

PART II. RESPONSIBLE FISHERIES MANAGEMENT PRINCIPLES FOR LARGE RIVERS IN LATIN AMERICA

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INTRODUCTION

Throughout most of their courses, large rivers constitute highly complex river-flood plain systems in time and space. This complexity, together with human preference for settling along the margins and plains, makes these systems very complicated to manage. Waters from the upper tracts carry the necessary nutrients to sustain the high productivity of flood plains, as well as polluting substances resulting from development that are potentially toxic to the biota. Transformations to the physical environment, such as the construction of dams, channels or irrigation intakes, further contribute to the complications of fisheries management.

All fisheries depend on complex interactions between fish, fishers, the environment which the fish depend on, and the social environment in which the fishers live. The great complexity of the factors interacting in large river fisheries has been recently summarized in a comparison by Hoggarth *et al.* (see Table 1). Inter-annual variability in the intensity and duration of flood periods for a large river leads to a natural oscillation, sometimes abrupt, in the abundance of most fish species from one year to the next. From the standpoint of the fishery, this phenomenon results in fish catches by fishers being dependent upon river characteristics in the years when the captured fish were born.² In summary, this type of fisheries naturally display a high variability in captures (Welcomme, 1985).

Table 1. Characteristics of large river fisheries compared to other fisheries managed in a relatively simpler manner*

Resource Component	Simple fishery (for example, lacustrine)	Large river fishery
Environment	Stable in time Simple habitat The resource is mainly used by the fishery	Seasonal fluctuations Flooding varies between years Many types of habitat The type of habitat varies between the different sites Strong competition for use of the resource
Fish	Single species or few species	Many species Variable behaviours and needs
Fisheries	Single fishing gear Commercial/capital intensive Similar fishers communities Few landing ports	Different types of fishing gear Artisanal/labour intensive Different types of fishing communities Many scattered landing ports

* From: Hoggarth *et al.*, 1999.

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² See Welcomme (1985) for an overall review and Novoa (1989), Quiros and Cuch (1989), and Smolders *et al.* (2002) for reviews of the middle Orinoco River, the lower Plata basin and the lower Pilcomayo River, respectively.

Fisheries management requires first a decision on the objective for which the fishery is oriented or will be developed. In the more economically developed regions, characterized by recreational fishing, the approach is to develop conservation and management measures for those fisheries. However, in less developed economies, where fishing is a source of food, the approach is to focus on the immediate needs of human consumption. The complexity of fisheries in large rivers (see Table 1) does not facilitate fisheries management as simple as that required by lacustrine fisheries (Welcomme, 2001). This generalization is, within its limitations, usually valid for Latin America even though many exceptions could be mentioned for the region. It is common to see along a large river that more developed tracts of the river are mixed with others less developed. The basins of large Latin American rivers usually encompass several countries, many with different levels of development. However, it is also common to find differences in river development within one national state. For example, in the lower Plata Basin, both strategies co-exist within the same tract of the Paraná River. Given the lack of clear fisheries management, conflicts arise between recreational, industrial and artisanal fisheries (Quiros, 2003).

The principles for sustainable fisheries in inland waters reviewed in this paper are based on the Code of Conduct for Responsible Fisheries (FAO, 1995a) and on guidelines for the application of the precautionary approach to capture fisheries and species introductions (FAO, 1995b) as developed by FAO for application in capture fisheries (FAO, 1997a), aquaculture (FAO, 1997b), and inland fisheries (FAO, 1997c). The application of sustainable fisheries principles to large rivers includes particular issues analysed within the Latin American framework.

FISHERIES MANAGEMENT IN LARGE RIVERS OF LATIN AMERICA

Fisheries in large rivers in Latin America have been intensely developed in the last decades (see Quiros, 1988, 2003; COPESCAL, 1999; and Petrere *et al.*, 2002). Some noteworthy changes have occurred in the fisheries of large rivers in the region especially in the last 15 - 20 years. Fisheries for large catfish developed throughout much of the Amazon River basin, and the capture areas for *Colossoma* expanded significantly, while exploitation intensified in historic capture areas. In addition to the signs of "over-exploitation" of *Colossoma* in the middle tracts described above (Bayley and Petrere, 1989), recent reports indicate an increase in fishing effort and environmental pressure on catfish fisheries (COPESCAL, 1999). In addition to the observed reduction in catfish length and abundance, an increase has been seen in total fishing effort as well as environmental deterioration attributed to the oil and mining industries, drug processing and forest felling along river margins. The capture of juveniles for ornamental purposes represents an additional effort on catfish stocks in the Amazon region (COPESCAL, 1999). Exploitation of *Prochilodus* sp. and *Leporinus* sp. in the lower Plata basin fisheries intensified significantly, while the abundance and mean length of large catfish and other preferred large species continued to decrease (Quiros and Cuch, 1989; Quiros, 1990). River tracts near the Paraná-Paraguay confluence are mainly managed for sports fishing (Quiros, 2003), as are tracts in the upper basin of the Paraguay River (Petrere *et al.*, 2002). Regulation of the Paraguay River continued to increase in the upper basin, and industrial development and agriculture intensified (Quiros, 2003). Fishing in "slow river" type reservoirs of the upper basin displayed the expected low yields (Gomes and Miranda, 2001; Petrere *et al.*, 2002). On the other hand, fisheries in the Orinoco continued at a moderate to intense exploitation level, as described by Novoa (1989), and the Magdalena River suffered a significant environmental and fisheries collapse that continues to show no sign of recovery.

Problems occurring in the fisheries of large rivers in Latin America exemplify those of large rivers generally and point to the need for responsible fisheries management. Basically two types of problems are involved. (COPESCAL, 1999). The first type are associated with factors external to the fishery (such as forest felling and the use of rivers to produce energy or to dilute excrement and toxics). The second type are internal to the fishery, such as the

development strategy (e.g., recreational use or food production or mixed use) or exploitation intensity. These two types of problems must be clearly recognized and treated in order to efficiently advance towards responsible fisheries management in large rivers (*sensu* FAO, 1995a, 1995b, 1997a, 1997c).

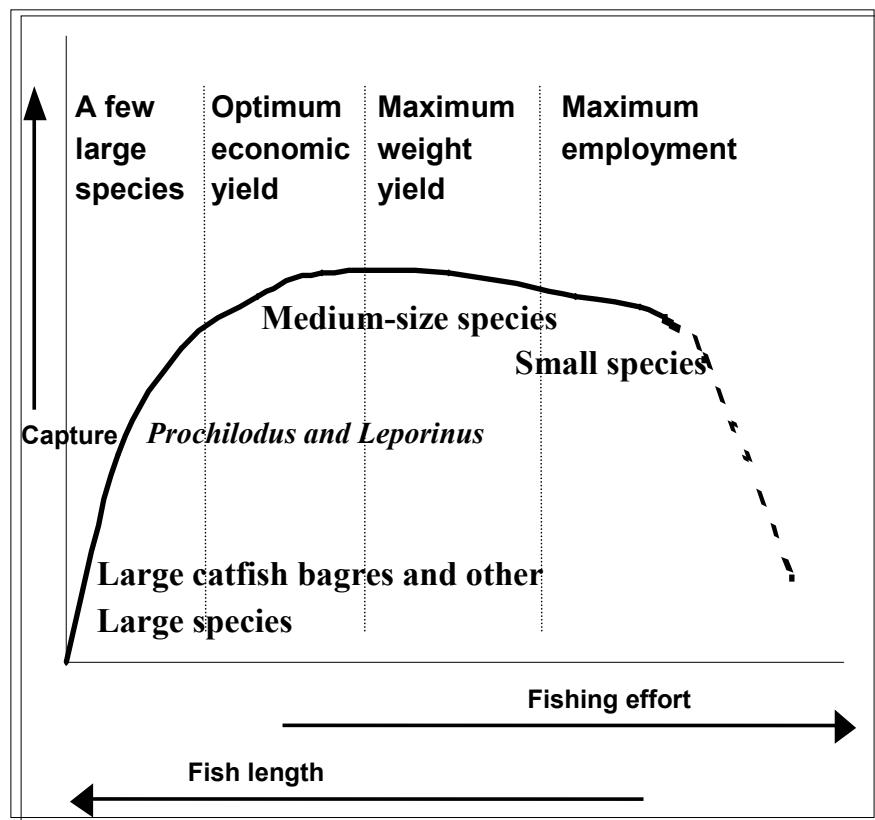
Several of the mechanisms that need to be applied for the responsible management of large river fisheries have already been analysed by COPESCAL (COPESCAL, 2000). The recommendations brought to the attention of FAO and the governments include the following.

- Encourage the adoption of inland fishery resource management plans for each watershed, so that ecological and production factors can be incorporated in an integrated manner.
- Promote formulation and implementation of management approaches favouring decentralization of decision-making and the transfer of relevant material resources to local administrative bodies.
- Assign fishers and their communities appropriate rights for the exploitation of fishery resources and support fishers' efforts to associate and to improve their access to the benefits derived from their activity.
- Promote harmonization of activities in inland and recreational fisheries, with a view to maximizing social benefits and ensuring food security.
- Take the necessary steps to improve institutional cooperation at national level and to ensure a healthy environment capable of sustaining inland fishery production and promoting aquaculture development.
- When implementing the Code of Conduct on Responsible Fisheries, special attention should be paid to introductions and transfers and the potential for disease transmission they entail.

The multi-specific fisheries model and large rivers in Latin America

The multi-species fisheries-multiple fishing gear model (Welcomme, 1985), is a description of the behaviour of total fish capture and its species structure in several large rivers throughout the world, given increased fishing and an escalation in development. This model predicts the behaviour of fish assemblages (including communities) when exposed to an increase in fishing and/or environmental pressure. As fishing pressure increases, the species preferred by the fishers, mostly those that reach greater lengths, disappear from the fishery and are replaced by others, usually smaller and of lower value. An example of this model, applied to large Latin American rivers, is presented in Figure 1.

Figure 1. Example of the multi-specific fisheries model for the main basins of Latin America



As initially proposed by Welcomme (1985), Coates (com. pers.) has developed a series of indicators, based on the multi-species-multiple fishing gear fisheries model, that describe the status of the fishery and, in addition, which management measures may be taken. This approach is shown in Table 2, which also outlines our possibilities for managing and exploiting large river fisheries. Fisheries in the large Latin American river basins fit the multi-specific fisheries model when comparisons are made for the various tracts of large rivers.

For example, total fishing effort in a large portion of the Amazon Basin would be of a relatively low intensity. The species and lengths captured are of the highest economic value (COPESCAL, 1999). The continuous and uncontrolled entry of new actors into the fisheries could be one reason for the reduced yields (COPESCAL, 1999). On the other hand, only a small portion of the Plata River basin would be in this condition of relatively low development. In the lower basin, large catfish have suffered a significant decrease in length and abundance, while the catch of less valuable species, such as *Prochilodus* and *Leporinus* (among others), has increased (Quiros, 2003). In the upper basin, because of significant environmental pressure, species and lengths captured are of relatively lower economic value (Petrere *et al.*, 2001). Figure 1 is a qualitative depiction of the different states of the fisheries.

Table 2. Change in the “quality” of multi-specific fisheries capture as the fishing and/or environmental pressure increases*

Indicator	Trend
Capture level	Reduced capture in uni-specific fisheries Sustained total capture in multi-specific fisheries
Mean length	Disappearance of larger fish and reduction in mean length of given species Disappearance of major species and reduction in mean length of total capture
Number of species in capture	Initially, there is an increase in the number of species captured from few and large to many and small Eventually the number of species is reduced until the fishery is limited to a few small species
Type of species	Decrease and disappearance of potamodromous and anadromous species Decrease and disappearance of native species Increase in number of exotic species, where introduced Decrease and disappearance of upper trophic levels (predators) Decrease and disappearance of species requiring high levels of oxygen (eutrophication)
Response time	Reduction of the period between flood events and the response of the fishery target stock
Other indicators	Increased P/B ratio Increased mortality rates (Z and F) Increased incidence of diseased and malformed individuals (extreme pollution)

* Welcomme, 1985; modified by Coates (pers. com., 2003).

Requirements for the implementation of responsible fisheries management principles in large rivers

Large river fisheries constitute a special case for management measures, given that most of the development in river basins is controlled by interests different from the fisheries, such as those associated with hydropower production, navigation and agricultural, urban or industrial demands. FAO has highlighted the difficulty of applying the Code of Conduct for Responsible Fisheries (FAO, 1995) to inland fisheries, and has interpreted Code articles for these specific needs (FAO, 1997c). Most policies to allocate river fisheries resources and their physical context are subject to decisions made outside the fishery. Therefore, fisheries should be managed within the limitations imposed by these external sectors and, provided there is room for conventional fisheries management as such, emphasis should be placed on techniques to mitigate or rehabilitate external impacts. This requires that the measures to be taken be determined through negotiation mechanisms between water users, so as to protect fishing under a multiple use regime.

In addition to depending on other water users, management strategies currently used for inland fisheries will also affect the approaches to responsible fisheries. According to FAO (1997c), the four most common strategies used today are as follows.

- (a) Fishing for food on fish stocks dependent on natural reproduction and fertilization. In many cases, these fisheries are exploited at a level that exceeds the maximum sustainable yield, and result in changes to stock structures.
- (b) Fishing for food in small bodies of water undergoes significant improvements to take productivity above the natural levels of selected species. This type of management is becoming ever more common, and technologies are being adopted by a growing number of countries.
- (c) Recreational fishing, although at a small scale, is becoming more common and, as it develops, will tend to replace commercial fishing for food. Recreational fishing may contribute to food supply, since in many cases it is subsistence or artisanal fishing.
- (d) Very intense local exploitation of juveniles or small adults for trade of ornamental species.

Each one of these uses requires a different approach within the framework of responsible fisheries. For example, strategies (a) and (d) are similar to those applied to unlimited marine fisheries, as they seek not to manipulate stocks beyond the extraction of fish. In these cases, the FAO technical guideline recommendations for fisheries management (FAO, 1997a) must be taken into account. In addition, the approach in strategy (b) sometimes overlaps with aquaculture and thus, FAO technical recommendations for aquaculture development become relevant (FAO, 1997b). Overall, strategies (a) and (d) based on natural production and productivity, may relate well to Code articles aimed more at conservation. However, the other two strategies are more reminiscent of agriculture, as they aim to deliberately manipulate the inland water stock structure and productivity in the interest of society-defined food production or recreational purposes. Care should be exercised in interpreting the Code (FAO, 1997c) in relation to this issue. The strategies most relevant to large river fisheries are the first, third and fourth. However, the second strategy, based mainly on aquaculture, is becoming more relevant in highly regulated river tracts.

Some key points when considering the role of fisheries in development policies have been proposed by Payne (2000). Several of these are recommendations relevant to responsible fisheries management in large Latin American rivers, such as the following.

- Promote and adopt the FAO Code of Conduct for Responsible Fisheries.
- Improve the development of management systems shared with the community and, if necessary, consider granting responsible ownership of the resources or limiting access to these.
- Recognize the interdependence of fisheries with other water-using sectors and agriculture, leading to integrated policies and planning (i.e., at the basin level).
- Although aquaculture may not be a good activity for the poorest, appropriate technological alternatives should be explored (i.e., pens) as a way to diversify their means of subsistence.
- Application of stock intensification measures (i.e., stocking) and/or habitat recovery measures is the only realistic way to increase fishing yields. The need to recover the cost of intensification measures links this to community management.
- Evaluate the need for assistance aimed at the development and implementation of sectoral plans, and to facilitate the development of legislation leading to the integrated and planned use of resources and to obtaining benefits for the poorest.

- Evaluate the impact of globalisation on the availability of fish, and the role of trade agreements.
- Foster the generation of jobs by adding value to processing.
- Improve the capability for joint efforts in resource management.
- Address the need for credit and micro-credit schemes to help the artisanal sector get free of informal and gatherer/vessel owner loans.
- Address the need to increase collection of key information and decision-making capability at all institutional levels.

Hoggart *et al.* (1999) prepared a fisheries management strategy for river-flood plain systems summarizing the management principles for responsible fishing (Table 3). Although developed for Asian systems, many of the recommendations were considered applicable to large Latin American rivers, like the Amazon (COPESCAL, 1999). Under this approach, local fishing communities play an important role in managing habitats and stocks of resident or temporary fish that only travel short distances to complete their life cycles. On the other hand, in order to manage fisheries of large migratory species, it is necessary to have the technical and scientific collaboration of various parties: local, national and international, public and private (FAO, 1997c). It should be noted that there is a need for relevant and quality information to be shared among fisheries managers.

Part of the effort to manage fisheries in large rivers currently focuses on environmental management to mitigate the negative impacts of other activities on fishing (FAO, 1997c). Responsible fisheries management in large rivers implies environmental management suited to optimise fishing within the external restrictions imposed by other activities of social interest. The latter must be clearly agreed among all water users, as well as other stakeholders, and must prevail over time in order to increase the social benefits (Table 3). For example, the downstream effects of fisheries intensification measures applied to a river tract should be included in agreements to be reached between the various water users and other interested parties. In addition, stocking of desired species may be opposed by some parties interested in the protection and conservation of species (biodiversity). In principle, these parties may believe the preservation of certain species is a necessary condition for the sustainable use of a river. Obviously, even in cases where maximizing social benefits would require maximizing production through a few selected species, some agreements among all parties must be reached.

Community and decentralised management of river fisheries is desirable, in some cases, because unrestricted access may lead to an overexploitation of the resource. Restricting access to the fishery would seem to be a fisheries management measure capable of controlling total fishing effort and, in addition, its application would seem to be relatively simple (Welcomme, 2001). However, cooperation among the various organizations with jurisdiction over the fishery and the environment must be promoted. Education and training on the fundamental principles of responsible fishing among managers and members of other organized interested parties should be an important component in managing large river fisheries.

Table 3. Large river fisheries. Alternative management objectives to be selected by different social levels*

Objectives	International officials	National officials	Regional fisheries managers	Local communities
General				
Sustainability (of the following)	☒	☒	☒	☒
Ecology				
Biodiversity	☒	☒		
Conservation	☒	☒	☒	
Primary Use				
Food/Nutrition	☒	☒	☒	☒
Ornamental fish		☒	☒	
Sports fishing		☒	☒	
Social				
Income for fishers		☒	☒	☒
Equity/Distribution		☒	☒	
Employment		☒	☒	☒
Reduce poverty	☒	☒	☒	☒
Reduce conflict	☒	☒	☒	☒
Government				
Return to government		☒	☒	
Contribute to GDP		☒		
Income from exports		☒		

* From: Hoggarth et al., 1999.

In Latin America, the most important river basins are common to two or more countries. In order to ensure responsible fisheries exploitation in shared rivers, cooperation is necessary among neighbouring countries and with international organizations. The downstream effects of many intensification measures also merit the attention of international cooperation to ensure and maintain a sustainable resource. The need for information should not exceed the ability to manage it. However, countries that are members of basin management committees should ensure, as a long-term commitment, the regular compilation of information on the most relevant parameters (i.e., capture, effort, water and habitat quality, social indicators).

Several countries in the region are studying and analysing the application of norms for responsible fisheries in large rivers. In all cases and regardless of the type of fisheries management adopted, it is advisable that exploitation consider the recommendations of the Code of Conduct for Responsible Fisheries (FAO, 1995a) as adopted by FAO for application in capture fisheries (FAO, 1997a), inland fisheries (FAO, 1997c) and aquaculture (FAO, 1997b).

PART III. RESPONSIBLE FISHERIES MANAGEMENT PRINCIPLES FOR RESERVOIRS IN LATIN AMERICA

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INTRODUCTION

The principles for sustainable fisheries in inland waters are based on the Code of Conduct for Responsible Fisheries (FAO, 1995a) and on the guidelines on the precautionary approach to capture fisheries and species introductions (FAO, 1995b) as developed by FAO for application in capture fisheries (FAO, 1997a), aquaculture (FAO, 1997b) and inland fisheries (FAO, 1997c). The application of sustainable fisheries principles to reservoirs includes particular issues analysed within the Latin American framework. Several countries in the region have already explicitly included sustainable and responsible fisheries provisions in their regulations for fishing in reservoirs.

FISHERIES MANAGEMENT IN RESERVOIRS OF LATIN AMERICA

General issues

Fisheries management in reservoirs requires first a decision on the objective for which the fishery is oriented or will be developed. Two groups of basic strategies could be adopted for managing reservoirs for fishing purposes (Welcomme, 2001). In the more economically developed regions, characterized by recreational fishing, the approach is to develop conservation and management measures for those fisheries. However, in less developed economies, where reservoirs are a source of food, the approach is to focus on the immediate needs of human consumption. (Table 1). This distinction generally fits the Latin America situation, even though many exceptions could be mentioned. It is not uncommon to find both types of strategies applied to the same reservoir, with their associated conflicts.

When reservoir fishing is aimed at fish production, conflicts arise between the stakeholders of the water resource generally, and between those interested in the fisheries resources in particular. The conflicts are particularly intense among the latter concerning the abundance and sizes of certain species preferred by sports fishers (Quiros, 2003).

In Latin America, when the appropriate species (i.e. tilapia) is introduced in reservoirs located in relatively small river basins, fish yields are generally higher (30 – 60 kg/ha/year; Quiros, 1999). Remedios (2002) in his review on aquaculture in small reservoirs of Latin America and the Caribbean, notes the lack of reports on production and productivity obtained from extensive and semi-intensive farming in small reservoirs throughout the region. Venezuela reports productivity between 1 000 and 2 000 kg/ha/year when using organic waste and agricultural by-product-based feed farming techniques, and in Mexico extensive mono-species experiences have an average yield of 120 kg/ha/year and between 750 a 1 500 kg/ha/year with extensive multi-species farming. Maximum yields reported for the country have been 2 450 kg/ha/year in extensive farming with supplementary feed. For small reservoirs in Cuba, Fonticiella *et al.* (1995) maintain that average yields may vary between 1 500 and 5 000 kg/ha/year.

¹ FAO /FishCode Consultant

Table 1. Management strategy for inland fisheries in developed and developing regions*

	Developed regions	Developing regions
Objectives	Conservation/preservation Recreation	Food source Monetary income
Mechanisms	Sports fisheries Recovery of habitat Selective and environmentally acceptable stocking Intensive, discrete, industrial aquaculture	Fisheries for food Modification of habitat Intensification, intensive stocking and ecosystem management Extensive, integrated, rural aquaculture
Economy	Capital intensive Monetary benefit	Labour-intensive Protein production

* From: Welcomme (2001).

Mid-size reservoirs in northeast Brazil and Cuba show relatively high yields, mainly in exotic species, oscillating between 30 and 900 kg/ha/year (Quiros, 1998), with an average higher than 200 kg/ha/year for the Cuban reservoirs (Fonticiella *et al.*, 1995; Quiros y Marí, 1999). On the other hand, fish yields from large reservoirs located in the large river basins of Latin America are considerably lower in general, even in cases where the introduction of species that develop satisfactorily in small and medium-sized reservoirs has been attempted (Petrere, 1989). For example, large reservoirs in the upper basin of the Paraná River show yields of 2.1 to 11.5 kg/ha/year (Petrere and Agostinho, 1993). The short holding time of water in the large South American reservoirs makes these resemble slow rivers without floodplains. Usually, primary production in this type of reservoir is severely limited by light (Quiros, 1980). This characteristic, together with the lack of species appropriate for that type of environment, may contribute to the explanation of its relatively low fish yield (Gomes and Miranda, 2001).

Once stabilized, large reservoirs tend to exhibit highly variable fish yields. Like lakes, their yields depend on various external characteristics: the climatic area where they are located, the edaphic drainage features, and their morphometry. Therefore, it should be expected that, all else being equal, tropical reservoirs would potentially be more productive than those located in other latitudes or altitudes with shorter growing seasons. The time that water remains in the reservoir is an important aspect when determining productivity and potential fish yield. Holding time is partially determined by climate and morphometry, but also, significantly, by the placement of the reservoir in the river continuum. The reservoir drainage rate usually increases as its location is farther away from the riverhead and closer to its mouth. Therefore, it is to be expected that the naturally most productive reservoirs would be located in tropical and subtropical regions, over sedimentary geology and highly developed and fertile soils, relatively shallow and with comparatively high water holding values.

$$Y = a f(TDS / Z_{\text{mean}}) f(T_w) + b f(T_{\text{air}}) + \sum c_i f(\varepsilon_i) \quad [1]$$

[Y] = fish yield (kg/ha/year)

[f(X)] = function of reservoir characteristic X

[TDS] = concentration of limiting nutrient or correlation such as total dissolved solids (the latter only applied in low salinity waters)

[Z_{mean}] = mean depth (m)

[T_w] = mean water holding time (year)

[T_{air}] = mean air temperature (°C)

[ε] = other variables not explicitly included in the model, usually of biological and environmental nature, and related to the use of space.

Although the mathematical model expressed in equation [1] is not widely known, several approaches have been developed in the literature. For example, the direct relationship between fishing yield (Y, kg/ha/year) and the quotient of total dissolved solids (TDS) or the concentration of nutrients (usually total phosphorus) and mean depth (Z_{mean}) is the basis for the MorphoEdaphic Index (MEI; Ryder, 1965; Ryder *et al.*, 1974). The Schlesinger and Regier model (1982), that includes MEI and mean air temperature (T_{air}), has been recommended to estimate potential fish yield in reservoirs (Jackson and Marmulla, 2001). The direct relation with water holding time is found in the well-known Vollenweider model (1968) used to estimate nutrient concentration in a reservoir based on its load of nutrients.

Reservoirs, however, present a fundamental difference from most lakes: reservoirs usually do not have a balanced fish community resulting from the co-evolution with their environment. Fish assemblages resulting from impounding rivers are generally formed from the ichthyo-fauna of the original river. However, many of these species are incapable of adapting to the new regime, and rapidly disappear from the main body of the reservoir (Welcomme, 2001). It is not unusual for the pelagic areas of reservoirs to exhibit fish depletion, an effect that could be reflected in a fish yield lower than forecasted from external characteristics of the reservoir (see equation [1]). It is advisable to introduce lacustrine species in these cases, to offset the relatively low fish yield, usually carp and tilapia in small and medium-sized reservoirs (Cuba, NE Brazil) and clupeids in large reservoirs. In some cases, for example, when mixed use was sought in reservoirs for fish production and sports fishing, in addition to stocking carp and tilapia, predators such as "black bass" (Cuba, Panama, Brazil) or *Cichla sp.* (Panama, various Brazilian reservoirs) were introduced.

If we closely observe the structure of the equation [1], we can deduce what reservoir characteristics can quite easily be controlled by humans to increase yield. One of these relates to increasing nutrient concentrations in the water through fertilization; a second deals with the use of space (pens and enclosures); and a third entails manipulating fish assemblages. The type and intensity of intensification measures to be applied in a particular reservoir usually depend on its size (Table 2). As previously proposed by FAO, commonly applied intensification measures make reservoir fisheries resemble agricultural and cattle-raising activities more than classic capture fisheries (FAO, 1997c).

Table 2 shows that fish yield expected from applying intensification measures varies by approximately one order of magnitude in each type of reservoir. It is obvious that the yield obtained will depend on the type and degree of intensification measures applied, as well as on the level of control resulting from the fishery and environmental management of the reservoir.

Table 2. Reservoir characteristics and management for responsible fisheries, according to size

Type of reservoir	Small	Medium	Large	Very large
Most frequent location	Very small rivers	Small to medium rivers	Large river heads	High and mid tracts of large rivers
Natural productivity	Medium to high	Medium	Medium to high	Low
Productivity after intensification	400-6 000 kg/ha/ year	100-1 500 kg/ha/ year	40-500 kg/ha/year	20-300 kg/ha/year
Most frequent intensification measures	Elimination of undesired species Stocking and restocking External feeding and fertilization	Introduction of species Stocking Stocking and restocking Fertilization	Introduction of open water colonizing species Growing pens and/or enclosures	

From the perspective of fisheries management, the differences among reservoirs should dictate that not all reservoirs be managed in a similar manner. The advantages of applying one or several fisheries intensification measures currently available (Petr, 1998) should be analysed in the context of the desired exploitation and reservoir size. Small and very small reservoirs, in addition to naturally being more productive, are usually the most appropriate, from the cost-benefit standpoint, to implement such intensification techniques as the elimination of undesired species, and the stocking, harvesting, and restocking of desired species. External fertilization and feeding may lead these reservoirs to yield high production levels (Table 2). In the region, various groups of mid-sized reservoirs are used for farming fisheries (i.e., Cuba, northeast Brazil). The most common intensification measure applied is stocking desired species, such as tilapia and carp. In some cases, natural fertilizers are also used, resulting in higher yields. Fisheries management in large reservoirs on large rivers requires techniques to supplement fish assemblages by introducing open water species, as well as fish farming in floating cages, and the intensive use of shallow bays for pens and enclosures. The use of pens to increase reservoir production is a practice commonly used in countries such as Brazil, Mexico, Chile, Colombia and Costa Rica (Welcomme, 2001), and their use is rapidly extending to reservoirs in other countries of the region.

Requirements for implementing responsible fisheries management principles in reservoirs

Inland fishing in reservoirs is a special case when it comes to management, mainly due to the fact that most reservoirs are controlled by interests different from the fisheries, such as hydropower generation, navigation, agricultural, urban, or industrial demands. This means that most policies to allocate fisheries resources to reservoirs and their physical context are subject to decisions made outside the fishery. Under these circumstances, States must adopt the necessary measures to protect reservoirs by expanding their participation in basin

management (FAO, 1997c). This, in turn, requires extending the principles of Article 10 of the Code of Conduct to include river basins and lakes, and establishing negotiation mechanism to protect inland fisheries under a multiple use regime.

In addition, fisheries management strategies currently used in inland waters affect the approaches adopted under the Code of Conduct. The four current strategies are:

- (a) Fishing for food on fish stocks dependent on natural reproduction and fertilization. In many cases, these fisheries are exploited at a level that exceeds the maximum sustainable yield, and result in changes to stock structures.
- (b) Fishing for food in small bodies of water undergoes significant improvements to take productivity above the natural levels of selected species. This type of management is becoming ever more common, and technologies are being adopted by a growing number of countries.
- (c) Recreational fishing, although at a small scale, is becoming more common and, as it develops, will tend to replace commercial fishing for food. Recreational fishing may contribute to food supply, since in many cases it is subsistence or artisanal fishing.
- (d) Very intense local exploitation of juveniles or small adults for trade of ornamental species.

Each one of these uses requires a different approach within the framework of responsible fisheries. For example, strategies (a) and (d) are similar to those applied to unlimited marine fisheries, as they seek not to manipulate stocks beyond the extraction of fish. In these cases, the FAO technical guideline recommendations for fisheries management (FAO, 1997a) must be taken into account. In addition, the approach in strategy (b) sometimes overlaps with aquaculture and thus, FAO technical recommendations for aquaculture development become relevant (FAO, 1997b). Overall, strategies (a) and (d) based on natural production and productivity, may relate well to Code articles aimed more at conservation. However, the other two strategies are more reminiscent of agriculture, as they aim to deliberately manipulate the inland water stock structure and productivity in the interest of society-defined food production or recreational purposes. Care should be exercised in interpreting the Code (FAO, 1997c) in relation to this issue. The first three strategies are relevant to reservoir fisheries. The impact of external forces contributes to aggravate the situation since in many cases it restricts fishing and adds to other factors that lead to unsustainability.

Currently, some reservoir fisheries management efforts are aimed at environmental management to mitigate the adverse impacts of other activities (FAO, 1997c). Responsible fisheries management in reservoirs implies environmental management to optimise the fishery within the external limitations imposed by other social interest activities. The latter should be clearly agreed among all water users, as well as other stakeholders, and must prevail over time in order to increase the social benefits of reservoirs. For example, the downstream effects of fisheries intensification measures implemented in a reservoir should be included in the necessary agreements to be achieved among the various water users and other interested parties. Some parties interested in the preservation and conservation of species (biodiversity), for instance, might be opposed to the elimination of undesirable species, stocking of desirable species, and the stocking, harvesting, and restocking of desired species. Such parties may consider that the conservation of species is a necessary condition for sustainable use. Obviously, even in cases where maximizing social benefits would require increasing production through a few selected species, agreements between all parties should be reached.

Community and decentralized reservoir fisheries management is desirable in certain cases, as unrestricted access to the resource may lead to overexploitation. Restricting access to the fishery seems to be a fishery management measure capable of controlling total fishing effort and, in addition, its application would seem to be relatively simple (Welcomme, 2001). However, cooperation between the different organizations with jurisdiction over the fishery

and the environment must be promoted. Education and training on the fundamental principles of responsible fishing among managers and members of other organized interested parties should be an important component in reservoir fisheries management.

In Latin America, several large reservoirs are located in border areas of two or more countries of the region. In order to ensure responsible fisheries exploitation in shared reservoirs, cooperation is necessary among neighboring countries and with international organizations. The downstream effects of many intensification measures also merit the attention of international cooperation to ensure and maintain a sustainable resource.

Some countries in the region, specifically Mexico and Cuba, have already included sustainable and responsible fisheries provisions in their legislation for reservoir fisheries. Several other countries have developed them and are awaiting definitive approval. Finally, there is a small group of countries that, although having studied and analysed the application of norms for responsible reservoir fisheries, have not yet included these in their legislation, or in the effective management of reservoir fisheries. In all cases and regardless of the type of fisheries management adopted for reservoirs, it is advisable that exploitation consider the recommendations of the Code of Conduct for Responsible Fisheries (FAO, 1995a) as adopted by FAO for application in capture fisheries (FAO, 1997a), inland fisheries (FAO, 1997c) and aquaculture (FAO, 1997b).

PART IV. NATIONAL REPORTS

1. INLAND FISHERIES IN ARGENTINA

1.1 Situation and trends

Argentina obtains the majority of its fresh water fisheries product from the Plata River basin (3 100 000 km²). Other non-river environments are exploited at the recreational level and sometimes for commercial purposes, without any fisheries management. The Plata River Basin has been deteriorated by various factors. Its artisanal and multi-specific fisheries are prosecuted from canoes and flat-bottom boats and in few cases, slightly larger vessels. Fishing gear mainly consists of trammel nets and gillnets or "mallones", with mesh sizes regulated and controlled by the corresponding authorities.

Among the negative factors affecting the fisheries, the following are the most important:

- (a) closing of the large rivers (Paraná and Uruguay) by dams: Yaciretá on the Paraná and Salto Grande on the Uruguay in Argentina and Itaipú (Brazil) upstream from the Paraná;
- (b) increased pollution, particularly from agricultural activities, together with industrial discharges impacting the Plata River; and
- (c) overfishing in the Paraná-Paraguay, particularly along the Argentina-Paraguay border on high value commercial and sports fishing species and probably, nowadays, in the middle and lower basin.

Exploitation of the lower basin for export purposes has increased dramatically since 1994, leading to an upward trend in river fisheries from an historic average 10 000 mt/year to more than 30 000 mt in the year 2000.. This increased pressure has had particular impact on "sábalo" (*Prochilodus lineatus*), which is now regarded by some technical experts as being dangerously over-exploited. There is insufficient information from the Basin to confirm this, but if statements from the cold storage industry are to be believed, the problem is serious. Reports indicate that there is a high percentage of discards at the plants, in addition to the extraction of sizes smaller than permitted.

A decrease in large carnivores (surubí and dorado) has been observed for the past 20 years. Recent research has indicated that the species that has benefitted most by dam regulation of the river has been "sábalo" (particularly in the lower basin), which, given its detritus-eating habits, is able to make effective use of readily available nutrients and organic matter.

Fisheries production in large rivers is closely related to the space and time characteristics of the respective drainage basins, flooding and the intensity of floods in years prior to the capture. Together with weather conditions and pollution, flooding intensity would affect fish spawning and subsequent recruitment, particularly in the first year of life. The Paraná River has exhibited low volumes for the last three years and this, together with the heavy exploitation of the fisheries, could negatively affect the stocks and fishing production. The "sábalo" has a positive relation to flooding plains and it reproduces well in lagoons or flooded areas, so mortality is high in dry or low river volume years. Fishers have noted a decrease in fisheries throughout the basin, and they report finding "nothing to fish". This notably affects their lifestyle, along with the fact that several provinces have decreed closures to favour sports fishing. The situation has had a particularly high social impact in the upper basin, on the Paraguay and Paraná rivers and more recently in the middle and lower basin.

1.2 State of management

From the mid 1990s little progress has been registered in terms of inland fisheries research that would allow a correct assessment of the current state of commercial fisheries in the Plata River Basin. Existing data are insufficient to allow assessment of basin resources and even less, to commence fisheries management. The FAO-COPESCAL Workshop organized in Uruguay (1993), indicated the basic management aspects and established the guidelines for developing a project for the “conservation, management and rehabilitation of living aquatic resources in the Plata River Basin”, and for the application of techniques to mitigate impacts caused by dams and other anthropogenic effects.

The reform of the Argentinean State in the beginning of the 1990's incorporated plans for the re-adaptation of fisheries resources (marine and inland) research and management organizations and of fisheries and aquaculture administrations. To support the reform, the government requested technical cooperation from FAO (TCP/ARG/9155) for Fisheries Planning and Research (1991-1993). However, the primary objective was later established for marine fisheries and aquaculture in general, delaying issues associated with management in inland waters.

Before the reform, inland fisheries research was led by the Department of Inland Waters and Aquaculture of the National Fisheries Development and Research Institute (INIDEP). The priorities established for the Plata River Basin allowed progress in researching fisheries resources in the Uruguay and later in the Paraná and Plata basins, in addition to including studies on pollution and impact to habitats caused by damming.

The constitutional reform of 1994, Article 124, established that natural resources are the property of the provinces of the Argentinean territory (in a federal political organization) and there was a “transfer” of responsibility for fisheries studies, control, statistics and management. Since 1994, therefore, the national territory as a whole has lacked a unified system for inland fisheries statistics collection.

The strong economic crisis that started in Argentina in the last decade negatively influenced the availability of resources earmarked for studying river fisheries by the provinces included in the Plata River Basin, resulting in a general absence of fisheries management at the basin level.

The first attempt to reduce fishing extraction in the middle and lower basin was in the form of an agreement in late 2002 between the two provinces that primarily exploit “sábalo”. The agreement aimed at reducing exploitation of the species to a level of 10 000 mt per year (total limit for both domestic and external markets), until new studies are carried out. There was also a partial closure of the fishery in one of the provinces, because the registry of buyers was closed.

1.3 Management actions foreseen

The only progress on the international front regarding inland fisheries resources is the bi-national Agreement signed with Paraguay (1998) that initiated establishment of rational fishing criteria for the resources shared in the border tracts of the Paraná and Paraguay rivers. It adopted the current approach of understanding the exploitation of shared fisheries in the upper basin. The result of this joint action was made concrete in the harmonisation of the legislation in force, agreement on single fisheries regulations and joint participation in controls, establishment of reserves and plans of action to safeguard migratory fish. Joint scientific-technical cooperation is also promoted.

Within the Argentinean territory, given the evident lack of studies related to river and other fisheries, the Secretary of the Environment and the Fisheries Management Authority in 2002 signed a Cooperation Framework Agreement with a mandate to update studies (re-establishing research in inland waters by INIDEP) within the geographic scope of the Plata River Basin. The objectives were to implement fisheries management and advance their sustainable use.

It still has not been possible to harmonise criteria for fisheries management in the basin among the seven provinces that share the resource. The recent agreement signed for the middle and lower basin attempts to make the legislation compatible and to establish common quotas for "sábalo". Environmental organizations began a large movement in relation to the above-mentioned "over-exploitation of the lower basin." This resulted, among other things, in a focussing of support from provincial governments and provincial departments of justice (original parties to the agreement) as well as national level agencies for the identification of a methodology that would permit more efficient control, with updated data, to decrease current exploitation of river fisheries.

Prompted by these actions, and in the absence of fisheries management policies and measures coordinated at basin level and by the absence of joint action by provincial and national authorities, a Draft Inland Water Fisheries and Natural Resource Protection Law has been formulated that proposes the following priority lines:

- creation of the Federal Inland Fisheries Council, comprised of representatives from all the provinces [the Secretariats of Fisheries Management and Environment and Foreign Affairs], which would establish the Secretariat of Agriculture, Livestock, Fisheries and Food (SAGPyA) as Application Authority;
- division of the national territory by basins under Law;
- emphasis on the need for joint studies between the provinces and the national level;
- determination of INIDEP activities for updating studies and/or their supervision, with the incorporation of provincial technicians.

The Draft Bill was submitted, corrected and accepted by the corresponding Commission of the National Congress in December 2002. It will be necessary to await processing and the formation of the Federal Council to be created by the Law (if approved), to then undertake the formation and start up of the basin Councils and thus determine the studies to be carried out, to improve management at the national level.

2. INLAND FISHERIES AND AQUACULTURE IN BRAZIL

2.1 Situation and trends

The largest river basins in Brazil are the Amazon, Paraná, São Francisco, Northeast and Southeast. All of them have significant fisheries, although there is insufficient information on the phylogenetic relationships of the fish and their reproduction, growth and feeding habits. The simple taxonomic descriptions and life cycle studies have been limited to the largest and most commercially important species.¹

Regarding aquaculture production, Brazil has an enormous potential to expand. It possesses almost 12 percent of the planet's fresh water distributed in a wide network of rivers, lakes and about 5 000 000 ha of reservoirs, has a climate favourable to aquaculture, and contains abundant areas of land appropriate for aquaculture development.

The Amazon River Basin

The Amazon Basin is characterized by great heterogeneity in space and time, significant diversity of species and high fishing yields. Commercial fisheries exist within a radius of between 100 and 1 000 km from the large urban centres and impact a large number of species. Capture composition exhibits significant seasonal variations, while dominated, however, by corvina/pescada (*Plagioscion squamosissimus*), tucunarés and jaraquis (*Semaprochilodus insignis* and *Semaprochilodus taeniatus*), curimatá (*Prochilodus nigricans*), cachamai/tambagui (*Colossoma macropomum*)², piramutaba (*Brachyplatystoma vaillanti*) and ornamental species, particularly cardinal tetra (*Paracheirodon axelrodi*).

Fisheries resources as a whole are considered to be under-exploited, with localized or specific risks. Bailey and Petrere (1989) describe the decline of the larger species near the urban centres. Depletion in the stocks of some species landed in Manaus is described by Bittencourt (1991), who believes fisheries in this region are operating near maximum sustainable yield. But Bailey and Petrere (1989) state that extinction of the species, even with overfishing, is improbable if environmental conditions are maintained.

However, increased human settlements in the Amazon basin are endangering stocks and fishing yields in the region. Environmental disturbances caused by these settlements include mining, deforestation and construction of reservoirs. Measures are required to monitor and control such human interventions.

Paraná River Basin

In the Paraná River Basin, fish composition also exhibits a notable heterogeneity in space and time. In the more unrestricted parts of the basin, captures are mainly of large migratory species such as surubi pintado (*Pseudoplatostoma corruscans*), dorado (*Salminus maxillosus*), barbado (*Pinirampus pirinampu*), piaparas/bogas (*Leoporinus elegatus* or *L. obtusidens*), mandi/bagre amarillo (*Pimelodus maculatus*) and, more recently, armado (*Pterodoras granulosus*) (Petrere and Agostinho, 1993), with wide domination by the first two.

In the reservoirs of the upper basin, fishing is dominated by corvina/pescada (*Plagioscion squamosissimus*), mandis (*Pimelodus maculatus* and *Jheringichthys labrosus*),

¹ Petrere, 1994. Synthesis on fisheries in large tropical reservoirs in South America.

² Petrere, 1978a, 1978b, 1982; Bailey and Petrere, 1989.

curimba/curimbatá (*Prochilodus lineatus*), small Characids (*Astyanax* spp., *Moenkhausia intermedia*) and traíra/tararíra (*Hoplias malabaricus*)³.

In the Itaipu reservoir, landings consist of about 50 species, of which five represent 78 percent of the annual yield (1 600 tonnes). These are sardela (25%), corimba (19%), corvina/pescada (16%), armado (14%) and cascudo preto/vieja (*Rhinelepis aspera*, 4%) (Agostinho *et al.*, 1993b).

São Francisco River Basin

In the unrestricted areas of the basin, fishing is dominated by large migratory species such as surubi pintado (*P. corruscans*), curimatá (*Prochilodus marginatus*), and dorado (*Salminus brasiliensis*). Although somewhat important in the Sobradinho reservoir, migratory species, with the exception of curimata, are not significant in the Tres Marías reservoir fishery, where sedentary medium sized or lesser commercial value species are dominant⁴.

The San Francisco River basin has 11 reservoirs and an elongated area that represents about 23.3 percent of the total area of reservoirs in Brazil.

Northeast Basin

The Parnaíba River (362 000 km²) constitutes an important fishing region between the states of Maranhão and Piauí. Artisanal fisheries in the flood plains of Maranhão are influenced by the Pindaré, Grajaú and Mearim rivers, and are highly seasonal because they dry almost totally in the summer. During the ebb season, fishers capture Curimatá (*Prochilodus lacustris*, *Prochilodus cearensis*, *Prochilodus argenteus*), pescada (*Plagioscion* sp.) and piaus (*Schizodon* sp., *Leparinus* sp.), mainly using "tarrafas" (casting nets). Productivity varies from 50 to 250 kg/person/year, which are relatively low figures (Paiva, 1973, 1976).

In the public reservoirs of the Northeast basin, the most significant fisheries resources captured were Nile tilapia (*Tilapia niloticus*, 26%), pescada/corvina (*Plagioscion squamosissimus*, 22%), shrimp (*Macrobrachium* spp., 11%), tucunaré comum (*Cichla ocellaris*, 10,9%) and curimatá comum (*Prochilodus cearensis*, 6,4%) (Paiva *et. al.*, 1994). Fisheries production in the Northeast reservoirs has shown a decline, as adequate restocking has not occurred.

Southeast Basin

Two hundred eighty-five species have been listed for the Southeast Basin, of which 95 percent are endemic⁵. This basin sustains the largest urban concentrations in the country, which heavily impact its important ichthyofauna. The Southeast Basin rivers, the Paraíba, Doce and Jequitinhonha, are comparatively short and the main fisheries resources are tararíra (*Hoplias malabaricus*) and several bagres (*Pimelodidae*)⁶.

³ Torloni *et al.*, 1991; Correa *et al.*, 1993; Carvalho Jr *et al.*, 1993a et 1993b Moreira *et al.*, 1993. Produção pesqueira e composição das capturas no reservatório da UHE Mário Lopes Leão, Promissão, CESP, São Paulo. Série Pesquisa e Desenvolvimento, 62, CESP, 1991.

⁴ Agostinho, 1993. Estratificación especial y comportamiento de *Prochilodus scrofa* en distintas fases del ciclo de vida, en la planicie de inundación del alto río Paraná y embalse de Itaipu, Paraná, Brasil. *Revue d'hydrologie tropicale*.

⁵ Bizerri, Análise taxonômica e biogeográfica da ictiofauna de água doce do Leste Brasileiro. Acta Biológica Leopoldensia. 1994.

⁶ Petere, 1989. Op. Cit. p.1.

Paraguay River Basin

Professional and sports fisheries are traditional and mainly target large migratory species, such as cachara (*Pseudoplatytoma fasciatus*), pintado (*P. corruscans*), pacu (*Piaractus mesopotamicus*) and curimba (*Prochilodus lineatus*), contributing half of the fishing production exported to other regions, mainly the state of São Paulo.

Araguaia and Tocantins River Basins

Ichthyofauna in the Araguaia and Tocantins rivers is represented by close to 300 species, 126 genus and 34 families with a predominance of Characid, Siluridae and Cichlidae (Paiva, 1983; Santos *et al.*, 1984; Leite, 1993). Some authors consider the wealth of species in this basin to be low in comparison with the estimated 2 000 species in the Amazon River Basin (Lowe-McConnell, 1969; Roberts, 1972).

Large hydropower reservoirs

Regarding large hydroelectric power reservoirs, Paiva (1976) estimated the fisheries potential of the 46 largest reservoirs in Brazil to be about 123 091 tonnes/year. In the public reservoirs of the Northeast potential capture as a whole was estimated at 130 000 tonnes/year (Paiva, 1983).

2.2 State of management

Inland fisheries management in Brazil is very complex and therefore demands a broad negotiation process with the fishing communities involved. The measures adopted for the main basins and reservoirs vary according to the characteristics of the aquatic environments and that is the reason for adopting the hydrographical basin as the main unit for fresh water fisheries management.

The most important management measures include the definition of fishing seasons (closures), closure of fishing areas, protection of spawners, minimum capture size, fishing gear restrictions and limitation to levels of fishing effort.

It should not be forgotten that inland fisheries and aquaculture activities take place in complex environments and are subject to a series of internal and external effects. Thus, the main conflicts that exist are related to the use of certain fishing gear (allowed in some provinces but not in others) and to the relationships between artisanal fishers and the practices of the so-called sports fisheries.

Regarding aquaculture, several problems have limited its development. These include: the large number of species cultivated; lack of competitive production systems; lack of skilled labour; absence of modern feed, sanitary and environmental management techniques; and a lack of studies with a vision towards genetic improvement.

Even so, total production estimates for inland extractive fisheries and aquaculture in Brazil (Table 2.1 and Figure 2.1) for the period 1999 to 2002 shows a modest increasing trend, with an estimated 230 000 tonnes for 2002. However, production could be even larger if there were no disruptions caused by deforestation, mining, pollution from domestic waste, industry and the inputs used in agriculture, and construction of reservoirs (hydropower uses) that alter the habitats available for feeding and reproduction.

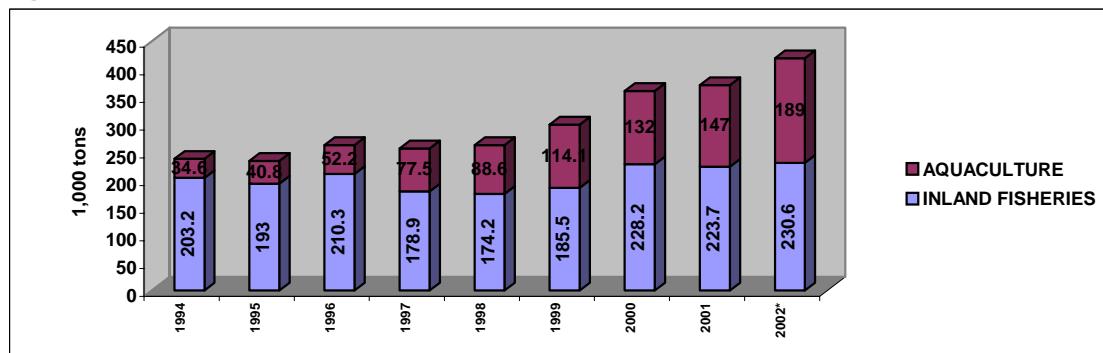
Table 2.1 Total and per environment production (in tonnes) of extractive inland fisheries and aquaculture for 1994 through 2002

Year	Inland fisheries	Aquaculture	Total
1994	203.2	34.6	237.8
1995	193.0	40.8	233.8
1996	210.3	52.2	262.5
1997	178.9	77.5	256.4
1998	174.2	88.6	262.8
1999	185.5	114.1	299.6
2000	228.2	132.0	360.2
2001	223.7	147.0	370.7
2002*	230.6	189.0	419.6

Source: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, IBAMA, 2002.

* Estimate: Ministério da Agricultura, Pecuária e Abastecimento-MAPA.

Figure 2.1 Inland fisheries and aquaculture (1994-2002)



2.3 Management actions foreseen

Inland fisheries resource management continues under the paradigm of seeking sustainable development. Thus, elaboration of management measures takes into consideration the best scientific data available, as well as the empirical knowledge of fishers. In order for this approach to be successful: (a) it is vital for the leaders to participate in the process and not only to be represented; (b) intense work is needed in clarifying the content of legal documents related to management, both for fishers as well as for fisheries supervisors; and (c) a transparent mechanism should be in place that would allow periodic reassessment of the efficiency of the process to achieve its objectives. To guarantee the effectiveness of management measures, cooperation has been promoted among the state organizations responsible for fisheries in each basin, including for the compilation and exchange of information related to research and fisheries management, harmonization of provincial regulations with federal legislation, and implementation of proposed fisheries management measures with the participation of fishers communities. Regarding development and promotion of inland fisheries and aquaculture, the priority activities established include articulation between actors and actions, stimulating production, promoting social inclusion and contributing to food security.

3. INLAND FISHERIES AND AQUACULTURE IN CHILE

3.1 Situation and trends

The very small scale inland fisheries occur in a coastal lagoon to the south of the country, where indigenous communities are involved in subsistence fishing, and in some altiplano lagoons and rivers featuring artisanal extraction of river shrimp.

Most inland bodies of water are used for recreational or sports fishing and about 50 000 fishers have been registered in the national territory.

3.2 State of management

There is no doubt that the most relevant economic activity in lakes and rivers of southern Chile is aquaculture to produce smolts, the initial step for the fattening phase of salmon production in marine waters. The 42 culture centres that operate directly on lakes and rivers were authorized before the entry into force of the current Fisheries and Aquaculture General Law. Later, given the procedures established in said regulation, no new inland water culture centres have been permitted. The demand from salmon producers has been satisfied by authorising land culture, where they have had to innovate and make technological investments in controlled circuit systems for the production of ova and smolts. These authorisations involve the right to non-consumptive use of water mainly from rivers and are subject to regulations on distance between centres and to compliance with effluent standards. In the last eight years the State has financed several studies in lakes with authorized centres and in others where smolt production of activities could potentially be established, for the purpose of assessing carrying capacity for nutrients from aquaculture as well as from other natural and anthropogenic sources. In general, the studies have concluded that aquaculture activities contribute, on average, no more than 15 percent of the total nutrients entering bodies of water. Most nutrients originate in other uses such as agriculture, forestry, cattle-raising and domestic waste from coastal human settlements.

Inland fisheries and aquaculture activities management are incorporated in the Fisheries and Aquaculture General Law of 1991. Regarding inland fisheries and specifically sports fishing, regulations associated with management and conservation measures exist (seasonal and area closures, number of specimens per fisher, fishing gear characteristics). All sports fishers must obtain and carry during their activities, a special license for certain regions of the country, and its cost varies depending on the region.

3.3 Management actions foreseen

A draft bill for recreational fishing was prepared in 2002, a process that included wide participation from the public institutions involved as well as from a broad spectrum of interested parties (sports fishing associations and clubs, universities, and non governmental organizations). This initiative incorporates objectives associated with local economic development and the conservation of resources targeted by recreational fisheries. The draft bill is expected to be submitted to Parliament in the first quarter of 2003 year and approval is expected by year's end.

Also during 2002, a proposed National Aquaculture Policy was prepared and broadly discussed, based on a comprehensive diagnosis of the different types of aquaculture and their special and cross-cutting advantages and challenges, including, very particularly, the

lack of institutional and legal conditions required for their development. From this diagnosis, a core objective for the policy was established, aimed at obtaining the maximum economic growth possible within a framework of environmental sustainability and equal access opportunities. This Policy is expected to become the benchmark for the public and private sector and to be the guiding instrument for coordination actions with other public policies and the basis for discussing modifications of the current legal and institutional framework.

4. INLAND FISHERIES AND AQUACULTURE IN COSTA RICA⁷

4.1 Situation and trends

Costa Rica has abundant water resources, but rivers and lakes with appropriate conditions for commercial fisheries are very few. Exploitation has been associated with sports or recreational fishing of native as well as exotic species; no permits have been issued for commercial exploitation.

Aquaculture in Costa Rica at this time is almost totally dominated by fresh water inland aquaculture of rainbow trout and tilapia. In 2002, over 12 850 tonnes of the latter were produced for domestic and international markets. For the same period, 350 tonnes of trout were produced for the domestic market. Culture in brackish water mainly involves shrimp, of the genus *Litopenaeus*, with a total production of 3 756 tonnes for 2002.

Prawns or Malaysia Giants are raised at a small scale, for a total production of about 8 tonnes per year. Table 4.1 and Figure 4.1 summarize this information.

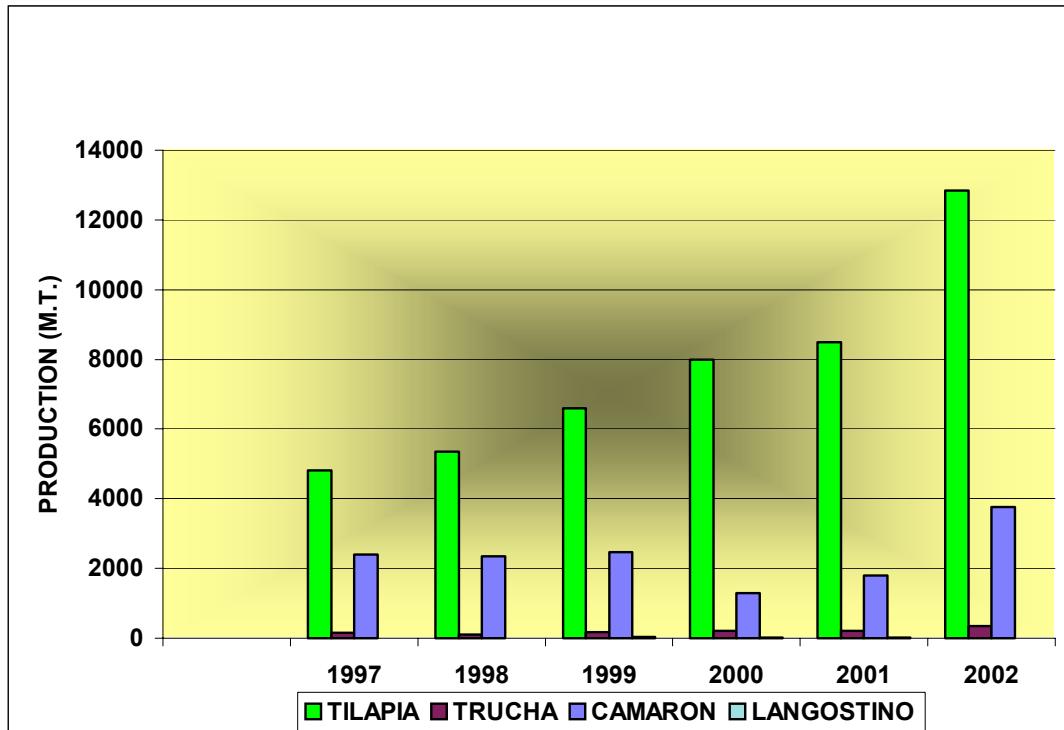
The number of producers has been significantly increasing, for a total of 1 143 in 2002, of which 75.2 percent produce tilapia, 16.6 percent produce trout, 7.9 percent shrimp and 0.30 percent "others," including fresh water prawns.

Table 4.1 Aquaculture production by species

Aquaculture production by species (1997-2002) (in metric tonnes)						
	1997	1998	1999	2000	2001	2002
Tilapia	4 817	5 346	6 588	8 000	8 500	12 850
Trout	152	104	181	200	210	350
Shrimp	2 404	2 348	2 465	1 300	1 800	3 756
Prawn	78.5	86.6	35	15	10	8
Total	7 373	7 798	9 269	9 515	10 520	16 964

⁷ Lic. Alvaro Otárola Fallas, Head of Aquaculture Department, INCOPESCA.

Figure 4.1 Aquaculture production by species in Costa Rica (1997-2002)



Source: Department of Aquaculture.

4.2 State of management

Resource management is the responsibility of the Ministry of Environment and Energy, according to Article 140, paragraph 3 of the Political Constitution of Costa Rica, under the Regulations for large and small game hunting and inland and island fisheries, Chapter VII, Inland Fisheries.

Said chapter establishes all prohibitions and authorizations concerning sports or recreational fishery species of great interest such as:

- trucha Arco Iris (*Oncorhynchus mykiss*);
- guapote (*Parachromis* spp.);
- róbalo (*Centropomus undecimalis*);
- sábalo (*Megalops atlanticus*);
- gaspar (*Atrostecus tropicus*).

Regulation mainly involves closures and minimum capture length.

Regarding management, some studies focusing on limnology aspects have been undertaken in bodies of water important to the country; however, no database exists to enable tracking capture statistics and management in the last ten years has focused on basin management. Currently, the Costa Rican Electricity Institute is developing a Management Plan for the Reventazon River basin and within the Central American Border Development Program. There is a Project called Formulation of an Integrated Plan of Action for Water Resources and the Sustainable Development of the San Juan River Basin and its Coastal Zone.

Although studies and efforts have been undertaken at the institutional level, these have been sporadic and have not guided by specific management plans for inland fishery resources.

An important aspect under study relates to the contamination of inland bodies of water and, to this effect, a direct negative effect has been observed over ichthyc stocks, caused by the indiscriminate use of pesticides, fertilizers and agro-industrial wastes.

Although there are no studies to prove it, the introduction of exotic species such as tilapia (*Oreochromis* sp.) and fresh water lobster (*Cherax quadricarinatus*) may be having a negative effect on native fish stocks.

Currently there is no fingerlings of native species stocking programme in inland bodies of water carried out by the government.

4.3 Management actions foreseen

A diagnosis is required in our country to obtain information on the current status of inland fisheries resources for more effective management. Given the economic limitations, a good starting point for such diagnosis would be the "Integrated Fisheries and Aquaculture Management Plan for Lakes, Lagoons and Reservoirs in the Central American Isthmus".

Among its specific objectives are:

- determining the fisheries and aquaculture potential of inland bodies of water;
- establishing a model for lake, lagoon and reservoir management with the participation of fishery and aquaculture organization representatives.

The plan will start this year and there are high expectations for its results.

5. INLAND FISHERIES AND AQUACULTURE IN EL SALVADOR

5.1 Situation and trends

El Salvador has 23 inland bodies of water, for a total area of 411 km². The number of inland fishers has been estimated to be 7 234 with 3 583 vessels (Table 5.1).

Table 5.1 Artisanal fisheries vessels, fishers and traders in El Salvador*

Description	Area	Amount	Total
Fishers	Marine	13 078	
	Inland	7 234	20 312
Vessels	Marine	6 180	
	Inland	3 583	9 763
Traders	Marine	200	
	Inland	117	317

* Source: Resumen nacional de encuesta de las actividades pesqueras con énfasis en la pesca artesanal, PRADEPESCA-CENDEPESCA 1995.

Inland artisanal fisheries are characterized by the prevalence of manual labour and the use of boats with capacity for two people in the fishing effort. About 60 percent of the boats are made of fiberglass with an average length of 4.6 meters, using outboard motors no larger than 15 hp; 40 percent are wooden rowboats. These vessels have no storage or preservation systems and their average fishing range is one day.

The most common gear are stationary gillnets, "atarrayas" or casting nets, harpoons and hooks. Some fishing practices consist of altering the habitat either by the use of sounds or

by altering the fishing grounds in order to increase capture, mainly of "tilapia" and "guapote tigre". The length and mesh sizes of gillnets and casting nets, depend on the regulations established by the Specific Fishing Regulations for the activity in each body of water.

Fishing is the main livelihood for families living in the communities and towns along the various bodies of water, as shown in Table 5.2. The capture reported by the Fisheries Development Centre (CENDEPESCA) for 2000 was 2 830 mt with a value of some US\$2.5 million, representing about 29 percent of the national production (Figure 5.2).

Table 5.2 Size of inland bodies of water in El Salvador

No.	Bodies of water	Area (km ²)
1	Cerrón Grande Reservoir	175.00
2	Ilopango Lake	72.50
3	15 de Septiembre Reservoir	35.00
4	Guija Lake	55.00
5	Coatepeque Lake	24.00
6	5 de Noviembre Reservoir	19.00
7	Olomega Lagoon	18.00
8	Metapán Lagoon	3.10
9	Los Negritos Lagoon	1.50
10	Managuara Lagoon	1.50
11	El Pilón Lagoon	1.50
12	El Jocotal Lagoon	1.20
13	El Espino Lagoon	1.00
14	Chamnico Lagoon	0.78
15	Apastepeque Lagoon	0.59
16	Verde Lagoon	0.50
17	Aramuaca Lagoon	0.26
18	Las Ninfas Lagoon	0.13
19	Chalchuapa Lagoon	0.50
20	Nauhualapa Lagoon	0.20
21	El Morán Lagoon	0.20
22	El Vijagual Lagoon	0.10
23	Alegría Lagoon	0.10
		411.66

Source: Documento peces nativos en vías de extinción en El Salvador, 1986.

There are 15 freshwater species targeted by the various inland fisheries (Table 5.3). As depicted in Figure 5.1, the contribution to national inland fisheries production is greatest for tilapia (42 percent), followed by plateada (31 percent), guapotes (12 percent), bagres (5 percent) and finally by mojarra and ejote (3 percent each). Sizes for commercial capture vary according to the species and the body of water where they are caught. In general, regardless of the species (with the exception of plateada and ejote), length should not be less than 16 cm. As is the case of nets, commercial fish size is regulated by the Fishing Regulations governing each body of water.

The general production trend has shown a decrease in past years. Production increased from 1 816 mt in 1986 to a range of 4 000 to 5 000 mt towards the mid 90s, but has since shown a continuous reduction to a level of 2 830 mt in 2000 (Figure 5.2).

Table 5.3 Fisheries resources in the various inland bodies of water in El Salvador*

Category	Groups	Common name	Scientific name	Family
Fish	Tilapias	Tilapia, buta, mojarra blanca,	<i>Sarotherodon niloticus</i> ,	Cichlidae
			<i>S. aureus</i> ,	"
			<i>S. mosambicus</i>	"
	Mojarras	mojarra negra, mojarra nativa	<i>Cichlassoma guija</i>	"
		Mojarra azul	<i>C. guttatum</i>	"
	Guapotes	Guapote tigre, carucos	<i>C. managuense</i>	"
		Guapote pando, guapote blanco	<i>C. motaguense</i>	"
		guapote jivado		
		Guapote nativo, guapote nacional	<i>C. trimaculatum</i>	"
		guapote criollo, guapote ojos rojos		
		Istatagua		
	Burras	Burra	<i>C. nigrofasciatum</i>	"
	Bagres	Bagre	<i>Arius guatemalensis</i>	Ariidae
Sardinas		Quisque o guicho	<i>A. taylori</i>	"
		Juilín o filín	<i>Rhadia guatemalensis</i>	Pimelodidae
	Plateada	Sardina plateada, Alma seca	<i>Astyanax fasciatus</i>	Characidae
		Sardina jivada, papelillo, llumina	<i>Roeoboides salvadoris</i>	"
	Carpas	Carpa común, carpa negra	<i>Cyprinus carpio</i>	Ciprinidae
		Carpa dorada	<i>Carassius auratus</i>	"
		Carpa cabezona	<i>Aristichthys nobilis</i>	"
		Carpa herbívora	<i>Ctenopharyngodon idellus</i>	"
		Carpa plateada	<i>Hypophthalmichthys molitrix</i>	"
	Ejotes	Ejote	<i>Melaniris guija</i>	Atherinidae
Cuatro ojos				
	Chimbolos	Cuatro ojos	<i>Anableps dowii</i>	Anablepidae
		chimbo común, Bute	<i>Poecilia sphenops</i>	Poeciliidae
Lobina negra		Chimbo blanco ó de 7 puntos	<i>P. gracilis</i>	"
		Lobina negra	<i>Micropterus salmoides</i>	Centrarchidae
Crustacea	Prawns	Camarón zacate, manudo	<i>Macrobrachium tenellum</i>	Paleomidae
		Zacatón, mica, Pulguilla		
		Mica chele.		
		Mamarón negro, mamarón prieto	<i>M. americanum</i>	"
		camarón americano		
	Crabs	Camarón gigante	<i>M. roseenbergii</i>	"
Mollusks		Pilero	<i>Atya sp.</i>	"
		Cangrejo de río		
		Cangrejo de agua dulce,		
	Caracoles	canecho	<i>Pseudothelphusa magma</i>	Potamonidae
		Caracol de agua dulce	<i>Pomacea sp.</i>	Class gasteropod

* Source: Anuarios de Estadísticas Pesqueras de CENDEPESCA y Documento peces nativos en vías de extinción en El Salvador, 1995.

Figure 5.1 Inland artisanal fisheries production by species, 2000

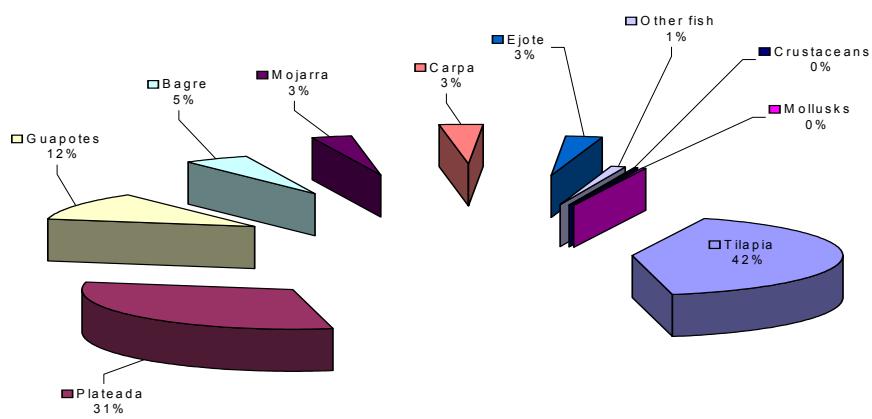
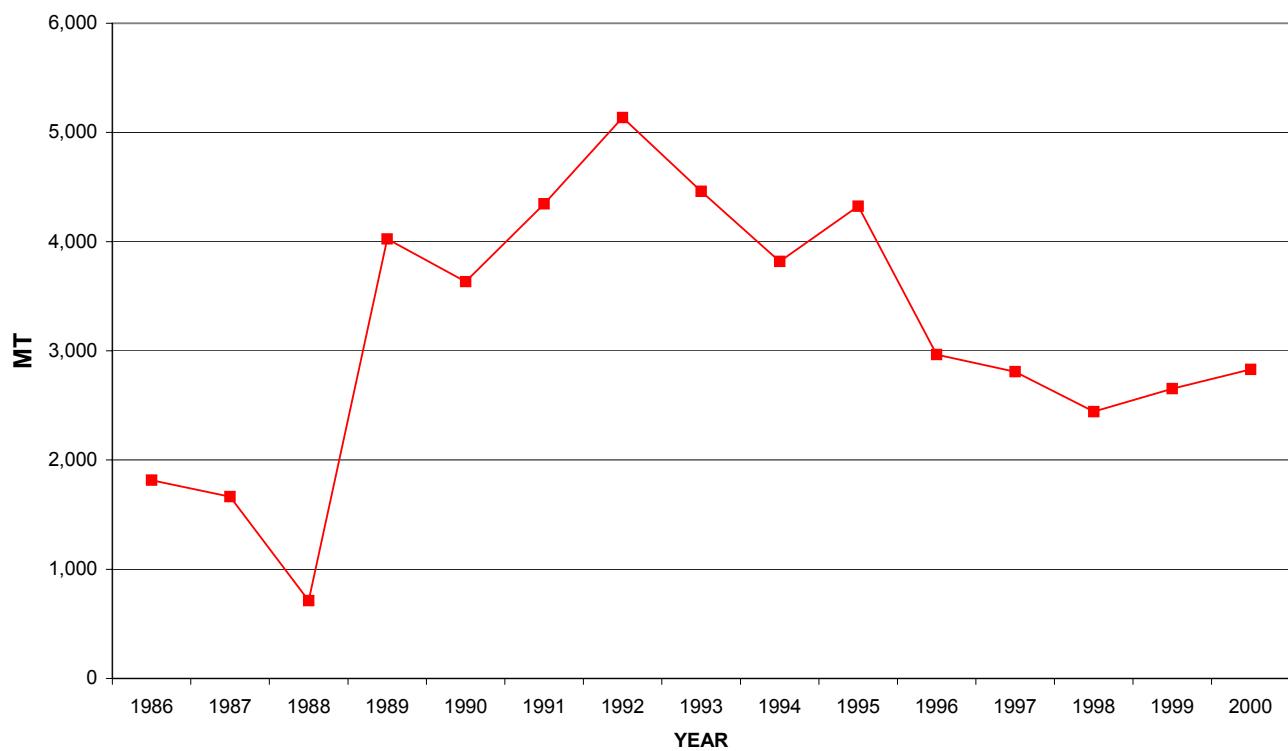


Figure 5.2 Inland and artisanal fisheries production trend (1986-2000)



5.2 State of management

The socio-economic level of inland fishers is low; the fisher combines fishing with other economic production activities including agriculture, raising animals and commercial activities.

The most common types of organizations among the inland artisanal fisheries sector are: Cooperatives, Community Fisheries Associations, Solidarity Groups and Fishers Committees. It is estimated that around 10 percent of fishers belong to some type of association, since there are about 45 organizations distributed around the inland bodies of water. Most fishers carry out their activities individually. In the last few years there has been a growing trend to participate in associations as a means to protect fishing-related interests.

The decreasing production trend of recent years is due to the interaction of many factors, including:

- the continuous growth in the number of fishers;
- increased use of nets with smaller mesh sizes;
- fishing practices that alter fish habitats;
- limited application of fisheries management measures;
- limited dissemination of fisheries management standards;
- lack of inter-institutional or inter-sectoral coordination with competent authorities;
- limited opportunities for fishing communities to participate in the drafting and application of fisheries regulations.

The current status of the fisheries, added to the developing fishing technology and marketing capacity of the fishers, has resulted in renewed interest by fishing communities and their organizations to coordinate actions with State entities to sustain fishing activities.

5.3 Management actions foreseen

Actions are currently being undertaken for managing the fisheries sector. The management is a priority action aimed at the rationalisation of the fishing effort, the recovery of fish stocks and the establishment of conditions for balanced development of the sector.

A clear example of this is that CENDEPESCA is currently promoting the concept of Fisheries Co-Management to develop inter-institutional coordination actions with other government, non-governmental and private organizations and the involvement of fishers, to formulate and implement Management Plans for the various bodies of water at the national level, based on the Code of Conduct for Responsible Fisheries. The following instruments have supported the preparation of the Plans:

- The National Management Plan;
- The National Fisheries and Aquaculture Policy;
- The New Fisheries and Aquaculture Management Law and corresponding regulations;
- The Specific Resolutions regulating Fishing Activities in each Body of Water;
- Inland Bodies of Water Re-Stocking Plans.

6. INLAND FISHERIES IN GUATEMALA

6.1 Situation and trends

6.1.1 Application of the FAO Code of Conduct for Responsible Fisheries

The first General Law on Fisheries and Aquaculture in Guatemala was in force for 70 years (1932-2002), an extremely lengthy period when considering that the dynamics of hydro-biological resources calls for short and medium term management regulations. Throughout those many years, the Guatemalan Fishing Administration was basically limited to managing fisheries resources. It was not until the issuance of the FAO Code of Conduct for Responsible Fisheries ("Code of Conduct") that the Guatemalan Fishing Administration availed itself of a support document to strengthen its hydro-biological resource exploitation management efforts.

The application of the FAO Code of Conduct to fisheries in Guatemala has involved the following activities.

- Guatemala informs the FAO of the total volumes of fisheries resources extracted by the fishing activity. For the last two years, the Fishing Administration Office has produced these reports, which contain real data (Article 4.2).
- Guatemala has used the Code of Conduct for Responsible Fisheries to take strong measures to avoid the over-exploitation of certain fisheries resources, and thus foster their recovery (Article 6.3), such as:
 - closing the coastal shrimp fishery on the Pacific;
 - closing the shrimp fishery on the Atlantic;
 - enforcing closures in Amatique Bay, Atlantic ("Manjua" and shrimp);
 - enforcing closures in the Amatitlán Lake.
- Due to the scarce and unreliable research, in 2001 the Guatemalan Fishing Administration created a Research Sub-Area under its organization, with the following objectives:
 - to identify and undertake the research necessary for the adequate management of fisheries and aquaculture resources within the national marine and continental water bodies;
 - to generate the necessary information to better understand the current status of fisheries resources in the country;
 - to elaborate a monitoring program to assess the status and evolution of fishing resources in the country;
 - to identify potential resources that could be utilised in the future; and
 - to assess the fishing practices used presently and analyse the impact of such practices on the sustainability of resources and their environments.

The first year of operation of this Subarea resulted in the following three concrete actions:

- the exploitation of ichthyc resources in the Amatitlán Lake was estimated, serving as the basis to regulate this body of water;
- the selectivity of the shrimp net mesh size of the industrial fleet was evaluated, enlarging the mesh size 1/4"; and
- the industrial fishery of "dorado" *Coryphaena hippurus* in the Guatemalan Pacific Ocean was analysed, and is now serving as the basis to develop regulatory measures.

Additionally, agreements have been signed with friendly nations to contribute to managing the fishing resources in continental waters, such as the shared management of the Guija Lake, Guatemala-El Salvador.

The State of Guatemala has complied with those elements of the Code of Conduct for Responsible Fisheries that pertain to the effective control of fishing vessels and tender vessels. Pursuant to the Guatemalan legislation, a fishing vessel cannot fly the national flag if it does not have a Fishing License, which is granted only after the Fishing Authorities have issued a Technical Recommendation. This limits the possibility for the Maritime Authority to grant flags of convenience.

The Precautionary Approach in the Code of Conduct for Responsible Fisheries has been an extremely useful tool. According to the previous legislation related to the issuance of Industrial Fishing Licenses, one Fishing Permit was issued for a certain number of vessels. In other words, most requests stipulated more than one vessel. The lack of scientific information on certain fisheries has hindered determining the Maximum Sustainable Yield. Based on this criterion, on several occasions the Fishing Authority reduced the number of authorized vessels to avoid the overexploitation of this resource. Considering that the industrial fishery jeopardizes environmental, social and economic conditions, other requests have been declined, as provided in the Precautionary Approach.

The Precautionary Approach has also been invoked to implement immediate management measures.

- The Guatemalan Fishing Authority has cooperated with the National Maritime Authority by providing fuel and equipment for its monitoring and control efforts in jurisdictional and continental waters, and to avoid the inclusion of fishing vessels of other nationalities.
- The Fishing Authority controls every single fishing concession granted by the State, and has total control over the movement of industrial vessels and catch volumes.
- The General Fisheries and Aquaculture Law, recently passed by the Congress of Guatemala by means of Decree 80-2002, was drafted in line with the Code of Conduct for Responsible Fisheries. The guidelines to ensure responsible fisheries have almost been fully translated into the local language. The Precautionary Approach is defined in Article 7 of Chapter I (Basic Regulations); and the Code of Conduct for Responsible Fisheries is defined in paragraph 20, Article 8, Chapter II (Definitions).

For the two large lakes, Amatitlán and Atitlán, a Fishers, Fishing Gear and Vessel Register has been developed over the two past years, and responsible fishing identification cards have been issued to prevent the expansion of an unregistered fishing population.

- At Amatitlán, fishing schedules have been set, and the fishers are now organized in two associations.
- Concerning continental aquaculture, environmental impact assessments and management programmes must be submitted prior to initiating any sea shrimp and fish raising operations.
- Farms in continental waters are inspected, and discharge water and disease control is monitored.

6.1.2 Dissemination of the Code of Conduct

The text of the Code has not been broadly disseminated, especially among the users of continental fisheries.

UNIPESCA is in the process of printing the Code of Conduct for Responsible Fisheries for its distribution among the different sub-sectors of the hydro-biological sector in the country.

6.1.3 Fisheries management in large rivers and reservoirs in Guatemala

Hydrography

The hydrographical system is determined by three regions: the Gulf of Honduras, with an area of 57 005 km²; the Gulf of Mexico, with an area of 50 803 km²; and the Pacific Ocean, with an area of 23 990 km², including the following rivers:

- hydrographical region of the Gulf of Honduras: Motagua or Grande, Polochic, Sarstun, Belice, Hondo or Azul;
- hydrographical region of the Pacific: Suchiate, Naranjo, Ocosito or Tilapa, Samalá, Sis or Icane, Nahualate, Madre Vieja, Coyolate, Guacalate-Achiguate, Michatoya, Los Esclavos, Paz, Ostua, and Olopa;
- hydrographical region of the Gulf of Mexico: Usumacinta, San Pedro, De La Pasión, Santa Isabel or Cancuen, Chixoy or Negro, Lacantún or Lacandón, Cuijco and Selegua.

Lakes, lagoons and ponds

Guatemala has approximately 1 151 lake systems, with 7 lakes, 365 lagoons, and 779 ponds. Their distribution, by altitude, shows that 80 percent of these water bodies (916 lake systems) are situated at altitudes ranging from 0 to 200 masl, while the rest are above 200 masl and up to 3 590 masl. An analysis of the locations of such lake systems by Department shows that 54 percent (620) of these are in the Department of El Petén. The watershed of the Gulf of Mexico has 682 lake systems, representing 59 percent and a total of 278 49 km² of the water mirror; the Antilles watershed has 112 systems, equivalent to 10 percent, with a surface of 682 98 km² of water mirror (Castañeda, 1995).

The geological origin of the lake systems in Guatemala may be one of the following: volcanic or volcanic-tectonic, such as the Lakes of Atitlán, Amatitlán, Güija, Ayarza, and most of the lagoons and ponds above 1 000 masl; tectonic and elevation of the seabed, such as the Lakes of Izabal, Petén Itzá, and most of the systems located below 200 masl; change of course of rivers or floods, such as the San Juan Acul Lagoon in La Pasión River, and others along the Usumacinta, San Pedro, Chixoy, Motagua, Polochic and Dulce Rivers in the north, and the Achiguate and Suchiate Rivers in the south.

The lake systems in Guatemala are of outstanding beauty, as well as being of economic, biological and scientific importance due to the diversity of their resources. Many of them, including their basins, are used for recreational purposes, forestry, cattle-raising, wildlife flora and fauna refuges, artisanal fishing, regional crops, and reservoirs for drinking water and irrigation. They additionally serve to regulate the water cycle in the country. Natural resources in general and lake systems in particular are vital for human reproduction, but have shown alarming signs of deterioration in the last few years due to social imbalances (Castañeda, 1995).

6.2 State of management

Inland fisheries are currently an important factor for development, generating jobs and income in areas where other primary activities, such as agriculture and livestock, are marginal. Fisheries create a demand for goods and services that, in turn, are another source of employment and well-being. Regardless of the market that the product may be aimed at, fishing and aquaculture may be considered a strategy for social development. Despite the economic importance of fish production in these bodies of water, there is scarce knowledge about its hydrological, biological, and fishing conditions.

The critical status of fishing in lakes requires a sustainable development strategy with economic and social objectives. This, in turn, must be linked to environmental protection and improvement, namely of the ecological, biological and physical aspects, while also considering social equity and global consequences.

As the coastal communities have grown, the fishing effort has also increased to meet household food demands. Fish harvests from large rivers and reservoirs has decreased because of, *inter alia*, over-exploitation, pollution, lack of technological support (no re-stocking), and deficient environmental controls.

Because of the unrestricted access to fishing resources, mainly in large rivers, there is no accurate statistical information to help implement management measures. Industrial, agricultural and housing development activities have contributed to the degradation of the aquatic environment, resulting in a reduction of the ichthyc population, low levels of reproduction, and high mortality rates. The scarce controls over fishing gear, especially nets (casting nets and gillnets) with very small mesh sizes, lead to catch juveniles that have not yet reached sexual maturity.

All of these factors have had a negative effect on the role of inland fisheries as a source of food and income for local communities.

Although the fisheries in the large lakes of Guatemala are being strongly exploited, hundreds of smaller reservoirs (less than 150 ha) are under even greater pressure. Aquaculture techniques could be practised here, such as stocking native or exotic fingerlings.

The need for and the importance of human intervention to increase fisheries resources are evidenced by the status of the natural stocks of several aquatic species. Some species, depleted by excessive fishing or environmental degradation, have not yet recovered on the strength of the continuous stocking (re-stocking) of juveniles grown in nurseries. Significant efforts, both financial and in terms of organized labour, must be made for several years before noticeable results can be achieved.

Fishers, organized or not, are not taking advantage of credit, organization and training programs that would help them operate in a sustainable manner. Fishing is only a source of food.

Fishing in continental waters is performed with relatively simple, rudimentary and low powered-equipment and fishing gear, representing small capital investment, and low catch volumes. This knowledge is transmitted from one generation to another.

The legal system splits the fishing activity into two distinct types: industrial, or large and medium-scale fishing, and artisanal fishing, encompassing both inland and maritime waters.

The hydro-biological sub-sector includes maritime and inland fisheries and aquaculture. The inland fishery utilizes different native as well as introduced fish species, and a few species of

molluscs and crustaceans. Guatemalan aquaculture harvests mostly shrimp, and, to a lesser degree, prawns and fish. There is now an incipient production of frogs (Ministry of Agriculture, Livestock and Nutrition, MAGA, 2002).

Concerning the sustainable development of continental fishing, the State of Guatemala has supported groups of organized fishers in large reservoirs (Lakes Atitlán, Petén, and Izabal) via credits with funds from the National Agriculture and Livestock Development Programme (Programa de Fomento Nacional Agropecuario, FONAGRO) of the MAGA, to raise fish in pens or cages.

The Fisheries and Aquaculture Management Unit (UNIPESCA) of the MAGA, with the support of the Food Security Programme, has contributed adequate infrastructure and tilapia fingerlings to grow fish in cages in eight municipalities along the Atitlán Lake. The Unit has also provided technical assistance, training and community organization.

Title III of the new Fisheries and Aquaculture Law, Decree 80-2002, considers the promotion and development of aquaculture: "The State shall give special attention to the promotion of rural aquaculture with the aim of supplying low-cost aquaculture products to inland regions, utilizing fingerlings provided by the aquaculture centres of the Competent Authorities."

Fish aquaculture has not developed much in the country although there are natural growing conditions and local demand. Industrial shrimp farming is of economic importance, and has been developed on 1 500 ha of intensive and semi-intensive growing areas. There are also nauplii and larvae-production laboratories.

6.3 Management actions foreseen

The following are necessary actions for the management of large rivers and reservoirs in Guatemala.

- Develop a large river and lake fisheries resources utilisation model, providing sustainability and harmony for commercial fisheries, sports fishing, research, and domestic consumption.
- Encourage the formation of Cooperative Associations. These voluntary autonomous associations, which bring persons together to meet their needs and economic, social and cultural aspirations, are jointly owned and democratically managed. They are based on the values of self-help, self-accountability, democracy, equality, and solidarity.
- Implement programmes to record fishing activities in each river and reservoir by species, to complement studies, and provide data to evaluate production.
- Perform annual biological-fisheries assessments to build a database of the population dynamics of fisheries subject to commercial utilization, to issue technically founded opinions for adequate fisheries management.
- Implement a water-quality monitoring programme in reservoirs.
- Determine closure areas, and refuge and breeding areas for the different fish species, fostering a greater abundance of stocks, and partially mitigating the ecological impact of commercial fisheries that use small mesh nets.
- Establish closures for each reservoir in order to stabilize the fish stocks and their development, convincing fishers to fish 10 days and rest five days, thus allowing the fish to move and feed freely during that time.
- Promote recreational fishing using the "catch and release" method.

- Gradually increase the mesh size of gillnets and casting nets (atarrayas) from two to five inches, to obtain better yields in less time.
- Establish nursery centres for native species (“chumbimba”, “guapote”, “blanco”, etc.) and exotic species (tilapia, “bagre de canal”, “lobina”) to later plant these species in reservoirs, thus increasing fish production nationwide, as provided for in Decree 80-2002.
- Ease the fishing pressure by developing production projects in reservoirs together with organized fishers. These projects include, among others, growing fish in pens, dry salted fish, smoked fish, fibre-glass boat construction, outboard motor repairs, eco-tourism, and “catch and release” sports fishing.

7. INLAND FISHERIES IN PERU⁸

7.1 Situation and trends

Large rivers

Large river fisheries in the Amazon region contribute significantly to the regional and national economy, through the production of food and the generation of employment and foreign currency. In many places of the region, fishing is the only economic activity possible and the main source of food.

Amazon fisheries in Peru occur in the area of influence of the Amazon, Ucayali, Marañón, Napo, Putumayo, Yavarí and Madre de Dios river basins, in the Departments of Loreto, Ucayali and Madre de Dios, across an area of approximately 58 000 km² that includes rivers, streams, creeks, lagoons or “cochas” and flood plains.

Currently, official statistics only record the landings from commercial fisheries in the main ports of the region (Iquitos, Yurimaguas, Requena, Nauta, Contamana, Caballo Cocha, El Estrecho, Pevas, Mazán, San Pablo, Pucallpa and Puerto Maldonado). These landings were estimated at 29 500 tonnes for 2002. Fisheries for human consumption target about 70 species, where 40 represent 90 percent of the total production. The activity focuses on the exploitation of “boquichico”, “llambina”, “ractacara”, “palometa”, “sardina”, “doncella”, “yulilla”, “sábalo” and “lisa”.

About 80 percent of the catch for human consumption consists of boquichico (40%), “llambina”, “yahuárachi”, “chio chio”, “ractacara”, “yulilla”, “palometa”, “sardina”, “maparate”, “corvina”, “sábalo”, “dorado”, “doncella”, and “saltón”. Around 400 fish species are captured for ornamental purposes, some of which are juveniles of species for human consumption. The most valued of these are “arahuana”, “pez torre”, “pez disco”, “neon tetra”, “raya motoro”, “zungaros”, and “paiche”.

Depending on the capacity of the isothermal well of the vessel, commercial extraction can be large or small scale. In the first case, fishing is contingent upon the mobilization ability or scope of action of the vessels to exploit remote fishing grounds, while small scale fishing is carried out by a limited-radius fleet, with bases in all major cities.

⁸ Carlos Cisneros Vargas, National Aquaculture Directorate, Ministry of Production, Vice-Ministry of Fisheries.

Fishing vessels are classified as follows:

- commercial, either large scale (with isothermal well or similar storage over 10 m³ of capacity) or small scale (isothermal well or similar storage up to 10 m³ of capacity);
- non-commercial, including subsistence, scientific research, and sports fishing boats.

In commercial fisheries, fishing gear requires collective operations and includes seine nets ("honderas") and trawl nets ("chinchorro"). Casting nets ("atarrayas"), vertical nets ("cortinas"), arrows, and harpoons are also used.

Border fisheries mainly target large "bagres". Production indices are better when rivers start to rise, as schools migrate during the spawning period. Fishing products are marketed in the bordering areas of Leticia (Colombia), and Tabatinga, Benjamín de Constanza, Atalaya del Norte (Brazil).

Fishing in bordering areas uses wooden boats called "doraderas", with mechanic propulsion systems, and the fishing gear consists of "mallones" or trawl nets, "puitas" and "espineles" or trotlines. Fishing takes place during the day and the product is collected into isothermal boxes located along the river margins.

Subsistence and small- and large-scale commercial fishing activities in protected natural areas, such as Pacaya Samiria Natural Reserve, are carried out by people from other regions and from adjacent towns and settlements.

Fishing products for human consumption are marketed fresh, refrigerated, salt-cured and dry-salted. About one fifth of the catch for human consumption is estimated to be lost before landing, due to the lack of product preservation facilities. Fish for human consumption is sold in the Amazonian cities, where there is a well-developed tradition of fish-consumption, and in other cities where Amazonian fish has to compete against marine fish products.

Subsistence fishing is mainly aimed at self-consumption and bartering. This is an ancestral activity, practiced by aboriginal groups and new river communities scattered along different parts of the Amazon, where thousands of people from small communities fish and at the same time participate in agriculture and other rural activities. Indirect calculations have estimated that subsistence fisheries represent about 67 percent of total fishing in the Amazon. The canoes are 3 to 7 m long, powered by oars, with a very limited radius of action. Fishing gear consist of hooks, arrows, harpoons, nets and other manual equipment, and occasionally include fishing with "barbasco" and closing streams with nets.

Ornamental fish species are captured using 4 to 7 m long canoes with oars. Live fish are transported in motor-powered 9 to 14 m long boats. The most common gear is "pusahua" (calcales), "tarrafa" (casting nests) and purse seines. Trade exists in connection with this fishery, dedicated to the stablign and export of ornamental fish. This activity has existed for half a century, based exclusively on capturing fish in their natural habitat, and no progress has been made in the integrated aquaculture of these species, developing the complete biological cycle.

The hydrographical system of the Amazon River features two distinctly opposite hydrological cycles, dependent on the climatic regimes of the southern and northern hemispheres, respectively. This characteristic impacts ichthyologic production, since a natural closure of species occurs during river flooding. Production decreases due to the increase in water levels, expanding the habitat to active flooding areas, allowing scattering, and improving the feeding and reproductive conditions of the fish.

During ebbing, stream flows progressively decrease, with the resulting concentration of fish in the main river courses, where fishing yields are optimised due to the vulnerability of fish to capture. Markets become saturated and since there is no processing infrastructure, extractors must diminish fishing pressure. However, production of dry-salted and salt-cured fish is stronger now in the communities.

Currently, fishing areas are sources of conflict between communities and fishers. The former develop a sense of ownership over the bodies of water near their jurisdictions, regardless of whether they have a right to or not, and fishing permits issued by the sector in many cases are of no value to community authorities.

Reservoirs

Peru has water storage reservoirs for hydropower and irrigation, and in some cases the reservoirs are used for fishing and aquaculture production.

Artisanal fishers living around the area extract the resources, and there is no adequate record of captures.

In addition, some reservoirs are being used for aquaculture activities, either intensively through the use of pens, or in ponds utilising water from the reservoirs. The primary species cultivated is tilapia. On the other hand, some reservoirs located in the high Andean region of Peru are periodically stocked with trout. Communities of farmers began this practice to supplement their normal activities, but have now turned it into their main livelihood.

7.2 State of management

Management measures applicable to fisheries in large rivers in the Amazon region are included in Law N° 25977, General Fisheries Law and its Regulations approved by Supreme Decree N° 012-2001-PE, as well as in the Fisheries Management Regulation for the Peruvian Amazon Region approved by Ministerial Resolution N° 147-2001-PE. In addition, specific norms are provided in Ministerial Resolution N° 213-2001-PE that establishes the fishing season in Imitia-Ucayali Lagoon to be between 20 April and 30 September, and Ministerial Resolution N° 215-2001-PE that establishes the annual fishing season for “paiche” to be between March and September.

The principal measures pertaining to the conservation of resources and access to fisheries included in the Fisheries Management Regulation for the Peruvian Amazon Region are:

- prohibition of fishing methods that threaten the conservation of the resource;
- minimum mesh sizes of 2 inches for fin fish and 8 inches for large “bagres” and “paiche”;
- minimum sizes for capture, accumulation, transportation and sale for 7 fish species with the greatest commercial value;
- prohibition to catch, process and sell minor cetaceans as the *Inia geoffrensis* (red porpoise) and the *Sotalia fluviatilis* (black porpoise), as well as the Amazon manatee or sea cow *Trichechus inunguis*;
- prohibition to extract and sell fingerlings and juveniles of 41 species from their natural habitat;
- fisheries products shall be destined for direct human consumption;
- prohibition to discard dead fish during capture, as well as to the sacrifice of fish and the sole use of gonads (ova or “hueveras”);
- establishment of an access regime to extraction activities pursuant to the level of exploitation of hydro-biological resources. In addition, the capture of fingerlings for

- aquaculture development requires fishing permits, after obtaining a favourable scientific opinion;
- subsistence fisheries can freely access the resources and therefore are exempted from obtaining fishing permits;
- communities living in areas along the margins of bodies of water within their area of influence have preferential rights to exploit the hydro-biological resources for subsistence;
- large and small-scale commercial vessels may operate in lagoons or “cochas” with established communities only during river flooding.

On the other hand, there are no specific fishing norms for reservoirs; only the legislation pertaining to closures and minimum extraction sizes applies.

The main difficulty that fisheries management faces is the non-compliance by fishers with the existing norms, arguing social reasons. The problem is exacerbated by the geographic layout of the country, the lack of logistical resources within the administrative entity, and the lack of budgetary resources for monitoring and control.

The structure of the public fisheries sector provides for policy development, implementation and supervision and tracking, control and surveillance of fisheries and aquaculture activities with the support of Artisanal Fisheries Monitoring Committees. This arrangement aims to foster an integrated and functional association between users (fisher-aquaculture farmer) and the management authority, for overall joint benefit.

7.3 Management actions foreseen

The Management Regulations for the Amazon region include Fisheries Management Programmes to ensure the controlled exploitation of a species, or set of species, in a specific environment, under regularly monitored standards that respond to socio-economic needs.

Programmes must be implemented by basin and by species, with special legislation for fisheries in border areas to establish closures during breeding seasons for the most exploited species.

A good example of management efforts is evident in the large “bagre” fisheries in most of the rivers of the Amazon region. With the experiences in specific fishing grounds, a self-regulating mechanism has emerged including such elements as the number of boats in a fishing area, the work shifts (day and night), and the mesh size. The actions have been supplemented by sectoral work in training, research and documentation.

In addition, future programmes will include actions to strengthen the surveillance and control actions undertaken by the sector, to ensure compliance with the regulations in force.

8. INLAND FISHERIES AND AQUACULTURE IN URUGUAY⁹

8.1 Situation and trends

With a surface of 3 100 000 km², the Plata River basin is the second largest in South America, and fourth in the world. This area includes all of Paraguay and considerable portions of Brazil (17%), Bolivia (19%), Argentina (37%) and Uruguay (80%). Basin fisheries provide almost the total inland captures of Paraguay, Argentina and Uruguay, and a substantial proportion of captures in Bolivia and Brazil.

Based on the limnology information available and the nominal captures recorded from Argentine landing sites between 1945 and 1984, Quiros and Cuch (1989) concluded that the system as a whole is lightly exploited, with fisheries based mainly on the capture of adult fish in the four to six year classes. The analysis undertaken also shows that captures are related to the intensity of flooding and the amount of water remaining in the low water level periods of previous years. The observation that catches in the Uruguay River show a better correlation with the hydrologic conditions of the Paraná River than with the local ones is consistent with the fact that the reproduction areas of the main stocks of migratory species captured in those environments are located in the lower and middle Paraná River (CARU-INAPE-INIDEP, 1990).

Mean nominal capture for the period 1945-1984 and for Argentine landing sites in the lower Plata basin was 11 119 tonnes/year, 73 percent of which was shad (sábalo) (Quiros and Cuch, 1989). Considering the area of the floodplain, this yield represents less than 10 percent of the potential estimated by the Welcomme equations (1985). Even considering that real captures could have been up to three times larger than nominal, the system would be lightly exploited (Quiros and Cuch, 1989).

The composition of the species captured and their relative abundance show long-term trends, at least partially attributable to increased human activity in the basin. Quiros (1990) suggests that the decline in the abundance of species that feed on fruit and seeds and species of marine lineage in the lower tracts of the rivers, as well as in the captures of "dorado", is related to deforestation along the margins and the impact of pollution from agro-toxics, and industrial and urban waste.

8.1.1 Ichthyo-fauna

The southern part of the Plata River basin considered in this document is included in the ichthyo-faunistic Parano-Platense Province (Ringuelet, 1975), that includes the sub-basins of the Plata River, the Uruguay River, the Paraguay River up to Bahía Negra (on the border with Bolivia) and the Paraná River up to the Guayrá falls. As in the whole basin, fish communities are dominated by representatives of the following orders: Cypriniforms (46%) (sub-orders Characoidei and Gymnotoidei), and Siluriforms (39%). The rest of the species are distributed among the orders Perciforms, Atheriniforms, Myliobatiforms, Clupeiforms, Synbranchiforms and Lepidosireniforms.

The approximate number of species in the main rivers and the percentages of the orders best represented are (López, 1990):

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- Paraná: 222 species; Characoidei (45%); Siluriforms (37%); Gymnotoidei (4.5%); Perciforms (6.5%).
- Uruguay: 130 species; Characoidei (39%); Siluriforms (41%); Gymnotoidei (38%); Perciforms (11.5%).
- Paraguay: 165 species; Characoidei (44.8%); Siluriforms (38.1%); Gymnotoidei (4.2%); Perciforms (6.0%).
- Río de la Plata: 119 species; Characoidei (36.1%); Siluriforms (42.8%); Perciforms (5.7%), Atheriniforms (5.8%).

Bonetto (1986) provides a description of the characteristics of the ichthyofauna and the biology of the main species. The fish of greatest fisheries interests are characoids or siluriforms, and most exhibit a potamodromous migratory behaviour. Annual longitudinal migrations, which could extend along the riverbeds for hundreds of kilometres, are part of the reproduction, feeding and habitat occupation strategies of these species.

According to the basic scheme of reproductive migrations in the Paraná and Uruguay rivers described by Bonetto (1963), the fish form schools and swim upstream towards the spawning areas. For many species, this activity begins in the spring, when water levels begin to rise and the maximum level coincides with the peak of the flood tide. Spawning occurs in open waters and the eggs, larvae and juveniles drift downstream and enter the bodies of water in the flood plains, where they find the appropriate conditions to continue developing. Adults return downstream in a relatively slow and apparently erratic manner.

This generalized pattern exhibits particular characteristics in different areas of the basin, according to the prevailing environmental conditions. In the Paraguay River (due to the regulating effect of the Pantanal), as well as in the Uruguay River, the spawning season (spring-summer) is out-of-synch with the hydrological cycle, and coincides with the low water level. It is possible that in these cases secondary peaks trigger the spawning activity during flood tides.

Migratory fish stocks in Río de la Plata and the lower tract of the Uruguay River swim upstream through the lower and middle Paraná River at the beginning of the fall and return during the spring (Sverlij and Espinach Ros, 1986). Spawning probably takes place in early spring or during the fall spawning period, in the lower Paraná River and the final tracts of the middle Paraná. This behaviour, which is opposite to the generalised pattern, may be explained as an adaptation that allows utilization of the significant trophic resources of the southern end of the basin during months when temperatures are within the appropriate range for subtropical species. Information gathered from fish tagging and recapture studies suggest the existence, within the same species, of active and passive migrants (Bonetto, 1986). The proportion of active migrants in the stock is higher in the upper river tracts and in the main tributaries and lower in the potamon, with the exception of Río de la Plata and the lower segments of the Paraná and Uruguay rivers, where thermal factors determine massive participation in migrations.

8.1.2 River and reservoir fisheries

Inland fisheries in Uruguay can be divided into four bio-geographic regions with distinct characteristics: the Uruguay River basin with its main tributary the Negro River; the reservoirs on these rivers; Río de la Plata; and the Atlantic coastal lagoon system.

The Uruguay River basin exhibits a high-energy production potential that has been tapped through the installation of four hydroelectric power plants, one on the Uruguay River and three on the Negro River.

Uruguay River

The Uruguay River, with more than 150 species, is of great importance from the biodiversity, as well as economic, tourism and recreational standpoints (Forni, 2002). The most valuable species for commercial and sports fishing purposes are usually the larger ones, which exhibit migratory behaviour: Characiforms (fin fish) such as “sábalo”, “dorado”, “boga”, “pacú” and “pirapitá” and Siluriforms (scaleless fish or hide fish) like “surubi”, “patí”, “manguruyú” and “armadas” (Iwaszkiw, 2002).

Since the Salto Grande dam was closed in 1979, variations in population dynamics of fish species have been studied, particularly migratory species. Artisanal fisheries along the Uruguay River, mainly located along the Uruguayan margin, have survived these changes in the environment but have developed very little, and their captures have decreased as consequence of anthropogenic changes to the system (Forni, 2002).

“Sábalo” is the species yielding the largest catch in the Plata River basin. It is distributed throughout a wide area that includes the Parana, Uruguay, Plata rivers and their main tributaries. This results in captures distributed along the basin, and evaluated and managed by different organizations. It is difficult to study the stock as a whole, as the information is scattered in different regional centres.

In the Uruguayan River, “sábalo” yields the largest fresh water capture. DINARA statistics indicate that this species accounts for an average of 63 percent of total inland captures for the country in the period 1990-2000. Average yearly capture was 742 tonnes, ranging between a minimum of 178 and a maximum of 1 262 tonnes (DINARA, 2003).

On the Argentine margin of the Uruguay River, the fisheries exploiting this species at an industrial level are located around the town of Gualeguaychú. Production is used to manufacture fish meal and fish oil. The fishing gear used is beach trawl nets, 400 to 800 m in length. The centre panels are taller than the rest and form the purse where the fish are captured. Stretched mesh size in the bag is 80 mm and 105 mm in the wings. When a school is spotted, the net is deployed with the help of a boat, and is recovered using four trained horses or sometimes tractors. Average capture per set is between 10 and 30 tonnes, although, exceptionally, more than 100 tonnes can be caught in one single set. On average, two sets are made per day. The fishing season is regulated by the government of the province of Entre Ríos, Argentina, and stretches from October to April of each year.

On the eastern margin along the same river tract, an artisanal fishery for fresh “sábalo” using stationary gillnets deployed by motor-powered canoes and “chalanas” (flat-bottomed boats). The capture volume is quite smaller.

Since 1984, the Uruguay River Management Commission (CARU, Comisión Administradora del Río Uruguay) has coordinated a fisheries resource research programme, conducted by the fisheries research institutes of Argentina and Uruguay (INIDEP and INAPE, respectively). Until mid 1994, the programme included assessment campaigns by exploratory fishing using bottom-trawl nets operated by two outboard powered boats. Population structure and migratory behaviour studies were carried out for the main species in the area (“sábalo” and “boga”).

Exploratory fishing with bottom trawl nets included an area of 780 km², and yielded mean catch-per-unit-of-area values between 10 kg/ha and 170 kg/ha. Forty species were captured, “sábalo” being the most abundant, with percentages between 40 percent and 95 percent of the capture by weight. Other frequent species in the catch were “armado”, the catfishes: “amarillo”, “trompudo” and “porteño”, “viejas de agua” and “patí”. The strong variations

recorded in fish density could at least be partly due to stock location fluctuations in their dispersion area, which is larger than the area assessed (CARU–INAPE–INIDEP, 1990).

Catch-per-unit-of-area estimates in the lowest tract of the Uruguay (Km 0 to 90) are related not only to resource abundance but also to spatial distribution at the time of assessment. This situation implies that biomass estimates obtained from catch-per-unit-of-area data are only for the fraction of the stock accessible at the time and to the effect of the current on the fishing gear, in other words, a fish stock underestimate. Despite this, fish densities estimated in the lower tract of the river are relatively high when compared to values found in similar tracts of other rivers in the world (Welcomme, 1992).

The high fish biomass could be partially explained by the abundance of fine sediment deposits with high contents of organic matter that constitutes the main food source for “sábalo” and other illyophagous fish; and the interaction of the area with the Paraná River system, where the spawning areas for the species of greatest fishing interest are located, through the tributaries of the Paraná delta (CARU–INAPE–INIDEP, 1990).

Exploratory sampling in recent years has continued to determine the location of juvenile habitats upstream and downstream from the dam (Errea, 2002). In addition, genetic marker studies are being conducted on “sábalo” to show there are no differences between the stocks in the middle and lower Paraná, the lower Uruguay (downstream from the Salto Grande dam) and the inner Plata River (Pereira 2002, com. pers.).

In February 2003, a biomass assessment campaign for the lower Uruguay River (Km 0-90), and a fish density and distribution study (Km 0 to Salto Grande dam), were undertaken to update existing information and to improve resource management. A new methodology was used, combining hydro-acoustic readings and fishing sets with “mallón” (gillnet 250 m long by 4 m high). Fishers use this net as an active seine-type fishing gear.

Negro River

The Negro River is one of the main tributaries of the Uruguay River where a series of chain hydropower projects have been constructed, and small fisheries have developed in the reservoirs. Hydropower projects along the Negro River are an important source of energy, with three power plants with an installed capacity of 569 MW that, together, represent 37.6 percent of the national hydroelectric system. The three artificial waterfalls located on this river are: Central Hidroeléctrica Dr. Gabriel Terra Hydropower Plant with the Rincón del Bonete reservoir, and downstream from it, Rincón de Baygorria and Constitución (Paso del Palmar). The Dr. Gabriel Terra plant was built between 1937 and 1948, and the oldest reservoir is Rincón del Bonete, followed by Baygorria and finally Constitución between 1977 and 1982.

Salto Grande Reservoir

A significant modification to catch composition was observed in the Salto Grande reservoir in its first five years of operation. There was a reduction in the amount of “sábalo” “dorado,” and “boga” and several species of “viejas de agua” of the Loricariidae family, while the presence of “patí” increased. It should be noted that during this period, the fish crossings on the dam were not in operation (Boiry *et al.*, 1988). Although most exhibited a decreasing trend in abundance in the 80's, due to interference in migratory routes and reproductive processes, some showed evidence of recovery. Such is the case for “sábalo”, “boga” and “dorado”, which increased in frequency in the 90's. Others, however, such as “bagre cucharón”, “armado chancho” and “surubí” continued on a downward trend and practically disappeared from catches. “Pacú” and “salmón criollo” or “pirapitá” were absent in reservoir samplings. This marked reduction is associated with deforestation along the margins, since these are frugivorous species (Quiros, 1990). Agricultural and cattle raising activities around

the reservoir are frequent sources of pollution given the abusive and untimely use of various types of fertilizers and pesticides with varying levels of toxicity and persistence (Delfino and Baigún, 1991).

Fish community structure in the reservoir continues to evolve to a new one determined mainly by the expansion of free water (pelagic) and bottom environments and by the existence of a large slightly modified river tract upstream from the reservoir that allows reproduction of migratory fish, and their larvae and juveniles to live mainly in the branches of the reservoir, which have become nursery areas.

Negro River Reservoirs

The most important reservoir from the fishing point of view is Rincón del Bonete. In recent years, artisanal fisheries were established in collaboration with the Directorate for Development Projects (DIPRODE, Dirección de Proyectos de Desarrollo) Presidency of the Republic, through the donation and construction of a fish filleting plant and a cold storage room. The fishers became organized into cooperatives with the support of the Intendancy of Tacuarembó. The fishery continued to gain relevance until it became an important source of employment in the area of San Gregorio de Polanco. Currently, the main species landed are "tararira" (*Hoplias malabaricus malabaricus*) and, to a lesser degree, "bagre Negro" (*Rhamdia sapo*) and "bagre Amarillo" (*Pimelodus clarias*).

Today, the San Gregorio de Polanco Fishers Cooperative (COPESANG) captures up to 30 tonnes/month of "bagre" and "tararira," and the monthly average for the last year has been 12 tonnes/month. These volumes required fishing research to assess the resource and implement management measures, and to establish the optimum number of fishers it can support.

Subsistence fisheries operate in the section downstream from the Rincón del Bonete Lake up to the border with Brazil. In the Baygorria and Palmar reservoirs, there are few subsistence fishers, and sports fishing has developed in parallel.

In the lower tract of the Negro River up to the Palmar dam, the fisheries are based on the same species found in the Uruguay River, that is, "sábalo," "boga," "dorado" and "bagres". The most important fishing settlement is Villa Santo Domingo de Soriano, close to the mouth. The fishing operation unit is a 4 m "chalana" for two fishers using nylon monofilament gillnets, and boulders or trotlines. Larger boats, up to 10 m in length, also operate setting 300 m gillnets, basically operating as purse seines.

Atlantic coastal lagoon fisheries

Artisanal fisheries in the Merín lagoon basin are similar to the Negro River in the domination of "tararira" and "bagres" in the catch. The main fishing ports are La Charqueada (Department of Treinta y Tres) and Río Branco (Department of Cerro Largo). The first research campaigns started in 1997 to assess the fishery resources in that environment. Hydro-acoustic surveys and scientific sampling with low-selectivity nets were used, as well as artisan fisher surveys.

The main artisanal fishery in other Atlantic coastal lagoons targets shrimp (*Penaeus paulensis*). It is practically a harvest, as extraction takes place at the beginning of the fall, mainly in the lagoons of Castillos and Rocha, and with lesser intensity in José Ignacio and Garzón.

Estuary fisheries

The Plata River is divided in three zones with different hydrology and ichthyofauna characteristics. From the fisheries point of view, the inner and middle areas exhibit the same

conditions as the lower Uruguay River. The main fishing settlements are in Carmelo, Nueva Palmira (Department of Colonia) and Kiyú (Department of San José) and they target “sábalo” and “boga”. In the outer Plata River, the species of greatest commercial interest is corvine, heavily exploited in the coastal area by artisanal fishers in Montevideo (Pajas Blancas) and Canelones (San Luis resort) (CARP-INIDEP-INAPE, 1990).

8.1.3 Aquaculture

The organization responsible for aquaculture is the National Directorate for Aquatic Resources, DINARA, formerly INAPE, a state institution belonging to the Ministry of Livestock, Agriculture and Fisheries. Responsibilities include studying, promoting, fostering and providing technical assistance to individuals or companies, and public and private institutions in this area. The Directorate has a Fisheries and Pisciculture Research Centre, CIPP, (Centro de Investigaciones Pesqueras y Piscicultura) located in Villa Constitución (Salto), the only one at state level with the appropriate infrastructure for fish stock nurseries.

Aquaculture is part of the strategic line of national interest, due to its scientific as well as industrial, economic and social implications. To this effect, a Draft Economic Development Law was submitted to the National Parliament in 2000, to generate financial incentives and fiscal benefits for the purpose of supporting and developing this activity, mainly in rural areas.

The past few years have witnessed increased interest in supporting the policy to develop aquaculture in Uruguay, mainly through extension programmes and providing advice and information. The interest has been expressed by private initiatives as well as state organizations, especially at the level of departmental municipalities.

Several projects have been undertaken and others are about to begin in different areas of aquaculture, including those described below.

Extensive pisciculture

There are three modes or levels of development in this activity, namely:

- (a) individual stock bodies of water for different purposes (sports fishing, personal consumption, restocking, etc.) without adding food supplements, with little management, and without monitoring the evolution of the environment;
- (b) small producers incorporate this activity to complement and diversify other animal-raising and agricultural activities. In most cases there is coordination between DINARA and the Municipal Intendancies to support these undertakings;
- (c) producers that in addition to focusing their activities on the final stages of development (growth and fattening) are also involved in the management of the complete cycle, including reproduction and hatching of fingerlings.

The production of “bagre negro” (*Rhamdia quelen*), “carpa comun” (*Cyprinus carpio*) and “carpa herbívora” (*Ctenopharyngodon idella*) larvae and fingerlings is the responsibility of DINARA’s CIPP (Centro de Investigaciones Pesqueras y Piscicultura), which fulfills all stocking requests at the national level, after completion of the specific viability studies.

Regarding production, hatching and fattening of “pejerrey” (*Odontesthes bonariensis*), this is now privately managed, after the production technology was transferred by DINARA and it is found in the group described as type (c) above.

Table 8.1 shows the number of fish stocked in the period 1993-2002. The harvest or production of fish seedlings begins in the spring of each year and extends through the summer, so the stocking season is from September through August of the following year.

Table 8.1 Stocking in the period 1993-2002

Harvest Year	Larvae	Fingerlings	No of Fish Stocked
1993-1994	74 500	2 500	77 000
1994-1995	45 500	4 500	50 000
1995-1996	170 800	2 600	173 400
1996-1997	1 874 970	1 650	1 876 620
1997-1998	1 798 250	2 250	1 800 500
1998-1999	1 172 300	800	1 173 100
1999-2000	268 905	27 110	297 015
2000-2001	191 000	28 810	219 810
2001-2002	124 700	92 060	216 760

Stocked fish values are highest between 1996 and 1999 for the same larval stage, utilized mainly for restocking natural bodies of water. Starting with the 1999-2000 harvest, production focuses on achieving fingerlings (45 days old) to reduce natural mortality in the first phase, as they are targeted for supply to type (b) producers. In fact, since the year 2000, cultivation has begun in vegetable and fruit farms and cattle raising ranches with bodies of water available for irrigation and watering livestock. The rearing system utilized is extensive or semi-intensive, and the species stocked in most ponds is “bagre negro”. In these cases, production requires minimum investment (cost of the fish stock), since most of the food is contained in the growing medium and in household wastes.

Table 8.2 shows the total number of fish stocked by Department and the number of producers interested in pisciculture at the national level.

It should be noted that the 2002 harvest has not yet been completed, but there are already 26 additional producers in the Department of Flores and eight more in Cerro Largo, who have joined the activity through their respective Intendancies. Individual producers requesting stocking material for sports fishing should be added to this figures.

Commercial pisciculture

There is currently one example of commercial pisciculture in the country, on the Negro River in the Baygorria Reservoir (Department of Durazno). The target species is “esturión siberiano” (*Acipenser baerii*), in a floating pen production system. The project is being undertaken by the company Esturiones del Río Negro SA, working the complete cycle, that is, producing meat and caviar mainly for export (Table 8.3).

Table 8.2 Total number of producers and fish stocked by Department (2000-2001)

Department	Nº Fish	Nº Producers	Nº Fish	Nº Producers
			Year 2001	
Artigas	6 850	4	6 940	11
Canelones	40 400	17	17 250	13
Cerro Largo	9 550	4	9 140	11
Colonia	3 950	4	1 900	4
Durazno	2 000	1	18 100	5
Flores	13 200	5	500	1
Florida	31 000	2	10 000	1
Lavalleja	13 000	4	1 000	1
Maldonado	2 200	4	13 050	7
Montevideo	4 600	5	14 930	14
Paysandú	4 200	2	5 350	2
Río Negro	---	---	4 000	1
Rivera	9 900	15	2 200	1
Rocha	6 000	2	1 000	1
Salto	---	---	33 000	5
San José	17 800	4	54 400	3
Soriano	7 310	2	20 800	3
Tacuarembó	47 850	7	3 200	3
Treinta y Tres	---	---	1 050	2
Total	219 810	82	216 760	87

Table 8.3 Production of meat and caviar, Baygorria Reservoir*

Production of meat and caviar		
YEAR	2000-2001 (12 months)	2001-2002 (7 months)
Production of meat	4 000 kg	3 000 kg
Production of caviar	180 kg	700 kg

*Data provided by company Esturiones del Río Negro SA.

Carcinoculture (Crustaceans)

Two private projects have started in this area, attempting the viable production of two species of fresh water lobster, (*Cherax quadricarinatus* and *Cherax tenuimanus*), both of Australian origin.

Raniculture (Frogs)

Production of bullfrogs (*Rana catesbeiana*) in 2001 was about 9 000 kg (9 tonnes). The product is sold as frog legs or shredded, both frozen. The sale of raw or frozen hides has recently started, and around 1 000 pieces have been sold.

Mariculture: Mytiliculture (Sea farming)

Mussel cultivation has been implemented strongly in Uruguay in recent years in joint projects between DINARA and private investors. The target species is *Mytilus edulis platensis*, an autochthonous species of enormous socio-economic interest.

Summary of aquaculture development activities

An overview of aquaculture activities in Uruguay is given in Table 8.4.

Table 8.4 State of development of aquaculture activities

FISH	DINARA PRODUCTION	PRIVATE PRODUCTION
Species utilized for cultivation		
Bagre negro (black catfish) (<i>Rhamdia quelen</i>)	Reproduction and sale of larvae and fingerlings	Fattening: personal consumption, sports fishing, marketing Small producers organized by Intendancies Private individuals
Carpa común (common carp) (<i>Cyprinus carpio</i>)	Reproduction and sale of larvae and fingerlings	Fattening: personal consumption, sports fishing, marketing Small producers organized by Intendancies Private individuals
Carpa herbívora (grass carp) (<i>Ctenopharyngodon idella</i>)	Reproduction and sale of larvae and fingerlings	Fattening
Tararira (<i>Hoplias malabaricus</i>)	Reproduction and sale of larvae and fingerlings	Fattening
Pejerrey (silver side) (<i>Odontesthes bonariensis</i>)	Reproduction and sale of larvae and fingerlings	Reproduction and sale of larvae and fingerlings Fattening: personal consumption and sports fishing
Esturión (sturgeon) (<i>Acipenser baerii</i>)		Reproduction, fattening and sale of meat and caviar
Potential Species		
Sábalo (shad) (<i>Prochilodus lineatus</i>)	Reproduction and cultivation tests	
Boga (<i>Leporinus obtusidens</i>)	Reproduction and cultivation tests	
Pacú (<i>Colossoma macropomum</i>)	Reproduction and cultivation tests	
CRUSTACEANS		
Camarón malayo (giant prawn) (<i>Macrobrachium rosenbergii</i>)	Reproduction and cultivation tests	
Langosta australiana (freshwater crayfish) (<i>Cherax quadricarinatus</i>) (<i>Cherax tenuimanus</i>)	Reproduction and cultivation tests	Reproduction and cultivation tests
REPTILES		
Yacare (alligator) (<i>Caimán latirostris</i>)	Reproduction and cultivation tests	Reproduction and cultivation tests
AMPHIBIANS		
Bullfrog (<i>Rana catesbeiana</i>)	Reproduction and cultivation tests	Reproduction, cultivation and marketing

8.2 State of management

The fisheries in Uruguay have not developed in a uniform manner throughout the different regions, and depend on ecosystem morphology, abundance and distribution of fisheries resources, environmental impacts and location of urban centres in the areas of influence.

From the biological standpoint, exploitation may be considered to be generally moderate; however, it is possible that in some areas, mainly near urban settlements, fishing pressure may reach sufficient intensity to substantially modify the catch composition and size, with a decline in the larger species of commercial or sports fishing value.

Hydropower projects and pollution have had the biggest impacts on the fish communities, especially on migratory species that, at the same time, are of greatest importance to the fisheries and the most sensitive to this type of environmental modifications. Analysis of heavy metal residues in fish of economic importance in the lower Uruguay River shows that the current concentrations of lead and mercury are below the limits accepted for human consumption (Forni, 1998).

Another disturbance to the fisheries is caused by conflicts in the use of the resource in the different environments. In the middle and lower tracts of the Uruguay River, problems exist between artisanal and sports fisheries. The public controversy between the two groups focuses on the concept of conservation and the predatory nature of the fishing gear used. Artisanal fishers support their position on technical arguments such as the selective nature of the “mallón”, the fishing gear most commonly used in the area.

Although management instruments have to be adequate for the particular conditions of the various fisheries, the adoption of appropriate tactics, coinciding with the interests of the fishers, is common to all of them. Allocating fishing areas and limiting access to the fisheries are examples of such regulations. An important aspect is the review of the foundations and the practical value of the management measures widely used in the basin, such as space and time closures, prohibiting or limiting fishing in tributaries, establishing minimum catch sizes, and regulating minimum mesh sizes.

Given the shared nature of the main resources, agreements for their utilization should be inter-jurisdictional (provinces, departments, countries). Some progress to this effect is being made in the Uruguay River by the Uruguay River Management Commission (CARU), and the Salto Grande Mixed Technical Commission (CTMSG) (Argentina-Uruguay) in the Plata River by the Río de la Plata Management Commission (CARP) (Argentina-Uruguay), and the Laguna Merín Commission (CLM) (Uruguay-Brazil) for the Merín lagoon.

Within the framework of agreements with bi-national organizations, summarized information from the surveys carried out in the inland bodies of water of the country indicates that maximum allowable catches would be about 6 000 tonnes/year for the Uruguay River, 350 tonnes/year for the Negro River, and 2 000 tonnes/year for the lower Plata River (CARU-INAPE-INIDEP, 1990; DIPRODE-INAPE, 1992; CARP-INIDEP-INAPE, 1990). Results from the Merín lagoon assessment programme determined potential fishing yields for the Uruguayan sector of around 300 tonnes/year (CLM-DINARA, 2003).

The latest artisanal fisheries surveys conducted by DINARA in 2002, as well as records of commercial landings, indicate that captures in the Uruguay River are close to 1 600 tonnes/year for Uruguay and about 3 000 tonnes/year for Argentina (Forni and Swidzinski, 2002), 400 tonnes/year of the lower Plata River for the Uruguayan sector, 300 tonnes/year in the Negro River system - Rincón del Bonete reservoir - and 200 tonnes/year in the Uruguayan coast of the Merín lagoon.

8.3 Management actions foreseen

In Uruguay, sustainable fisheries principles for inland waters are based on the Code of Conduct for Responsible Fisheries (FAO, 1995a). DINARA is the organization responsible for managing the fisheries resources. To fulfil this function, it carries out biological research of the fisheries to assessing them and to determine their state of exploitation.

Fish are renewable living resources and therefore rational exploitation, far from presenting negative effects, enables recovery of the stocks with a resulting increase in productivity. The methodologies used for such research activities include scientific fishing with specially designed gears, sampling commercial landings, and surveys using hydro-acoustic techniques.

In order to apply biological-fisheries models, it is important to understand the age class composition of the stock, or at least an indirect estimate, such as size composition. Other variables of interest studied include sex composition and fish size at first sexual maturity.

Several fisheries management mechanisms exist to prevent depletion; they depend on the state of exploitation of the fish stocks living in the body of water under consideration. The results of the research may indicate that resources are either being exploited to their maximum potential or under their optimum levels (understanding optimum exploitation level as the annual catch that can be sustained indefinitely without affecting the resource—Maximum Sustainable Catch). In the first case it may not be necessary to adopt new fisheries regulation measures. In the second case, it may be necessary to apply mechanisms to encourage fishery development. Another possibility is that the assessment will show that maximum recommended levels are being exceeded. In this situation, it would be necessary to regulate fishing effort. Some possible measures could be to: limit the number of fishers or boats; prohibit access to the resource in a certain area or at certain times; reduce the efficiency of fishing gear used (regulating hook or mesh size); and establish maximum catch quotas.

Fishers survey

In 2002, an artisanal fisher census was started in the Eastern Republic of Uruguay. It will produce a database that includes characteristics of the fishing grounds, operational modes, fishing gear, characteristics of the families working in and dependent on the fishery, and profitability of the fishery. This census will, first of all, update DINARA information, in order to determine those areas with the greatest concentration of artisanal fisheries, to allow for the future issuance of new permits based on the availability of resources and the number of fishers settlements. To date, the census has covered approximately 700 artisanal fishers active in the Atlantic coast, the Plata and Uruguay rivers, coastal lagoons and San Gregorio de Polanco.

Fishing permits

In order to participate in artisanal fisheries, the person must have a permit issued by DINARA. It can be for land fishers (those who fish without boats or only use one for deploying the net but not to transport it) or for artisanal fishing. The boats used in this activity shall have wells with capacities equal to or less than 10 tonnes of gross registered weight (GRW).

The permit includes the name and registration of the boat, date of issuance and validity, fishing gear to be used, and base port of operations. Since the status of the resources in each environment or body of water considered is different (some rivers may have under-exploited stocks while others might be at maximum sustainable catch levels, or may even be over-exploited), these permits are only valid in the river for which they were issued (fishing is not permitted in the Negro River if the permit was issued for the Uruguay River).

The issuance, or not, of a fishing permit based on scientific criteria only constitutes a regulation mechanism aimed at protecting the resource. For this measure to be effective, the control functions exercised by the National Naval Prefecture and the National Police are essential. Poaching or extraction by unregulated fishers (without fishing permits) may lead to resource over-exploitation, since it causes additional mortality not accounted for in the biological-fisheries

models used to estimate maximum allowable catches. A boat without the corresponding fishing permit, or operating in areas not authorized in such permit, is not in compliance with the legislation and must be confiscated, as well as the fishing gear and the product.

Artisanal fishers must periodically submit a monthly record with the details of the type and size of the fishing gear used, the species captured, and the catch, by weight and in numbers. The forms to record this information are provided by DINARA. It should be noted that the data are used for statistical purposes, so it is vital for fishers to understand that it will not be used to penalise or harm them in any way. The cooperation of the National Naval Prefecture is very important (under the mechanisms in force, this is the organization responsible for distributing and gathering the fishing information forms) to transmit this concept to the fisher, with whom it has contact when dispatching the boat or when clearing it for sailing. This could improve the quality of all information received.

In order to validate fishing information and to estimate the degree of reliability, biological sampling of the fisheries was implemented in recent years. Data are also cross-referenced with export data, although there is a significant bias due to fish products leaving the country unregulated.

Minimum capture size

Recruitment age into the fishery basically depends on the fishing gear used. Smaller hooks or mesh sizes catch younger individuals. To avoid depletion, it is desirable for fish to have reproduced at least once before being captured. Total length (Lt) and fork length (Lf) for fish captured after first reproduction has been recommended for the main species (Table 8.5).

Table 8.5 Permitted sizes in total length (Lt) or fork length (Lf) in cm for the main species

Species	Lt	Lf
Bagre negro	30	
Tararira	40	
Dorado		55
Pati		40
Boga	40	
Sábalo	40	

Although these values are recommended for non-predatory fishing, there will be a small portion of the capture (under 5%) with sizes smaller than recommended.

Closure areas

The closure areas considered for inland waters include those located up to 1 km downstream from hydropower dams. Fishing in these areas is considered to be predatory given the large accumulation of fish in them (because of the interruption of migratory routes, rheotropism and because these are natural feeding areas), and increased vulnerability to fishing gear.

Another predatory activity is the closing off river branches or streams with nets. Entangling gear or sets of aligned nets along the watercourse must be separated at least one hundred meters, and their length may not exceed one third of the width of the river at the gear deployment site.

Closure seasons

Inland fishing is currently subject to time limits throughout the year. The closure for the Merín lagoon and its tributaries runs from November 1st through January 31st each year, starting in 2001.

Another closure is from December 15th through March 15th, and includes the Solís Grande, Solís Chico, Pando and Santa Lucía streams, up to 2 km from the mouth, the Maldonado stream and the Negro River, from the city of Mercedes to the mouth of the Uruguay River and the Palmar reservoir dam.

The possibility of implementing this regulatory mechanism is being studied for *Netuma barba* (migrating marine catfish that enters rivers for spawning) in the migration period that covers spring and summer.

Capture quotas

To date, Uruguay has no capture quotas for inland species. In general terms, setting total capture quotas without allocating these among the interested parties is not advisable, since each party overstates its extraction capacity in order to obtain a maximum amount before competing, thus resulting in anti-economic situations and leading to an uneven distribution of fishing effort during the year.

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PROGRAMME

Seminar on Fisheries Management in Large Rivers and Reservoirs of Latin America

San Salvador, El Salvador, 29 January 2003

Purposes:

- Provide a forum for experts to review main principles of responsible fishery management in large river and reservoir, on the basis of the Code of Conduct for Responsible Fisheries and in the light of the state of inland fisheries in Latin America.
- Promote an in-depth understanding of and raise awareness on the importance of responsible fishery management for sustainable fishery development in large rivers and reservoirs.
- Contribute to improving management, conservation and recovery of fishery resources in large rivers and reservoirs.

Expected outputs:

Recommendations of the Seminar that will be submitted to the consideration of the Plenary Session of the Ninth Session, Commission for Inland Fisheries of Latin America (COPESCAL).

Participants:

Representatives from Member Countries and invited experts.

Programme:

1. Introduction
2. Review of responsible fishery management in large rivers of Latin America.
3. Review of responsible fishery management in reservoirs of Latin America.
4. National reports.
5. Conclusions and recommendations.