthes bonariensis* *Salminus* *Pseudoplatystoma* *Piractus*	UPPER MIDDLE CLASS AND MIDDLE CLASS	LOW-MIDDLE	NORTHERN PATAGONIA PAMPA PLAIN UPPER MIDDLE PARANA RIVER	MIDDLE
RECREATIONAL 3	NUMBER OF FISH CAUGHT	CARNIVOROUS, PLANKTIVOROUS AND OMNIVOROUS	*SALMINUS* *Pseudoplatystoma* *Odontesthes bonariensis*	MIDDLE CLASS-LOWER MIDDLE CLASS	MIDDLE-HIGH	LOWER MIDDLE PARANA RIVER PARANA DELTA PAMPA PLAIN WESTERN AND NOTHWESTERN RESERVOIRS YACYRETA DAM (NE)	MIDDLE - HIGH
RECREATIONAL 4 (BANNED BECAUSE OF ENVIRONMENTAL REASONS)	NUMBER OF FISH CAUGHT	OMNIVOROUS BUT MAINLY DETRITIVOROUS	*Cyprinus carpio* SMALL RIVERINE FISH	LOW-MIDDLE CLASS AND POOR PEOPLE	HIGH	RIO DE LA PLATA RIVER	HIGH

Northeastern fisheries

Recreational fisheries of North-eastern Argentina have several distinctive features from the others of the country. The most remarkable is the large number of targeted species as a result of the high diversity of native Neotropical fish fauna. The most common fishery types are recreational 2 and 3. World class fisheries and recreational 1 have been growing during the last 10 years, with highly priced recreational fishing and international quality fishing lodges. Those fisheries rely mainly on dorado (*Salminus brasiliensis*), a highly valued species for fly cast due to its aesthetic, fighting and size attributes.

A second particular feature in the large rivers of the region is the existence of an important commercial fishing pressure, which generates frequent conflicts among fishers. Third, the region shares international waters in both, Paraná and Paraguay rivers (Argentina-Paraguay border), which is an additional source of conflicts. In Paraguay the main fisheries is commercial, but with an emerging number of World Class and Recreational 1 fisheries. Fourth, most of the fishing activities are carried out in the large rivers or in some of their affluents, with almost no recreational fishing in the abundant shallow lakes of the region.

Finally, fishing tournaments are very popular and numerous, at the point that every important fishing town of the large rivers has at least one annual competition.

As well as for most fisheries in Argentina, there are very few scientific or technical studies on Northeastern fisheries, and those available are mostly for commercial fishing. Even crude statistical data are also rare and hard to find. Most works were published in reports of limited diffusion or in regional scientific journals. Therefore, very little is known about the fisheries biology of the targeted species, the impact of the fishing and the evolution of exploitation rates.

North-eastern Argentina (Figure 1) comprises six different provinces (Misiones, Corrientes, Chaco, Formosa, Santa Fe and Entre Ríos), and is also named fluvial littoral region. It extends over 0,5 million km^2, having a subtropical climate in the north that gradually changes to a warm temperate in the south. Population density is middle in the north to middle-high in the south (average of 16 inhabitants km^{-2}). The northern provinces of the region are among the poorest and less developed of Argentina, while the southern ones present much better human development. From the point of view of landscape, the region is placed in a transitional zone, moving from the Paraná subtropical rainforest in the north-eastern hills of Misiones Province and from Chaco dry forest in the plains of the north, to the Pampas plains in the south and south east. Many ecotonal landscapes develop between those major biomes.

The entire region belongs to Del Plata Basin, which is the second largest watershed of South America after the Amazon. This basin comprises two of the most developed regions of the subcontinent, placed at the headwaters (Sao Paulo, Brazil) and the Río de La Plata and Paraná River delta mouth (Buenos Aires, Argentina).The major watershed within the basin corresponds to the Paraná River (Figure 2), which has important affluents such as the Iguazú and Paraguay rivers. Other minor tributaries are also important for recreational fisheries such as the Yabebiry (Misiones Province), Corriente and Santa Lucia Rivers (Corrientes Province), Salado and Colastiné (Santa Fé Province). The

Paraná and Iguazú rivers have been heavily dammed and they are highly regulated by headwater dams in Brazil. This fact may be one of the reasons for a decline in population size of some valuable species, particularly omnivorus/frugivorous (*Piaractus* and *Brycon*) (Quirós, 1990).

Due to its size and complexity, the Paraná River can be divided in several reaches with their particular ecological features and recreational fisheries types. From the mouth of the Iguazú River up to Posadas City (Misiones Province), the river runs along a narrow and deep canyon almost without floodplain areas. From Posadas to Ituzaingó, the large reservoir created by Yacyretá Dam (1,140 km^2) dominates the scene, forcing fishermen to completely different fisheries styles since 1994. From this dam to the confluence with the Paraguay River the river has an anastomosed channel with important development of floodplain sectors and islands, as well as areas of rapids with bedrock outcrops. All these reaches belong to the so-called Upper Paraná River. Below the Paraguay River embouchure begins the Middle Paraná River, it has a large mean discharge (17.000 m^3 at Corrientes City) and a huge fringing floodplain attaining 100 km wide in some sectors. The most developed region of the country is the lower portion of the Middle Paraná, the Delta and the Rio de la Plata, but it is also the most heavily polluted, with organic contaminants widely incorporated by fish (Colombo *et al.*, 2000), a fact that precludes fishing for massive consumption. Paradoxically, waters from the Paraná River are mostly oligotrophic or mesotrophic. However, in the last years, large blooms of cianobacteria (mainly *Microcystis aeruginosa*) have been observed in the upper and middle sectors, probably related to upper dams and the growing load of wastewaters effluents.

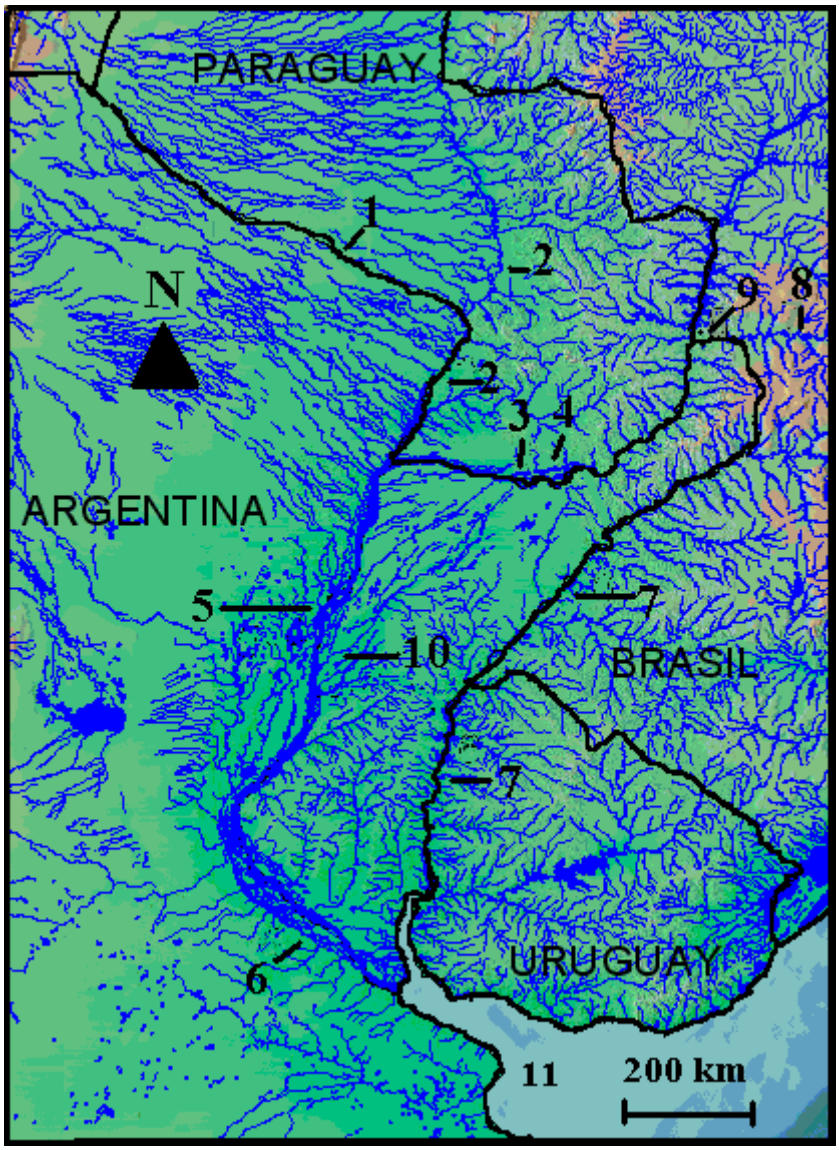
The other major river of the region is the Uruguay, which is also dammed, but bears a far less important development of recreational and commercial fisheries.

The Paraguay River basin is mostly undammed and unregulated, draining the Gran Pantanal waters in Brazil. This meandering river has a large alluvial plain, and collects waters of two important affluent from Andean mountains: the Bermejo and Pilcomayo rivers.

The Paraná River geological activity during the Pliocene and Pleistocene at Corrientes Province has brought a large alluvial fan which abandoned beds and levees constitute the large Iberá marshland complex and related wetlands (Popolizio, 2003). Some of these wetlands are pristine, and protected as provincial reserves or national parks. They are fed mostly by local rains with ultraoligotrophic or distrophic waters, with sandy bottoms widely covered by large floating peat soils. The most important wetland is Iberá, which comprises an area protected by a Provincial Reserve of 12.000 km^2, part of it belonging also to a Ramsar site.

Alluvial fans are also important in Bermejo and Pilcomayo Rivers, which have a large load of suspended solids (mostly colloidal clay). The old channels of these rivers in the Chaco encompass today important areas for fish reproductive migrations and spawning, and are exploited by type 3 Recreational fishers. All the fish of the area are also important to subsistence fisheries of aboriginal populations.

Figure 2. Hydrology of the Northeastern region: 1. Pilcomayo river, 2. Paraguay river, 3. Upper Paraná river, 4. Yacyreta dam, 5. Middle Paraná river, 6. Lower Paraná river and delta, 7. Uruguay river, 8. Iguazú river, 9. Iguazú falls, 10. Corrientes river, 11. Río de la Plata river.



Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America

This region possess by far the highest fish diversity of Argentina, which consist in about 350 fish species, being exotic only four of them (López *et al.*, 2005). Just in 12.000 km^2 of Iberá marshlands, more that 111 species have been described (Casciotta *et al.*, 2006). Most species belongs to the group of tetras and related species (Characiforms), as well as catfishes (Siluriforms of several southamerican families). About 20 species are the most important in recreational fisheries (Table 2), while other 10 are used as living baits.

Table 2. List of the most important recreational target species in North-eastern Argentina, with some relevant data on sizes and some regulations.

Order	**Scientific Name**	**Spanish Common Name**	**Habits**	**Minimum allowed length[1] (total length, cm)**
Characiforms	*Salminus brasiliensis*	dorado	potamodromous, top predator	75
	Piaractus mesopotamicus	pacú	potamodromous, omnivorous/ frugivorous	45
	Brycon orbignyanus	pirá pitá, salmón del Paraná	potamodromous, omnivorous/frugivorous	45
	Hoplias malabaricus	Tararira	non migrant, lake dweller, top predator	--
	Leporinus obtusidens	boga	potamodromous, omnivorous	45
Siluriforms	*Pseudoplatystoma corruscans*	surubí a lunares	potamodromous, top predator	85
	Pseudoplatystoma fasciatum	surubí atigrado	potamodromous, top predator	80
	Paulicea luetkeni	manguruyú	potamodromous, top predator	100
	Zungaro zungaro	manguruyú abá	potamodromous, top predator	40
	Luciopimelodus pati	patí	potamodromous, top predator	70
	Hemisorubim platyrhynchos	manduré tres puntos	potamodromous, top predator	35
	Sorubim lima	cucharón	potamodromous, top predator	40
	Pimelodus albicans	moncholo	potamodromous, top predator	30
	Oxydoras kneri	armado chancho	non migrant, benthic feeder	45
	Pterodoroas granulosus	Armado común	potamodromous, omnivorous	35
	Pimelodus maculatus	bagre amarillo	potamodromous, benthic feeder	25-30
Perciforms	*Plagioscion ternetzi*	corvina	non migrant, top predator	30
Atheriniforms	*Odontesthes bonariensis*	pejerrey	non migrant, lake dweller, planktonic and benthic feeder	--

1= May vary according to provinces and type of fishing.
"—"= not found.

Both major orders have large trophy size species, a fact related to their migratory behaviour. Indeed, most large fish are potamodromous species that move upstream every year during low water periods (late winter and spring) to spawn during late spring or summer at the rise of the water level. Migratory fish spawn in the water column. They usually employ reaches with intermediate depth and moderate currents. In the Paraná River, spawning takes place mainly in the Upper reach and in the northern portion of the Middle reach. This behaviour is important to consider for decisions concerning season closures. Eggs are semi pelagic and derivate downriver; larvae and juveniles enter the flooded areas where they found refuge and food to growing up, maturing in 2-4 years, to come back to the river main channel for migration and reproduction.

The dominant recreational fishery types of the region are extractive on most species and extractive and catch and release for dorado. However, this latter modality has begun also to be implanted in the latter years in most tournaments.

In the upper section of the Paraná River the presence of the largest specimens of surubí and dorado have given rise to recreational 1, 2 and 3 type fisheries. They are mostly boat fishers (Iwaszkiw, 2001) and in lesser proportion coastline fishers. They may be found in the area between Augusts to May, excepting during the season closure period in November-December. They use a variety of fishing gears including casting trolling, spinning and down rigging. Trolling is frequently employed to catch large silurid specimens, mainly surubí. High power outboard boats go upstream, and special artificial baits moves up and down within the water column. Depths can reach more that 20 meters in those sectors of the river, and the large silurids are usually found in the deeper channels. Many of them are virtually hooked by the tails, a type of fishing that is banned by present regulations. Every artificial usually bears two triple hooks and it has been suggested by managers to put out the distal one to avoid these unwanted catches. However, this change is hard to introduce in the artificial bait industry.

Living baits are common, which have giving rise to an occupational activity of locally named “moreneros” because they capture mainly morenas, a common name given to Gymnotiforms (knife fish), particularly of the genus *Gymnotus*, *Brachyhypopomus* and *Eigenmannia*. Other species used as living baits are swamp eel (*Synbrachus marmoratus*), South American lungfish (*Lepidosiren paradoxa*), cascarudos and hoplos (*Calliichthys calliichthys, Hoplosternum littorale and Lepthoplosternum pectorale*), and tararira (*Hoplerythrinus unitaeniatus*). All of them share adaptations to breathe atmospheric air and have high rusticity, standing alive for long periods of time in water containers, even during the hottest summer days. Unfortunately, all those fish are collected from floodplain and marshes and the angler demands are continuously growing. There are no regulations or rules for allocation concerning these fishes and particularly in the genus *Gymnotus*, several still unknown species are being used as baits. Fishermen only need annual licenses to carry out this activity, which is mainly for subsistence, since they usually belong to the poorest socio-economic levels.

There are little conflicts within the recreational fishing group in the large rivers of the region. Most problems are related to commercial versus recreational and the international use of waters by Argentina and Paraguay fishermen. A new controversy has been growing that confronts catch-and-release and conservationist organizations against extractive anglers.

Out of tournaments, catch-and-release practices are limited to affluents such as Corriente River, placed in the protected area of Iberá Swamps, where only this kind of fishing is allowed for dorado (Bechara *et al.*, 2005). Fisheries types are world-class and recreational 1. The technique employed is mainly fly cast but using large streamers, which occasionally promotes by-catch of piranhas (*Pygocentrus nattereri* and *Serrasalmus spilopleura*) and some other species (*Brycon orbignyanus*, *Hoplias malabaricus*, *Acestrorhynchus pantaneiro* and

Crenicichla vittata). Some anglers also practice catch-and-release spinning with artificial baits.

To support these fisheries, four lodges placed along the Corrientes river or its source lakes are presently operating. They are located close to the headwaters, where the largest fish concentrations occur. Several outfitters services are also offered. Fish caught are generally smaller than the big trophy size more commonly obtained in the Paraná River (Bechara *et al.*, 2005). Casting anglers go for a large number of catches (5 to 10 in a fishing day), and at least one of two specimens closer to trophy size (8-10 kilos). However, the number of fish caught is variable and there have been a decrease in the last five years, probably related to the lack of large floods within the system and the increase of extractive fishing.

A decrease in fishing success can eventually result in the closure of those expensive lodges. Fishermen pay several thousands US dollars a week of fishing including a variety of high quality level services. They usually fish with the help of local guides using specially prepared boats in pristine and isolated areas, surrounded by a rich and diverse wildlife of aquatic birds, caimans, marsh deers, capybaras and many other wild animals. All these features, plus the famous fighting ability of dorado makes the fishing in this area a highly searched experience for casting anglers from all around the world.

An evaluation of the mortality caused by catch-and-release practices, along with an analysis of the practices that reduce injuries are necessary. Although there are no studies on the impact of catch-and-release practices on dorado fish populations, they are supposed to be low, given that this species seems to be very resistant to physical injuries. However, as better-experienced fishermen arrive to the region, together with highly fighting behaviour of dorados, it is expected that mortality related to high and frequent stress will increase. This species makes large jumps over the water when caught, in an attempt to get out of the hook, a fact that is frequently achieved by the fish. Hooks produce injuries in the mouth and the gills, and large numbers of scales are lost during fights. Moreover, the same specimens can be captured several times in a year or during a fishing season.

This argument is used for local extractive anglers, who are in conflict with catch-and-release advocates; mainly lodge owners and conservationist organizations that are against extractive fisheries in Iberá marshes. A management plan for the whole wetlands was recently finished and is presently under intense debate among different social statements and interest groups, to be finally established as a provincial law. This plan, in its original form prohibits any type of extractive fishing and limits catch-and-release fishing of dorados. The unsatisfied fishermen that support extractive fishing are mostly Recreational 2 and 3 types. They obtained recently a permission from the Corrientes Province government to carry out extractive fishing in a reach of the Iberá Provincial Reserve. However, this allocation is allowed for all the species excepting the most valuable: dorado, surubí and manguruyú.

In the upper portion of the Middle Paraná, recreational 2 and 3 are the most common types of fishing. Most anglers search for fish in motorised high power boats because they have to rapidly find good fishing spots among thousands of islands and channels in the river corridor. Fishing excursions typically last a

complete journey from early morning to late afternoon. The fishing guides are usually well informed about sites of school concentration and move dozens and even hundred kilometres a day to find good fishing areas. The economic activity of this kind of fishing is extremely important. Cleminson (2000), estimated for the Santa Fe province a mean daily capture of 5.45 kg/day/fishermen. This activity resulted in about U$ 2 x 10^6 gross annual turnover for the most prosperous years for the six largest fishing shops of the province. To this figure we should also add the economic turnover of small shops, the secondary input from the boat industry, gasoline, hotels, baits, fishing and boat licenses, among many others.

The number of fish every fisher can catch per day is limited according to the species. However, particularly in recreational 3 type, cheating is a frequent practice, especially when large numbers of fish are present. As in any fisheries, fishing success is variable, and the level of exploitation in the Paraguay-Paraná is large enough to provoke a considerably reduction in the unit catch per fishermen. When large schools are found many fishermen take much more than the number allowed per day. This practice has given rise to a concealed fishing because some anglers may sell their catch in the black market, where in the case of dorados the commerce is banned by law in most provinces.

The general perception of fishermen is that number of fish is declining in the river (Cleminson, 2000), and that the fishing two decades ago was far more abundant and diverse. Fishers attribute this decrease to commercial fishing, concealed fishing, fishing in the Paraguay, and to the impact of Yacyretá Dam. However, the available statistics from tournaments in the last 10 years reveal that variations in catch may be related to river discharge and hence the amount of water that enters and remains within the floodplain. For example, the number and average weights of dorados remained constant in around 0.11-0.13 kg/hour/angler between 1998 and 2001. In addition, several studies in the Middle and Upper Paraná revealed a significant positive relationship between flood intensity and fish catch with a time lag related to fish size and mean age (Quirós and Cuch 1989; and Ruiz Díaz, 2004). This fact is rarely taking into account by anglers and even official managers. Others studies have shown that in commercial fishing, large silurid catches in the last 15 years remained fairly constant for the total fishery, although a decrease was observed in fish mean size and average total weight captured per fishermen (Vargas *et al.*, 2004). The total number of fishing licenses increased and the total capture per fisher remained constant probably because artisanal fishers retain species that were formerly discarded. In Yacyretá Reservoir yield-per-recruit assessments showed that *Leporinus obtusidens* present fishing effort is below maximum sustainable yield (Araya *et al.*, 2005). However, there are some evidences that the number per fisher and average sizes of large silurid and pacú decreased in the Middle Paraná River, independently of river discharge fluctuations (Cleminson, 2000; Iwaszkiw, 2001).

The total fish catch for the year 2001 in the Paraná River at Corrientes Province has been estimated from licenses in about 3.000-4.000 tons, being half attributed to recreational fisheries, 50% of the recreational catches correspond to dorado, 30% to surubí and the remaining to the other species (Ovidio Eclesia, pers. comm.). These figures were estimated based on the number of fishing licenses sold, which in that Province, the most important for recreational

anglers, amounted in that year near 5.000 a year for local anglers and more that 20.000 a year for tourist anglers.

Along the Paraná river at Corrientes Province, more than 100 lodges, hotels and fisher services are located in the eight more important fisher towns (Iwaszkiw, 2001). Services include experienced fishing guides, boats and bait provision, rooms in hotels and lodges of variable services according to the socioeconomic levels.

In the Yacyretá Reservoir and upstream, deep changes in fisheries occurred after damming. The dam produces a blockage of migrating fish schools coming from more productive areas downriver to spawn. Only a small fraction of these fish are allowed to pass presently by two fish elevators. Capture per unit effort was estimated in the Posadas City area, considering weekend fishing excursions and statistics of seven tournaments (Hirt *et al.*, 2003). They varied between 0.08 and 0.21 kg/hour/fisher, which is a very low value compared with the 0.7 kg/angler/hour that would correspond to Santa Fé Province (Cleminson, 2000, assuming a 8 hours fishing journey) and close to the figures found for dorado fishing tournaments (see below). The most common activity was boat and costal fishing of the type 3. The species more frequently caught were also uncommon for Paraná river recreational fishing due to the scarcity of potamodromous fish, consisting mainly in piranhas (*Serrasalmus* spp.), freshwater rays (*Potamotrygon* spp.) and small Pimelodidae (*Pimelodella* spp.). Other more valued species such as *Pimelodus maculatus, Leporinus obtusidens, Hemisorubim platyrhynchos, Sorubim lima* and *Zungaro zungaro*, were less common in catches.

Tournaments merit a special paragraph given their popularity and usefulness for fisheries' evaluation. Many type 2 and 3 recreational fishers desire to win one of those tournaments and they always participate in large numbers. Anglers competing in the famous dorado fishing tournament in Paso de la Patria reached a maximum of 582 fishers and 194 boats in 2004, while 1454 fishers and 497 boats participated in the surubí tournament in Goya (both localities in Corrientes Province) (Iwaszkiw, 2001). Those tournaments are major social, cultural and economical events for the riverine towns for more that 40 years. They are an important part of the tourist attractions of the region, assembling thousands of people during two to three days. Dozens of killed fish remained displayed in the "gancheras" after a fishing session being part of the show in these tournaments. However, as explained earlier, in the last three years there has been a decrease in the number of fish caught in the Middle Paraná River. This fact forced organizers to change from extractive to catch-and-release modes, a fact that allowed increasing the number of specimens to be caught because size is no longer a limitation. Now, the exhibition of killed fish is replaced by large screens showing to the public scenes of fishing and the prized fish registered by official video cameras during the day. With this new type of fishing, the number of dorados and surubí caught per angler during tournaments doubled or tripled, although the lower size range decreased in about 20-30 cm.

As explained earlier recreational fishing in Argentina is regulated by the provinces, except in National Parks. Giving that most rivers share provincial and international jurisdictions, this political scheme generates frequent problems

and conflicts concerning different uncoupling among provinces. Fortunately, during the last ten years, an international joint commission between Paraguay and four limiting provinces of Argentina has been consolidated. The countries signed an agreement and formed a coordinating committee for conservation and development of fisheries resources in the border reaches of the Paraguay and Paraná River. In order to establish regulations, the commission relies on consultation with an Advisor Committee formed by different interest groups related to the resource (e.g. scientists, technicians, commercial and recreational fishing organizations, outfitters and lodge owners and administrators, coast guard, etc.). The code establishes target species that may be captured in common waters; species specific daily catch quotas per fisher, fish size limit regulations for the most important species, season closure periods, types of gears and fishing practices banned, reserves and protected areas, and other general policies. These regulations apply to most waters of the large rivers of the region including interprovincial waters. For example, season closure, which usually takes place between November 1 and December 20 every year, is generally applied in the overall extent of the four northern provinces and Paraguay.

This code was achieved by consensus among the parts, taking into account previous management schemes, but without major revisions of the objectives and usefulness of the rules to be applied. As in other waters of Argentina, very little is still known about the processes that should direct sound management schemes. Real managers in most provinces are lacking (Cleminson, 2000) or in the best cases they cannot act as expected, because of the very few resources available, and the limited capacity for taking decisions. They usually work hard to solve critical or conflictive points that threaten political or social stability, remaining the rest of the time limited to bureaucratic tasks and trying to keep track of the fisheries without budget to consider any major management plan. Socials claims in Argentina have increased since year 2000, and artisan fishers do not hesitate to threat cutting the Paraná River commercial navigation with its boats or to stop the traffic for several days in critical bridges over the river if their claims are not listen by the government.

There are not catch quotas for any of the fishing types allowed. Therefore, the total fish catch in the region is open since the number of licenses sold is not limited and increases every year (Iwaszkiw, 2001) and the number of fish allowed per angler remains constant in time. Therefore, the only limitation to over fishing is the allowed fish minimum size, provided all anglers respect that size. Those sizes were fixed 30 years ago following approximate rules and kept with minor changes. Fortunately, most of them are no so far from critical sizes, according to the criteria of Froese and Binohlan (2000) (Table 2) and all figures are above mean size at first maturation. Presently, all those sizes are under revision by the advisory committee of the international joint commission of Paraguay and Argentina, and they possibly will be adjusted to closely follow actual critical size minus 10%. However, this kind of management presents several drawbacks. First, the lack of enough number of large specimens to fulfil some angler expectations will deter the highest levels of recreational anglers, and recreational 2 and 3 type anglers will be forced to target fish of the less valuable species. However, fish minimum size varies according to species, and fishing gears employed for some small species may force the by catch of larger

species below the allowed size. In some cases the fish can be released, but in others such as in the corvina (*Plagioscion ternetzi*) they generally die after being captured. Second, there are no allocations, so the fisher group with the most effective fishing technique will take a larger portion of the available fish, which is an unfair situation that can promote conflicts. Recently, provinces along with national officials have been trying, to convince commercial and artisan fishermen to limit the number of licenses, which seems to be hardly accepted by northern artisan fisher associations. The main reason of these new policy was the industrial fishing implanted in the lower portion of the Paraná River (Iwaszkiw, 2001), which is supposed to catch more than 50.000 tons a year of sábalo (*Prochilodus lineatus*) only for exportation. In the future, those limitations would extend to recreational anglers so as to establish quotas, which should be equitable and reached by consensus.

In Corrientes Province, the type of fishing (commercial vs. recreational, catch and release vs. extractive) is usually allocated for areas. Only a restricted section of the river is allocated for commercial fishing, while the whole river is open to recreational fisheries. In natural reserves, catch-and-release is the only allowed form of fishing. However, these rules are widely violated because artisan fisheries are established in areas where they are not supposed to be permitted. In other provinces of the Northeastern region, different kinds of fisheries share the same area. Those allocation schemes do not respond to an integral management perspective taking into account biological productivity of a given fishery, the mandates of different institutions and/or the requirements of fishers harvesting the resource. As in others rivers of Argentina, the lack of comprehensive management based on solid research programs and monitoring, generate conflicts such as when world-class fishing lodges oppose extractive fishing by local inhabitants (e.g., Corriente River). However the large spatial and temporal complexity of river systems makes this tasks a real challenge, and requires of flexible management plans that should be sensitive to many different types of needs with awareness of seasonal variability (Cleminson, 2000)

There are very few fish controls along the rivers, which opens the door to frequent rule violations. The most serious acceptance to the rules occurs during season closures, when controls are stricter and more frequent, and for which a general consensus among fishers exists about the importance and effectiveness of this management rule. However, from a strictly scientific point of view, there is no evidence of its effectiveness regarding species, time of the year and length. However, this practice is so popular and widely accepted, that it is worth to preserve as a management tool.

There is still a lot of work to be done in this region of Argentina to achieve an equitable sharing of the rich fish resources. Provinces and National government still invest very little in research for improving management, or in monitoring the actual impact of implanted regulations. The lack of funded research programs reflects also the slight interest that official managers put on knowledge to improve management policies, which is part of the general cultural backwardness of the region. This is somewhat contradictory because recreational fisheries are extremely important for local economies and many small towns along the river for which recreational fisheries and tourism are the main income source. Only fishing tournaments are carefully evaluated because

of the need of correctly giving the prize to the winners. The selling of licenses generates large revenues in some provinces, but they are not adequately employed to improve the present state of the fishery. It is expected that in a near future, authorities will finally understand the importance of scientific information, monitoring and adequate controls, and will establish sound policies of integral and equitable management in agreement with all parts ensuring the sustainability of this valuable resource.

Central, Western and Northwestern regions

The Central, Western and Northwestern regions of Argentina (Figure 3) have the most massive recreational fisheries in natural and artificial lakes. These fisheries are principally directed to the relatively wealthy Argentinean middle class. However, the socioeconomic information necessary to manage those fisheries is scattered in many provincial jurisdictions or it is directly lacking. The emphasis in fisheries regulation is usually stressed on closed seasons and bag limits but fishery regulations fluctuate widely among jurisdictions. In lakes and reservoirs, stocking of larval fish is the favourite tool for fisheries managers mainly due to the lacking of monetary and technical resources. The lack of studies or any other information about stocking results and efficiency is a general pattern.

For these regions, fish is a public common resource as well as for most of the Argentinean freshwaters but fisheries law enforcement and control is weak for most of the sites. Responsibility for regulating fisheries in public waters rests with provincial fisheries agencies. However, the disperse attempts to manage and control exploitation are generally insufficient and largely political. Fishery regulations have been issued generally in response to the declining fisheries and the desire to protect stocked fishes. Most laws regulate either the seasons or methods of recreational fishing. Closed seasons are implemented to protect spawning fish, under the implicit belief that spawners are needed to assure future catches. Such regulations interspersed with ambiguities and contradictions are usually ineffective for fish conservation,. The few regulations that do exist for sport fishing are even less likely to be enforced due to lack of coherent policies, and few fishery officials aided by ordinary police. Moreover, valuable data to fisheries managers like total catch and effort data are usually not sought for or reported.

The management of freshwater lake recreational fisheries is not an important issue for provincial and local government levels in Central and Northern Argentina. The participation of the public in the management decision-making process is practically null. The last country wide national intent in order to get basic lake and reservoir limnological and fish information crashed more than 20 years ago (Quiros, 1990). Fisheries science is at present dispersed in a few universities where poorly financed small research groups struggle to get some narrow local results.

In the central regions of the Pampas plains, both recreational and commercial fisheries are common. The pampean lakes contain a relatively diverse temperate fish community (Lopez *et al*., 1996); more than 60 fish species have been identified in these lakes (Lopez *et al*., 2001). The “pejerrey” (*Odontesthes bonariensis*), a visual planktivore atherinid, and the “tararira” (*Hoplias malabaricus*), an ambush top predator, are usually the fish species preferred by

both recreational and commercial fishers. A particular feature for the larger very shallow lakes at the Pampas is the existence of an important poaching activity for these fish species, which generates frequent conflicts with recreational fishers.

Recreational pampean fisheries are based mainly on “pejerrey”, a fish highly valued mainly due to its size and flesh flavour attributes. According with our classification, the prevalent recreational fisheries types are 2 and 3 (Table 1) for this region. The remnant shallow “clear” lakes are preferred fishery sites to catch few bigger big fish (Quiros *et al*., 2002). However, the large saline lakes are the preferred sites to fish more and larger “pejerrey” fish when diluted during heavy rainy years.

Recreational fishing is an important leisure activity for the habitants of the Pampa’s plains. There are more than 450 sport angler clubs in Buenos Aires metropolitan area (Lopez *et al*., 1996). Fishing tournaments are common for this region. The angler mean displacement for a fishing trip ranges between 150 and more than 500 km. The fishing gears used in the shallow lake recreational and sport fisheries to catch the pelagic “pejerrey” are exclusively monofilament nylon with floats and hook and bait. Rods and lines are operated from the lake shoreline, small boats or wading in shallow lakes. Hook and line gear is usually used to catch the predator “tararira” in the recreational fishery. However, flies and lures are also commonly employed to catch this last fish.

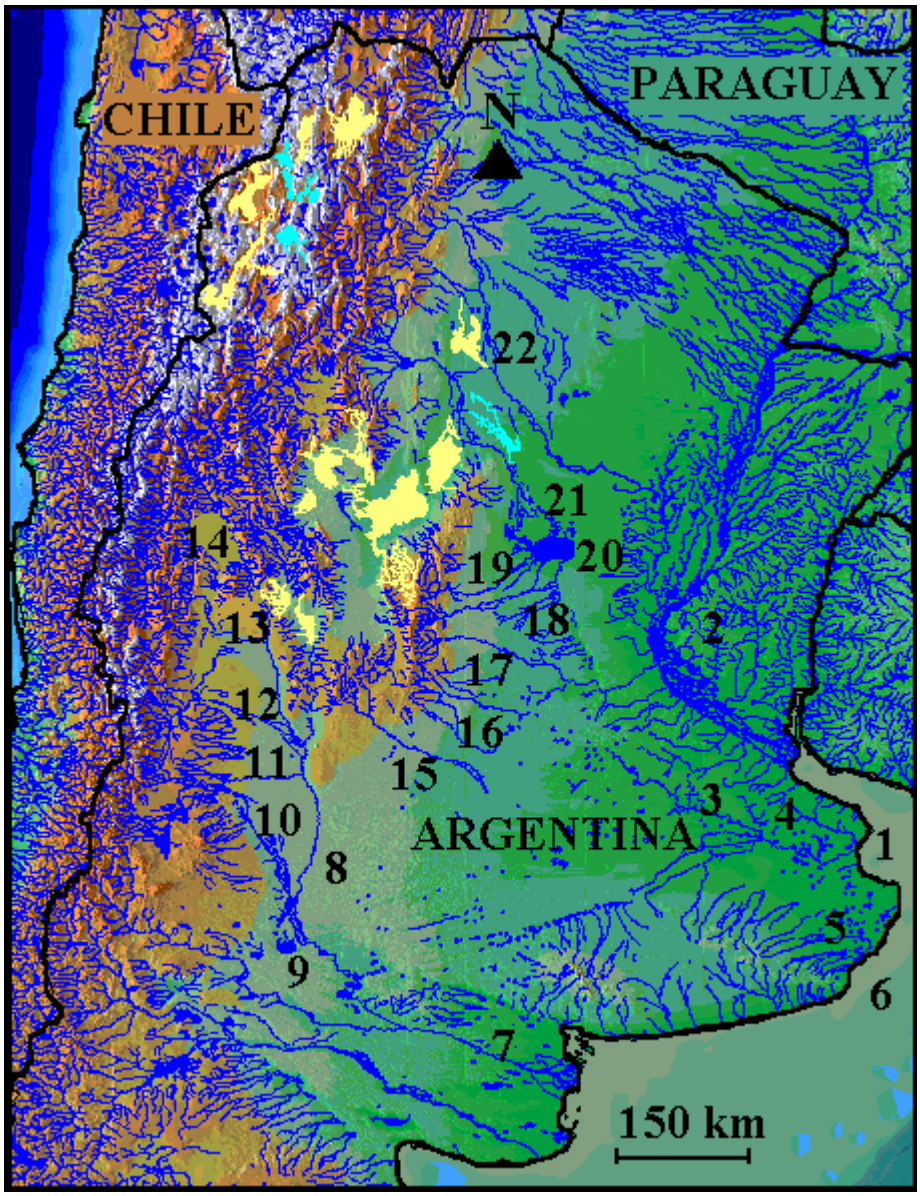
There is a general perception that recreational fisheries for “pejerrey” has deteriorated during the last 20-30 years, mainly due to habitat alteration by unregulated agriculture and urbanization development. The pristine lakes were “clear” and macrophyte dominated but lake eutrophication conducted to predominant “turbid” green lakes (Quirós *et al*., 2002). Recreational anglers are concerned that most of the lakes have not sustained populations of “pejerrey” with large fish. Moreover, for lakes heavily loaded with urban sewage discharges “pejerrey” is usually displaced by a pelagic filter feeding planktivorous fish (“bagarito”, *Parapimelodus valenciennesi*).

The numerous natural lakes in the Pampas and the lack of appropriate management and timely fishery information makes it difficult to predict the sport fishery. The “pejerrey” populations of a very few lakes have been studied more intensively (Freyre, 1976; Rosso unpublished data) but the general pattern is a lack of results from particular lake population studies. This insufficiency of fishery studies outcome makes fishery management for individual lakes still more difficult. Minimum size limits for “pejerrey” were recommended in lakes where the quality of the fishery needed to be improved, or for very productive lakes where fishing pressure is intensive. Slot limits have been also recommended in order to provide protection for a diversity of fish sizes (Baigún and Anderson, 1993). Although fish in pampean lakes have been exploited by commercial fisheries for many years, fishery management objectives are mostly directed to recreational fisheries by provincial law today (Table 1). Very few studies have been implemented in order to estimate angler preferences and exploitation rates (Baigun and Delfino, 2003). The highly variable ecological characteristics of the landscape are reflected in lake functioning, and hydrological variability among years is clearly reflected in lake fish population

abundance. This fate limits seriously the value of results obtained from the application of angling surveys to individual lakes on a time discontinuous basis.

In the Western and Northwestern arid and semi-arid regions of Argentina (Figure 3), recreational fisheries are mainly developed in small to middle-sized reservoirs (5-100 km^2). Riverine fisheries are only important in the northern part of the region, at the tributaries of the large rivers. The main land use in these regions is for agriculture and most of the reservoirs are eutrophic or hypertrophic (Quiros, 1990). Although fishing was generally a secondary objective for most reservoirs constructed in arid and semi-arid regions, they are intensively used for recreational fisheries today. The fish resource is middle to highly exploited by man but environmental degradation due to agriculture and urbanization is an actual threat for it (Quiros, 1990). There are not commercial fisheries in reservoirs but subsistence fisheries based in common carp are relatively important in some more densely populated poor regions. Also an increase of water reservoirs for aquaculture purposes is planned. Recreational fisheries in reservoirs are based mainly in introduced game fish as the pampean silverside “pejerrey”, the predator “tararira” and the common carp. Recreational fishermen do not depend on the fishery for employment, treating fishing more as a temporary pastime. They are often a relatively middle class wealthy group frequently with some urban professional backgrounds (Volante *et al*., 1997). They are, therefore, external to the rural milieu in which they find their sport. For these regions, recreational fisheries are, according with our classification, type 3 (Table 1); large fish are not usually common in Western and Northwestern Argentinean reservoirs.

Figure 3. Hydrology of the Central, Western and Northwestern regions: 1 Río De La Plata, 2. Paraná river, 3. Salado river (Buenos Aires province), 4. San Borombon river, 5. Canal 5 river, 6. Mar Chiquita, 7. Colorado River, 8. Slado river (La Pampa province), 9. La amarga lake, 10. Atuel river, 11. Diamante river, 12. Tunuyan river, 13. San Juan river, 14. Jachal river, 15. Quinto river, 16. Cuarto river, 17, Tercero river, 18. Segundo river, 19. Primero river, 20. Mar Chiquita lake, 21. Dulce river, 22 Salado river.



Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America

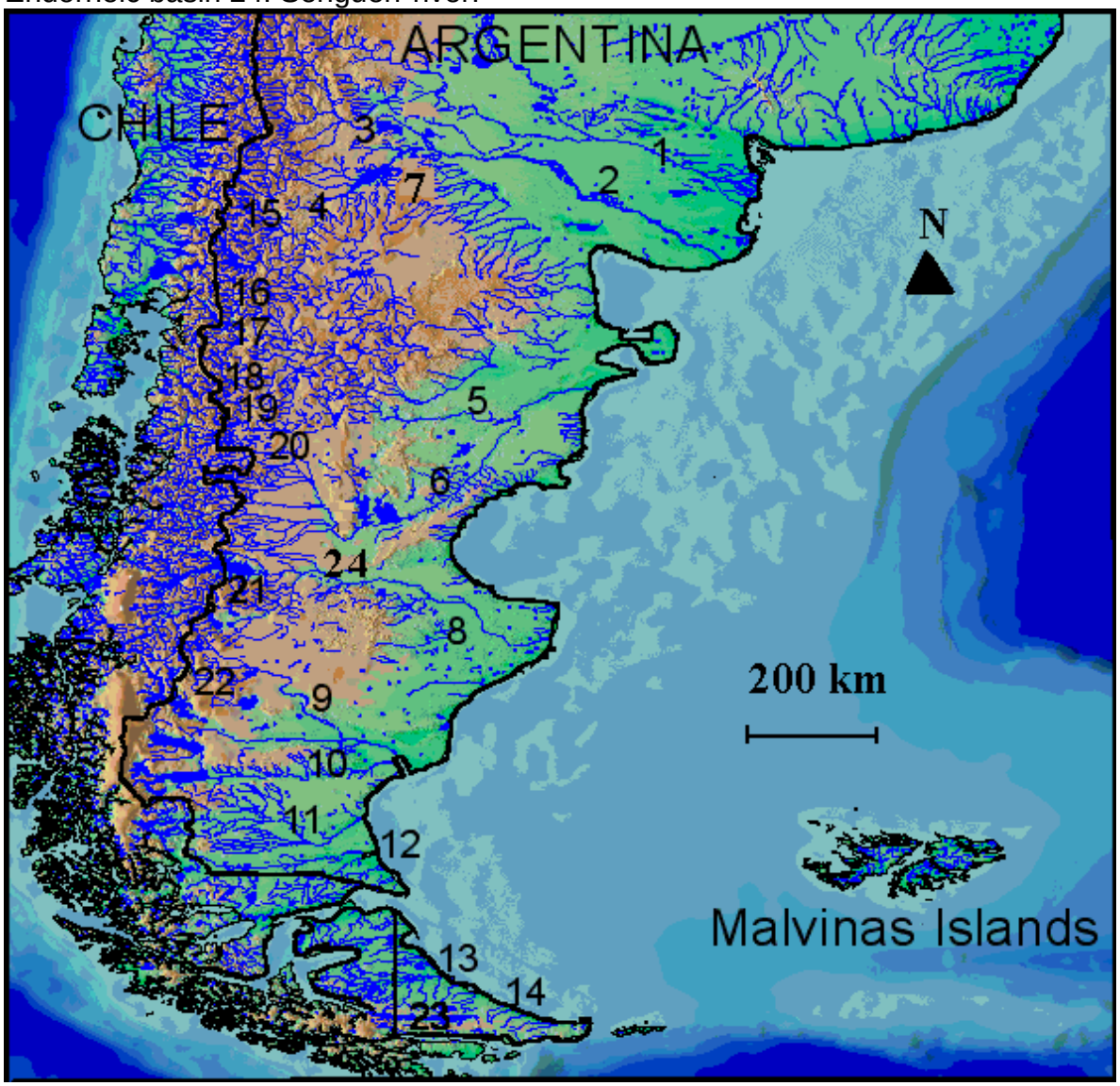
Patagonia and Tierra del Fuego fisheries

Patagonia and Tierra del Fuego recreational fisheries are centred on cold-water species, mainly salmonids that in some cases meet world-class standards (Leitch, 1991, Vigliano & Alonso in press). As a consequence during the past twenty years the region has seen a rapid development of highly priced recreational fishing and the establishment of international quality fishing lodges and outfitters. This in turn has brought to the attention of local governments the potential economic turnover of recreational fishing and in some cases conflicts with local, regional and national fishers.

Argentine Patagonia and Tierra del Fuego Figures 1 and 4) compromise the Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego provinces covering over 1,7million km^2, from the Andes on the west to the Atlantic Ocean in the east. The region is characterized by a harsh cold climate an low population densities (1.2 inhabitants km^{-2}). Most of Patagonia and Tierra del Fuego show a marked climatic gradient from west to east brought about by the Andes acting as an effective barrier against the moist westerly winds which causes humidity to drop rapidly from West to East defining two distinct sectors. The Andean sector in the West is characterized by a temperate forest landscape presenting countless ultra-oligotrophic and oligotrophic lakes and streams (Calcagno *et al*. 1995, Modenutti *et al*., 1998 a,b). The Patagonian steppe sector East of the Andes is an arid landscape that extends to the Atlantic Ocean. Nineteen major watersheds (Figure 4), fed mostly by thawing winter snows and spring and autumn rainfall are born in the Andes. Six of these drainage cross the Andean range draining into the Pacific Ocean. The remaining drainage's flow East through the Patagonian steppe draining into the Atlantic Ocean being their lower reaches under tidal influence. Some of these drainages like the Rio Negro basin in northern Patagonia have undergone huge changes due to the construction of hydroelectric dams along the Neuquén and Negro rivers. Others such as the Santa Cruz drainage in southern Patagonia are being considered for hydroelectric development.

According to Pascual *et al* (in press) protected areas in continental Patagonia usually located at the head of the major river drainages protect approximately 37 % of temperate rainforest and headwaters towards the Andes but only 5 % of Patagonian steppe water bodies. Within National Parks jurisdiction conservation of native fish species is a main priority, to the point that all native species caught within National Parks must be immediately released. On the other hand no further than 10 years ago, salmonids were unofficially seen as a nuisance that did not deserve to be studied or taken into account. Today, salmonid sport fishing is seen as an important recreational activity, but the processes that govern native – exotic interactions and thus structure fish communities are at best poorly understood (Pascual *et al*. 2002). Within this context possible outcomes upon fish communities brought about by fishing regulations such as mandatory release of all native fish and the kill quotas established for salmonids are anybody's guess.

Figure 4. Hydrology of Patagonia and Tierra del Fuego regions. Atlantic drainages: 1.Colorado river, 2. Negro river,3. Neuquén river, 4. Limay river, 5. Chubut river, 6 Chico river (Chubut province), 7. Senguerr river, Deseado river, 9.Chico river (Santa Cruz province), 10. Santa Cruz river, 11. Coig river, 12. Gallegos river, 13. Grande river, 14. Ewan river, Pacific draining: 15. Lacar lake, 16. Manso river, 17 Puelo lake, 18. Futaleufu river, 19. Corcovado river, 20 Pico. lake, 21. Pueyrredon lake, 22. San Martín lake, 23. Fagnano lake, Endorheic basin 24. Senguerr river.



Modified from USGS Global GIS Data Base. Digital Atlas of Central and South America

Argentine Patagonia and Tierra del Fuego have a low fish diversity consisting of 36 fish species of which 24 are of Austral, Brazilian and Andean Cuyan freshwater origin, 5 are marine and 7 exotics (Ringuelet, *et al*. 1967, Ortubay *et al*, 1994, Ferriz *et al*.1998, Bello 2002, Pascual *et al*. 2002, Lopez *et al*. 2003, Pascual *et al*., in press). Of these 16 species are targeted by recreational fishers (Table 3), being salmonids not only the most important group of introduced exotics but also the generally preferred targets (Pascual *et al*. 2002, Vigliano & Darrigran, 2002). Introductions started in the early 1900´s, (Tulian 1908, Marini, 1936), shifting stocking policies trough out time (Macchi, 2004, Macchi *et al*., in press) eventually gave rise to feral populations of rainbow trout (*Oncorhynchus mykiss*), chinnok salmon (*O. tshawytscha*), brook trout (*Salvelinus fontinalis*), lake trout (*S.namaycush*), brown trout (Salmo trutta) and landlocked Atlantic salmon (*S. salar*) (Pascual *et al*. in press). Of these species rainbow trout brown trout and brook trout became widely distributed and the basis for an extensive salmonid catch and release and extractive recreational fisheries through out the region. Also in some locations, like the Traful, Curruhue grande and Cholila lakes the Atlantic salmon managed to adapt becoming landlocked and giving rise to particular fisheries.

Native fish (Table 3) such as perch (four species), the pejerrey (two species), the common carp and some of marine origin such as the liza, robalo and flounders that swim into river mouths and tidal influence sectors are also sought for.

Biogeography, history of introductions, environmental and socio.-economic characteristics have determined the existence of distinctive fisheries in this region. Towards the west in the slopes of the Andean range unregulated streams and rivers and glacially originated lakes introductions of salmonids gave rise to feral populations and world class, recreational 1, 2 and 3 type fisheries (Table 1). Thus diverse groups of resource users which in general terms are shore and boat fishers (Vigliano & Lipppolt, 1991, Vigliano & Grosman, 1997) may be found in the area during the November to April fishing season using a variety of fishing gears and tackle (e.g. fly fishing, spinning, casting trolling, down rigging). The different human groups involved (e.g. strictly catch and release fishers, highly extractive ones, family recreational fishers, lodge owners and outfitters) do not share precisely the same goals and expectations with regards to fishing trip outcomes (Vigliano *et al*. 2000). This has brought about conflicts between fishers groups and their perceived right to access waters, catch and dispose of fish.

Today, salmonid sport fishing is seen as an important recreational activity, but the processes that govern native – exotic interactions and thus structure fish communities are at best poorly understood (Pascual *et al*. 2002). Within this context possible outcomes upon fish communities brought about by fishing regulations such as mandatory release of all native fish and the kill quotas established for salmonids are anybodies guess.

In northern Patagonia, rivers (e.g. Río Negro and Colorado rivers) that traverse the steppe and drain into the Atlantic ocean sustain type 2 and 3 recreational fisheries of mostly native species, which include two silversides (*Odontesthes hatcheri, O. bonariensis*), four species of Percichthyds, (*Percichthys altispinis, P.colhuapiensis, P. trucha & P. vinciguerrae*) and three species of marine origin

that swim up river: a mullet (*Mugil liza*), a flounder (*Paralichthys sp.*) and the patagonian blennie (*Eleginops maclovinus*). This fishery is predominantly extractive, life bait is commonly used and fishers goal generally is to maximize catch and retention of fish which are consumed.

Table 3 List of the most important recreational target species in Patagonia and Tierra del Fuego.

Order [1]	**Scientific Name** [1]	**Spanish Common Name**	**Habits**
Salmoniformes	*Oncorhynchus mykiss*	Trucha arco iris	freshwater and anadromous / top predator (fish and macrozoobenthos)
	Salmo trutta	Trucha marron	freshwater and anadromous / top predator (fish and macrozoobenthos)
	Salmo salar	Salmon encerrado	landlocked / top predator (fish)
	O. tshawytscha	Chinook salmón	anadromous / top predator
	Salvelinus fontinalis	Trucha de arroyo	freshwater / top predator
	S. namaycush	Trucha de lago	freshwater / top predator
Atheriniformes	*Odontesthes hatcheri*	Pejerrey	freshwater / benthic and planktonic feeder
	O. bonaeriensis	Pejerrey	freshwater / benthic and planktonic feeder
Perciformes	*Percichthys altispinis*	Perca	freshwater / fish and macrozoobenthos
	P. colhuapensis	Perca	freshwater / fish and macrozoobenthos
	P. trucha	Perca	freshwater / fish and macrozoobenthos
	P. vinciguerrae	Perca	freshwater / fish and macrozoobenthos
	Eleginops maclovinus	Robalo	marine – brackish water/
	Mugil liza	Liza	marine brackish water/
Cypriniformes	*Cyprinus carpio*	Carpa	Freshwater / omnivorous
Pleuronectiformes	*Paralichthys sp.*	Lenguado	Marine- brackish water / top predator

[1] Scientific names according to Fish Base

Some southern Patagonia and Tierra del Fuego rivers draining into the Atlantic and Pacific oceans sustain runs of anadromous salmonids which gave rise to world class and recreational types 1, 2 and 3 fisheries. The Santa Cruz River in the namesake province holds an anadromous rainbow trout population, that according to genetic analysis developed from fish originally introduced from populations of the Mc. Cloud river in California (Pascual *et al*. 2001, Riva Rossi, 2003). This has led in the past ten years to the development of an on growing recreational fishery centred on the Santa Cruz “steelhead trout”, which is rapidly becoming a local generator of economic turnover. Two types of fishers use the resource, local ones and people from other areas attracted by the possibility of catching steel head trout. Meanwhile the first group is mostly extractive, the second one is a mixture of catch and release fishers. An initial outfitter business is starting to develop, but formal international level fishing lodges have not established yet. Also, the establishment of a Chinook anadromous salmon population on the headwaters of the Santa Cruz drainage system has recently been confirmed (Ciancio *et al*., 2005), being this the first citation for an Atlantic draining system in South America. According to the same authors these fish may have originated from escapes from ranching experiments in the 1980´s or

from introductions conducted almost a century ago. Whether this will lead to a recreational fishery of economic importance remains to be seen.

Also draining towards the Atlantic: the Gallegos in Santa Cruz province and the Menendez, Grande and Ewan in Tierra del Fuego rivers have runs of anadromous brown trout, which are sought for by world class and recreational types 1, 2 and 3 fishers. In the first three rivers; caught specimens normally weight more than 5 kg. All three rivers have well-developed and established fishing lodges which restrict access to local and regional fishers. A good example of the importance of these developing fisheries in terms of local and regional economic turnover is the one supported by the world class Río Grande fishery in Tierra del Fuego. Twenty years ago only one fishing lodge existed which recorded a couple hundred caught and released fish averaging 5.5 kg. By 1997 this same lodge recorded releasing more than 4000 fish of approximately the same size, some weighting up to 12 kg and with records of up to 16 kg. The river now holds 5 fishing lodges with strict catch and release policies giving complete service to an international clientele that may pay between 3000 and 6000 United States dollars per week (Vigliano & Alonso in press). The river is also fished by people from the local city of “Río Grande” (40,000 inhabitants), which are mainly extractive and resent that access to most of the 150 km river has been restricted by lodges. The huge benefits for lodge owners makes them adamant to a less restrictive policy and suspicious of any approach to scientifically manage the resource. The huge success of the lodges has prompted other landowners to close access to the rivers that run through their properties in order to start their own lodges thus creating more conflict. The provincial government does not have a comprehensive policy or strategy to deal with these conflicts.

Because some of the drainages that originate in the Eastern side of the Andean range head west and drain into the Pacific Ocean (Figure 4) these systems are subject to colonization by salmonid species that escape from Chilean aquaculture facilities. Thus the Pacific drainages of the Futaleufu and Corcovado river basins in Chubut Province, have runs of Chinook salmon, that were first reported as spawning in 1991 (Grosman, 1991, Pascual *et al*, 2002). The appearance of this species has caused mixed feelings, while fishers are exited about the possibility some fishing guides and outfitters worry that it may produce a change in the system that could bring harm to the already successful recreational type 1 and 2 fisheries of rainbow trout and brown trout in the area.

Also reports of Atlantic salmon apparently appearing in other Pacific draining systems such as the Puelo basin in both Chubut and Río Negro provinces are starting to be common and even if they require confirmation, it may indicate future changes to come to the existing fisheries in those drainages.

Recreational fishing in Patagonia and Tierra del Fuego has been regulated for the past 10 years by a common fishing code developed and actualised every year by a Consultive Commission on Patagonia Continental Fishing, which brings together Provincial governments and the National Park Administration. In order to establish regulations the commission relies on consultation with different interest groups related to the resource (e.g. technicians, fishing organizations, outfitters and lodge owners and administrators, fishing guides, etc.). The code establishes target species that may be sought for in each water

body and jurisdiction; species specific daily catch quotas per fisher, special fish size limit regulations, fishing seasons, types of gears allowed and other general policies. For most cases these regulations are not based on formal fishery studies but rather on perceived resource status and trends. Thus for most environments regulations are set according to specific mandates of particular agencies such as the total protection of native species within National Park jurisdictions mentioned earlier, specific provincial policies or interest, or those of joint comities of shared basins between Chile and Argentina with little data on the resources involved to support them. While there has been a considerable increase on biological and biogeographical data on the past ten to fifteen years, what is known about the processes that could direct sound management programs it still very little. As stated by Pascual *et al*. (in press) research usually responds to concern of specific interest groups in relation to specific issues or fisheries, “but without the umbrella of an integral view of freshwater management”.

Within this context allocations in Patagonia and Tierra del Fuego as a policy is established in terms of catch quotas such as number of fish of a given species that may be retained, by any fisher on a daily basis varying according to water body jurisdictions and related interest groups. This allocation scheme usually does not respond to an integral management perspective taking into account biological capacities of a given fishery, the mandates of different institutions and/or the requirements of fishers harvesting the resource. Instead allocations as explained rely mainly on the particular perception of specific sectors and interest groups. The lack of comprehensive management based on sound research and more akin to interest groups has in many situations generated conflicts such as where world-class fishing lodges interest have restricted access to historical fishing grounds (e.g. rivers Grande, Menendez and Ewan in Tierra del Fuego, Gallegos in Santa Cruz province, Traful in Neuquén province etc.) to local and regional residents.

Shared jurisdiction is a common trait of Argentine Patagonia and Tierra del Fuego waters leading in many cases to contradicting regulations. Such is the case of Laguna Blanca, a Ramsar site mostly under National Parks administration but with a small portion under Neuquén province jurisdiction, meanwhile the former allows fishing the latter one prohibits it in its sector.

To ensure an equitable and sustainable use of the recreational fisheries of Patagonia and Tierra del Fuego more fishery oriented studies that take into account not only the environmental and biological constrains of the involved resources, but also the intricacies of the human factors associated to them are needed. For this the human resource base dedicated to the problem as well as the funding for infrastructure and research will have to be expanded. Today only four research groups related to the fish resources of Patagonia and Tierra del Fuego are radicated within the region. Lack of comprehension of the inherent complexities and economic potential of recreational fisheries is hardly understood by politicians and therefore funds are scarce and usually oriented towards particular problems and not to understanding the processes that lead to those problems. Comprehensive views for each fishery are lacking and will have to be developed in a dynamic way in order to produce management schemes that correspond to reality and offer chances of maintaining the recreational fisheries trough out time.

Final Remarks

As mentioned before, a wide body of laws and regulations exists in relation to conservation and management of natural resources. However, despite the existing jurisprudence, there seems to be a mismatch between the purpose of the law and actual management. This mismatch seems to stem from the lack of awareness of politicians and other stakeholders with regards to the importance and fragility of the resource and the complexities of managing the dynamic system of the involved fisheries.

Through out the present paper we have stated that allocations for most situations in inland Argentine fishing are not set by information resulting from management oriented research, but rather by decisions based on particular agendas or perceptions of particular interest groups. We have also to consider that particular allocation strategies are not usually monitored through out time, resulting on “guesstimates” of their outcomes, which some times are in term used as criteria to determine new allocations policies. This course of action tends to generate conflicts within and between sectors and no guarantees with regards to resource integrity and sustainability.

It thus seems obvious that a series of priority gaps must be resolved in order to ensure the sustainability of Argentina’s inland recreational fisheries. These should include: 1) creating awareness on all society levels about the fragility of the resource and the need of management-oriented research, 2) develop local and regional research programs that could generate environmental, biological and the human factor information that may lead to management decisions, 3) integrate all stakeholders of particular fisheries into the decision process.

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Bibliography

Araya, P., A. Agostinho and J. A. Bechara. 2005. The influence of dam construction on a population of Leporinus obtusidens (Valenciennes, 1847) (Pisces, Anostomidae) in the Yacyreta Reservoir (Argentina). Fisheries Research 74: 198-209.

Baigun, C.R.M., and R.O. Anderson. 1993. Structural indices for stock assessment of and management recommendations for pejerrey Odonthestes bonariensis in Argentina. North American Journal of Fisheries Management 13: 600-608.

Baigun, C., and R.L. Delfino. 2003. Assessment of social and economic factors for management of summer pejerrey recreational fisheries in pampean lakes (Argentina). Lake and Reservoir Management 19: 242-250.

Bechara, J. A. and F.J. Ruiz Díaz. 2004. Effects of mean annual discharge and dam regulation on fish biomass in the High Paraná River (Argentina). In: Pp. 95-101. García de Jalón, D. and Vizcaíno Martínez, P. (Eds.). Proceedings of the Fifth International Symposium on Ecohydraulics. Aquatic habitat analysis and Restoration. International Association of Hydraulic Research. Madrid.

Bechara, J., A. M. N. Alabarcez and F. J. Ruiz Díaz. 2005. Elaboración y validación de un modelo de hábitat para el crecimiento de dorado (Salminus brasiliensis). Report of the Instituto de Ictiología del Nordeste to the Fundación Ecos-Corrientes. Agreement between GEF-PNUD ARG02/G35 y la Universidad Nacional del Nordeste, 50 p.

Bello 2002, Los peces autóctonos de la Patagonia Argentina. Distribución natural. Cuadernos Universitarios de la Universidad Nacional del Comahue, 43, 1–54.

Calcagno, A., M.Fioritti, F.Pedrozo, P.H.Vigliano, H. Lopez, C. Rey, M.E. Razquin. And R. Quiros, (Eds.). 1995. Catálogo de lagos y embalses de la Argentina. IARH, INCYTH.

Casciotta, J.; Almirón A. and Bechara, J. 2005. Peces de Iberá. Hábita y diversidad. Editorial Grafikar. La Plata, Argentina, In Press.

Ciancio, J.E., M.A. Pascual, J. Lancelotti, C.M. Riva Rossi and F. Botto. 2005. Natural colonization and establishment of a Chinook salmon, Oncorhynchus tshawytscha, population in the Santa Cruz River, an Atlantic Basin of Patagonia. Environmental Biology of Fishes. In press.

Cleminson, A.M. 2000. A characterisation and economic valuation of a sport fishery on the Paraná River in Argentina. Master Thesis. Imperial College of Science, Technology and Medicine. University of London. London, 103 p.

Colombo, J.C.. C. Bilos, M. Remes Lenicov, D. Colauti, P. Landoni, and C. Brochu. 2000. Detritivorous fish contamination in the Rio de la Plata estuary: a critical accumulation pathway in the cycle of anthropogenic compounds. Can. J. Fish. Aquatic Sci. 57: 1139-1150.

Ferriz, R.A., H L López and S. Gómez. 1998. Bibliografía De Los Peces Continentales Patagónicos. Aquatec 6:1-30.

Freyre, L.R. 1976. La población de pejerrey de la laguna de Lobos. Limnobios (Argentina) 1:105-128.

Froese, R. and C. Binohlan, 2000. Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. J. Fish Biol. 56:758-773.

Grosman, F. 1991. Presencia de “Salmon del Pacífico” *Oncorhynchus tsawytscha* Walbaum, en las cuencas de los ríos Grande y Corcovado, prov. Del Chubut. Propuestas de pautas del Manejo del Recurso. Biología Acuática: 200-201.

Hirt, L; P. Araya and S. Flores. 2003. Evaluación de la pesca comercial, de subsistencia y recreativa en el embalse Yacyretá. Final Report. Agreement EBY-FCEQyN- MERNRyT, Posadas, Misiones, Argentina, 53 p.

Iwaszkiw, J. M. 2001. Pesquerías Continentales Cuenca del Plata - Recopilación de la Legislación Nacional, Convenios y Tratados sobre pesquerías CFI (http://negocios.cfired.org.ar).

Leitch, W.C. 1991. Argentine trout fishing. A fly fisherman's guide to Patagonia. Frank Amato Publications, Portland, Oregon, 192 pp

López, H.L., C.R.M. Baigun, J.M. Iwaszkiw, R.L. Delfino, and O.H. Padin. 2001. La Cuenca del Salado: uso y posibilidades de sus recursos pesqueros. Editorial de la Universidad de La Plata, La Plata, Buenos Aires, Argentina. 87 p.

López, HL., AM. Miquelarena and RC. Menni. 2003. Lista comentada de los peces continentales de la Argentina. PROBIOTA, Serie Técnica y Didáctica 5:1-90.

López, H., A. Miquelarena and Ponte Gómez. 2005. Biodiversidad y distribución de la ictiofauna mesopotámica. In: F.G. Aceñolaza (Ed.), Temas de la Biodiversidad del Litoral Fluvial Argentino, INSUGEO, Miscelanea 14: 311-354, Tucumán, Argentina.

Lopez, H.L., L.C. Protogino, and A.E. Aquino. 1996. Ictiología continental de la Argentina:Santiago del Estero, Catamarca, Córdoba, San Luis, La Pampa y Buenos Aires. Aquatec 3: 1-14. La Plata, Buenos Aires, Argentina.

Macchi, P.J. 2004. Respuestas de *Galaxias maculatus* a la depredación por parte de *Percichthys trucha* y los salmónidos introducidos en ambientes lénticos de la Patagonia norte. Doctoral Thesis. Universidad Nacional del Comahue. Bariloche. Argentina.

Macchi, P.J., P.H Vigliano, M.A. Pascual, M.F. Alonso, M.A. Denegri, D. Milano, M. García Asorey, and G.E. Lippolt. 2005. Historical policy goals for fish management in Northern Continental Patagonia, Argentina: a structuring force of actual fish assemblages? En: Nielsen, J., J. Dodson, K. Friedland, T. Hamon, N. Hughes, J. Musick, and E.Verspoor, editors. Proceedings of the Fourth World Fisheries Congress 2004. Reconciling fisheries with conservation: the challenge of managing aquatic ecosystems. American Fisheries Society, Symposium In press.

Marini, T.L. 1936. Los salmónidos en nuestro Parque Nacional Nahuel Huapi. Sociedad Científica Argentina 121:1-24.

Modenutti B.E., C. Balseiro, D.A. Añon Suárez, M.C. Diéguez, and R.J. Albariño. 1998a. Structure and dynamics of food webs in Andean lakes. Lakes and Reservoirs: Research and Management 3:179–186.

Modenutti, B. E., E. Balseiro, M.C. Dieguez, C. Queimaliños, and R. Albariño. 1998b. Heterogenity of fresh-water Patagonia ecosystems. Ecología Austral 8:155-165.

Ortubay, S., L. Semenas, C. Ubeda, A. Quaggiotto and G. Viozzi. 1994. Catálogo de peces dulceacuícolas de la Patagonia argentina y sus parásitos metazoos. Subsecretaría de Recursos Naturales, Río Negro, Argentina, ISBN 987-95272-0-8, 110 pp.

Pascual, M.A., P. Bentzen, C. Riva Rossi, G. Mackey, M. Kinnison and R. Walker. 2001. First documented case of anadromy in a apopulation of introduced rainbow trout in Patagonia, Argentina. Transactions of the American Fisheries Society 130:53-67.

Pascual, M.A., V. Cussac, B. Dyer, D. Soto, P. Vigliano, S. Ortubay and P. Macchi. (in press) Freshwater fishes of Patagonia in the 21st Century alter a hundred years of human settlement, species introductions, and environmental change. In C.K Minns & M. Munavar (Eds.) Fresh Water Fishes, Their Biodiversity, Fisheries and Habitats: Health and Prospects.

Pascual, M.A, P. Macchi, J. Urbansky, F. Marcos, C. Riva Rossi, M. Novara and P. Dell'Arciprete. 2002. Evaluating potential effects of exotic freshwater fish from incomplete species presence-absence data. Biological Invasions 4:101-113.

Popolizio, E. 2004. Estudio del macrosistema Iberá. Tomo II. Geomorfología. Revista Nordeste- Investigación y Ensayos. 2da Época. 22:1-122.

Quirós, R. 1990 . The Paraná River Basin and the changes in the lower basin fisheries. Interciencia 15: 442-451.

Quiros, R. 1990. Predictors of relative fish biomass in lakes and reservoirs of Argentina. Can. J. Fish Aquat. Sci. 47: 928-939.

Quirós, R. and Cuch, S. 1989. The fisheries and limnology of the Lower Plata Basin. Dodge, D. P. Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. Aquat. Sci. 106: 429-443.

Quiros, R., J.J. Rosso, A. Rennella, A. Sosnovsky, and M. Boveri. 2002. Estudio sobre el estado trófico de las lagunas pampeanas. Interciencia (Venezuela) 27: 584-591.

Ringuelet, RA, R.H. Aramburu, and A. Alonso de Aramburu. 1967. Los Peces Argentinos de Agua Dulce. Provincia de Buenos Aires, Gobernación: Comisión de Investigación Científica.

Riva Rossi, C. 2003. Origen y desarrollo de historias de vida alternativas en poblaciones introducidas de trucha arco iris (Oncorhynchus mykiss) en Patagonia. Doctoral Thesis. Universidad Nacional del Comahue. Bariloche.Argentina.

Tulian, E.A. 1908. Acclimatization of American fishes in Argentina. Bulletin of the Bureau of Fisheries, USA 18:957-965.

Urzua Vergara, 1992. Uso Múltiple de los Recursos Naturales de la Cuenca Binacional del "Puelo" (Río Negro – Chubut – X Región). Centro de

Investigación y Extensión Forestal Andino Patagónico, Esquel, Chubut, Argentina. 146 pp.

Vargas, F; J. A. Bechara, J.P. Roux and S. Sánchez. 2004. Propuesta para mejorar la explotación de los recursos pesqueros en Puerto Antequera (Provincia del Chaco). Final Report submited by Instituto de Ictiología del Nordeste (INICNE) to Subsecretaría de Medio Ambiente de la Nación, Corrientes (Argentina), 66 pp.

Vigliano, P.H. and M. Alonso. 2000. Potencial económico de la pesca recreacional en la Argentina: una forma de pesca artesanal poco conocida y su posible impacto en economías regionales de países no desarrollados. Gayana Zoológica, Chile. 64:109-114.

Vigliano, P.H. and M.F Alonso, In press. Salmonid Introductions in Patagonia: a mixed blessing. En: Bert, T.M. ed. Ecological and Genetic Implications of Aquaculture Activities. Kluwer Academic Publishers, Nordstadt. The Netherlands. 00-00. 2002 (anticipated).

Vigliano, P.H. and G. Darrigran. 2002. Argentina's Freshwater Systems, Aliens In Wonderland. Pages 25-44 in Proceedings of the 11th International Conference on Aquatic Invasive Species, 25-28 February 2002, Alexandria, VA. The Professional Edge, Pembroke, ON.

Vigliano, P.H. and F. Grosman, 1997. Análisis comparativo entre las pesquerías recreacionales de Bariloche, Pcia. de Río Negro y de Azul, Pcia. de Buenos Aires, Argentina. Medio Ambiente. Chile. 13 (1) 80 - 87

Vigliano, P.H. and G. Lippolt, 1991. El factor humano de la pesca deportiva y recreacional de salmónidos en el lago Fonck, provincia de Río Negro, Argentina. Medio Ambiente, Chile 11 (2) 69-78.

Volante, J.N., J.L. Garrido, J.J. Sauad, and V. Picon Matorras. 1997. Análisis de la pesca deportivo-recreacional en la provincia de Salta. Manejo de Fauna, Publicaciones Técnicas 4(8): 1-11.

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