
People in Nature



WILDLIFE CONSERVATION IN
SOUTH AND CENTRAL AMERICA

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AND JOSÉ M. V. FRAGOSO, EDITORS



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To José Márcio Ayres, 1954–2003



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That this book is dedicated to Marcio Ayres is powerfully appropriate, in that Marcio touched the lives and the intellects of so many of the authors. Marcio influenced the course of conservation in the Amazon probably more than any other single person in recent memory, and community-based management was at the heart of everything that he did.

Marcio will be forever associated with the creation of the Mamirauá and Amanã Reserves, two huge protected areas in central Amazonia that involve local communities in their management and development. In 1996, when the first was gazetted, Marcio helped introduce a new concept—the “sustainable development reserve.” As opposed to a national park, which in Brazil called for the removal of local people from the reserve, the sustainable development reserve actively involved local inhabitants in management. Brazil’s President Fernando Henrique Cardoso would later call Mamirauá “a living example of how it is possible to create positive coexistence between the inhabitants of a region and the preservation of that region.” This was not empty rhetoric. Marcio had realized early on that in the absence of strong governmental institutions in the Amazon, local people driven by their own self-interest could become the guardians of nature and natural resources. Mamirauá, situated in the flooded forests, contains important wildlife, timber, and especially fish resources. The management plan granted usufruct rights to the local people, allowing them with the help of government agencies to exclude nonresidents from fishing in the reserve. The result was one of those rare “win-win” situations: the average income of local fishermen rose from R\$320 in 1999 to R\$845 in 2001, based largely on an increase in fish production from management lakes from 6.2 to 15 tons, while at the same time populations of pirarucu (*Arapaima*), the most important fisheries species, tripled in density. And local people have seen a dramatic rise in their educational achievement and health.

Economic Incentives for Sustainable Community Management
of Fishery Resources in the Mamirauá Sustainable
Development Reserve, Amazonas, Brazil

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AND WILLIAM G. R. CRAMPTON

The increasing demand for and degradation of limited resources by the rising human population of the Amazon basin has precipitated a great deal of discussion about the sustainable use of its natural resources (Hall 1997; Ayres et al. 1999). For the most part the fisheries of the Amazon basin are underexploited, and fishing pressure is concentrated on only a few species (Bayley and Petrere 1989; Crampton and Viana 1999). Crampton et al. (this volume) provide a detailed account of the history and current status of floodplain fisheries in the Brazilian Amazon basin. Until the 1970s tambaqui (*Colossoma macropomum*) and pirarucu (*Arapaima gigas*) represented staple protein supplies in the Amazon basin. With the growth of commercial fishing fleets, these species began to show clear signs of overfishing and today are luxury food species (Petrere 1986; Costa 1992; Goulding, Smith, and Mahar 1996). In the last two decades the detritivorous curimatá (*Prochilodus nigricans*) and jaraquis (*Semaprochilodus* spp.) have become the staple food species. As yet, there is only anecdotal evidence for overfishing of these species (jaraqui sizes are decreasing in Manaus markets, V. Batista pers. comm.). The major challenge in Amazon fisheries management is to avert a situation in which one species after another is depleted.

This article describes the principal activities and results of an experimental community-based fisheries management initiative in the Reserva de Desenvolvimento Sustentável Mamirauá (Mamirauá Sustainable Development Reserve, or RDSM), a protected area of várzea floodplain in the Brazilian state of Amazonas. This reserve covers 1,124,000 hectares and is delimited by the rivers Solimões, Japurá, and Uatí-Paraná. The work reported here is centered on a smaller, 240,000-ha Focal Area, bordered by the Japurá and Solimões rivers and by a connection between them, the Paraná Aranapu (fig. 9.1). Resident and user communities in or near this reserve have exclusive access rights to fishing resources granted by its status as a conservation unit. In addition to providing strong economic incentives for the sus-

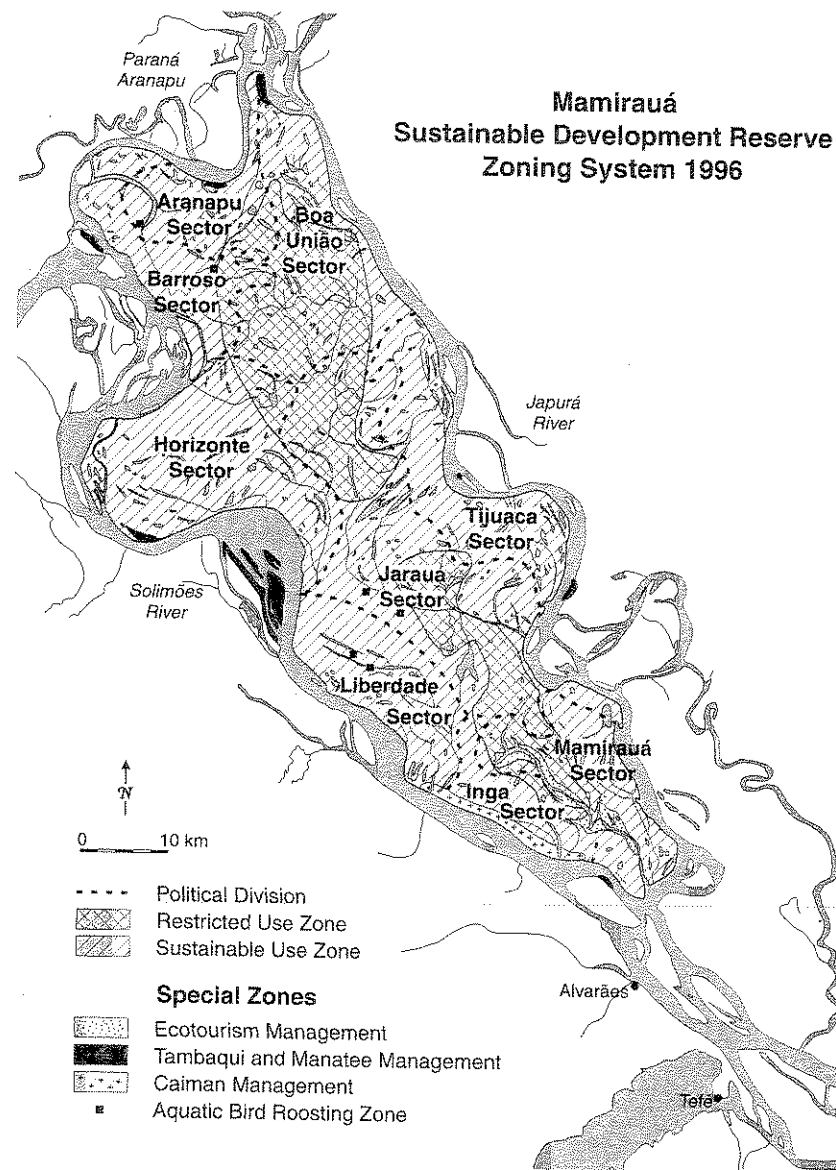


FIGURE 9.1 Organizational (political) sectors and Focal Area of the Mamirau Sustainable Development Reserve.

tainable management of fisheries, the program described here supplied scientific and technical support in the definition of sustainable quotas. The program strove to improve the production efficiency of an existing fishery and to diversify its species base—both important strategies for reducing the pressure on key commercial stocks (Crampton and Viana 1999).

The RDSM was created in 1990 by the state of Amazonas and is one of the largest areas of relatively intact várzea floodplains in the Brazilian Amazon. The lakes, channels, and seasonally flooded forests of this unique ecosystem offer fishes a rich supply of vegetation, detritus, seeds, fruits, and invertebrates (Junk, Bayley, and Sparks 1989). The immense productivity and size of this reserve probably means that the area is a regionally important nursery ground for commercial food species. Such resident species as pirarucu and tucunar (*Cichla* spp.) pass their entire life cycle in the floodplain. Many species of migratory characiform fishes, such as the detritivorous jaraquis and curimat, spend the first years of their lives in the várzea before migrating upstream to colonize other areas.

Crampton, Castello, and Viana (this volume) describe the human population of the RDSM. The principal economic activities of the area are fishing, agriculture, and timber extraction, which are undertaken seasonally and on a communal or familial basis. The average annual income of families in the reserve is around US\$ 900, of which 53% is spent on the purchase of food and basic supplies. Fishing represents by far the most lucrative source of income in the reserve, forming 72% of the average domestic income (SCM 1996).

The management of natural resources in the RDSM is based upon an alliance between the local resident and user population and a multidisciplinary research and extension project carried out by the Instituto de Desenvolvimento Sustentvel Mamirau (Mamirau Institute for Sustainable Development, or IDSM). The local people of the reserve are involved in making management decisions that reconcile sustainable economic development with the conservation of biodiversity (Howard et al. 1995; SCM 1996; Crampton, Castello, and Viana this volume). Because of their economic importance, fisheries resources represent a major focus of management initiatives in the reserve.

Research undertaken in the Mamirau reserve and negotiations with local communities resulted in the development of a series of restrictive and advisory measures designed to regulate fishery resource use in the area. These measures are outlined in the reserve's management plan (SCM 1996) and summarized by Crampton, Castello, and Viana (this volume). In addition to restrictive measures, the reserve's management plan established a zoning system. This comprises a core no-use zone surrounded by a zone designated for sustainable resource use by the residents and user communities of the Reserve (fig. 9.1).

To promote the conservation of biodiversity, to stimulate the sustainable use of natural resources, and to improve the economic well being of the residents and users of the Reserve, the IDSM is undertaking several extension programs in partnership with the local communities. One of the most important programs, named *Novas Alternativas Econmicas* (novel economic alternatives), aims to promote alternative economic activities, diversify income sources, and enhance existing activities by either increasing production efficiency and/or by forging more lucrative marketing arrangements. This initiative involves the organization and empowerment of production groups, technical and administrative training, the construction and implementation of new infrastructure, and the development of systems to keep

track of the dynamic market conditions. The experimental fish commercialization initiative described in this article is a central component of this *Novas Alternativas Econômicas* program.

THE FISH COMMERCIALIZATION PROGRAM

In 1998 an experimental Programa de Comercialização de Pescado (Fish Commercialization Program, or PCP) was implemented in one of the nine organizational sectors of Focal Area of the reserve. The Jarauá Sector, which comprises around two hundred inhabitants in four communities, was selected for this experimental program for four reasons:

1. Its communities are located strategically at the entrance to the largest lake system in the Focal Area.
2. Fishing represents the main economic activity.
3. The communities have a relatively well organized social structure.
4. The communities have a history of cooperation with the IDSM throughout the installation of the reserve.

The program began with an economic viability study prepared by outside consultants. This study projected the scale of fisheries production in the area and proposed an operational structure and chronogram (Bostock 1998). It assisted with the early planning of the program but underestimated the time and infrastructure that would be required.

Several meetings and consultations with the participating communities were held at the onset of the program in order to define the logistic and administrative organization necessary to stage a new fisheries production program. Training courses in fish processing were also given in order to improve the quality of fish for marketing. Also, visiting instructors ran workshops on the structure and management of commercial associations and cooperatives. As far as possible, the traditional systems of fish production were maintained, or altered only so as to improve productivity without drastically altering the community organization.

There was, however, room for consensual experimentation. In the beginning one attempt was made to conduct communal pirarucu exploitation in which labor was divided among the participants into fishing, transporting, and processing, and the income then equally divided. This strategy was proposed because of the relatively small fishing quota allowed (see below) and the unequal distribution of fishing equipment (canoes, engines, ice chests, and tackle) among fishermen. Most fishermen and the supporting staff felt that a communal organization with division of labor was more appropriate for such conditions. However, this approach was unsuccessful for several reasons. Friction developed around the division of duties and unequal division of labor. More importantly, pirarucu fishing is traditionally organized on an individual or family level or by small teams composed mostly of relatives. In view of the failure of communal fishing arrangements, the organization of

pirarucu fishing expeditions reverted to individual or small group affairs organized by the fishermen themselves.

Following capture, fish are transported from the managed area to a processing base located at the Jarauá community. The base comprises a covered floating raft with a large icebox and water purifying system. This facility was built in partnership with the fishermen and serves as a base for eviscerating, cleaning, and chilling fish, as well as an administrative base for the fishing operations. The base allows up to 4 tons of fish and ice to be stored. When this limit is reached, the fish are transported to the nearby city of Tefé in a boat dedicated to this program and equipped with an ice hold. The fish are either sold in Tefé or sent to Manaus or other cities. The IDSM invested (at no cost to the fishermen) approximately US\$ 15,000 capital funds into the construction of the floating fish processing base plus the purchase of the boat and some equipment and supplies (a scale, office supplies, ice chests, etc.). The participating fishermen contributed manual labor and wood for the base.

The most important feature of the PCP is the elimination of intermediaries (*atravessadores*) between the fishermen and the market. Intermediary purchasers travel around the interior buying fishes at prices way below the market values. Most of the transactions are based on an exchange of fish for household supplies, such as cooking oil, salt, sugar, and coffee, all of which are bartered at inflated prices. By removing intermediate purchasers and improving production quality of the fish products, the fishermen of the Jarauá Sector are able to achieve a far greater economic return with smaller landings of fishes. Fishing expenses are the responsibility of the fishermen, while commercialization expenses are discounted proportionally from the sales. The profits are then divided according to the amounts and species of fishes captured by different fishermen. For team efforts the leader is responsible for paying the others according to the arrangements made with his partners.

The original proposal of the PCP was for fishermen of the Jarauá Sector to avoid capturing species which are prohibited by IBAMA bans and to capture fish only above legal minimum sizes. The idea was to divert fishing pressure toward species without capture restrictions and toward those for which there is no evidence of current overfishing (Bostock 1998). However, from the onset it became clear that only a few species, including pirarucu and tambaqui, were capable of generating sufficient profits to make the PCP an economically viable operation.

THE PROBLEMS OF PIRARUCU AND TAMBAQUI

Pirarucu is the most economically important species of fish for the residents and users of the RDSM (Queiroz and Sardinha 1999). It made up around 40% of the total weight of fish landed for sale and local consumption in the early 1990s. In six communities between 1993 and 1995, an average annual catch of between 1.4 and 1.6 tons was registered. On the basis of this information, the annual capture of pirarucu in the Focal Area of the reserve was estimated to be in the order of 110 to 150

RESOLVING THE PROBLEM OF PIRARUCU

From the onset of the PCP the biggest difficulty was related to the restrictions placed on the species with highest commercial value. The participating fishermen made it clear that the initiative would not generate financial returns unless pirarucus were involved. A monitoring system was implemented in early 1998 with the objectives of evaluating local fish production and identifying alternative species for extraction. The first results made it clear that the fishermen were right. Without pirarucu and tambaqui the yields of other species when weighed against production expenses would not generate profits.

The IBAMA decrees banning pirarucu since 1996 do allow for the controlled capture and commercialization of the species provided that they derive from *bona fide* managed fisheries. The PCP therefore proposed a system of managed pirarucu extraction involving a rotation system in thirty-one of the eighty lakes in the sustainable use zone of the Jarauá Sector. This proposal, requesting an initial quota of 3 tons of pirarucu for the late 1999 season, was submitted to IBAMA-Amazonas and accepted in June 1999. The quota was based on a previously published estimate of pirarucu production in várzeas of the Peruvian Amazon at around 0.3 kg/ha/year (Bayley et al. 1992). The Jarauá Sector comprises 56,300 ha of floodplain lakes and forests, allowing a crude production estimate of around 15 tons/year of pirarucu in the sector (assuming that the area is under low-fishing pressure). Considering an average weight of 40 to 50 kg for a 1.55 m pirarucu, this production corresponds to an annual harvest of 375 fish. The quota was set at a conservative one-third of this number in order to err on the side of caution during the beginning of this program and to review the results thereafter.

The first year's quota of 3 tons was significantly below the previous levels of pirarucu fishing in the Jarauá Sector. Monitoring data in the peak production months of September to December 1998 showed a total landing of around 600 pirarucu (12 tons of mantas), of which at least 95% were below the legal minimum length of 1.5 m. We later learned from the fishermen themselves that the number was actually higher, maybe around eighteen to twenty tons of mantas, because the fishermen smuggled part of the production. Of course, due to the continuing IBAMA ban on pirarucu fishing, all these fish were illegally captured, including those above the minimum size. Even though the 3-ton quota was well below previous harvesting levels, the fishermen of the Jarauá Sector were satisfied to reduce production and to follow all of the RDSM fisheries guidelines in return for being able to sell IBAMA certified legal pirarucu and to avoid intermediary purchasers.

In the PCP's second year (late 2000 season), a new tool became available to monitor pirarucu stocks. This tool was a direct counting method conducted as a collaboration between local pirarucu fishermen and a researcher from IDSM (Castello in press). Pirarucu are obligatory air breathers and betray their presence to fishermen when they rise to gulp air from the surface. Using a combination of

tons. The production of pirarucu occurs mostly during the low-water months of September to December. Queiroz and Sardinha (1999) showed that only 30% of the landed pirarucu were larger than the legal minimum total length (TL) of 1.5 m. This shortfall indicated that the species was being exploited beyond a maximum sustainable yield in some parts of the Reserve.

These studies led to the establishment of pirarucu fishing guidelines in the reserve's management plan (SCM 1996). The closed season and minimum capture size follow those established by federal legislation (IBAMA decrees 480/1991 and 8/1996). However, other guidelines imposed by IDSM were more restrictive. IBAMA decree 14-N/1993 established legal minimum sizes for the salted and sun-dried flanks (*mantas*) of pirarucu at 1 meter, effectively allowing the landing and commercialization of pirarucu well below 1.5 m TL. Instead, the Mamirauá management plan set limits of 1.15 m for salted and dried mantas and 1.25 m for fresh mantas. Given the economic importance of pirarucu, these restrictions on the commercialization of mantas were predictably unpopular with the reserve's residents and created some animosity towards the IDSM. Nonetheless, they were considered necessary to regulate pirarucu fishing, along with other measures proposed by reserve residents and users. These measures included a minimum gill net mesh size for pirarucu fishing (29 cm measured across opposed angles) and the prohibition of fishing soon after the water level starts to drop, extending until the floodplain lakes become isolated.

From 1996 onwards the IBAMA representation in Amazonas declared pirarucu stocks to be in a critical stage of overexploitation and established a two-year statewide ban on the capture and commercialization of this species. This ban was enacted by prohibiting fishing from June through November because a 1996 decree by the IBAMA head office in Brasília had already banned fishing from December through May every year throughout the Amazon basin (a period that roughly corresponds to the species reproductive season). So far this statewide suspension of pirarucu fishing has been renewed twice without interruption, and there are no indications that it will be lifted in the near future.

The ban ruled out the possibility of legal pirarucu fishing within the RDSM, in principle resulting in a potentially significant decline in income for the resident communities. Tambaqui fishing is still permitted by IBAMA, with a minimum landing size of 55 cm TL (IBAMA decree 8/1996) and a closed season, which lasts from three to four months and varies in exact dates from year to year (IBAMA decrees 6/1996 and 142/2001). The minimum size of 55 cm TL drastically complicates the capture of tambaqui in the reserve. Tambaqui spend the first five years or so of their life in floodplain lakes and forests and then, as adults (above around 55 cm TL) undertake upstream migrations along main whitewater river channels (Goulding 1979; Costa, Barthem, and Correa 1999). Only around 5% of the tambaquis in the floodplain lakes of the RDSM are larger than the legal minimum size of 55 cm TL (Costa, Barthem, and Correa 1999).

auditory and visual cues, experienced fishermen are able to distinguish between several fish surfacing at the same time and are able even to estimate the approximate size of the fish. These abilities, when used in the context of quantitative methods, yield replicable information about pirarucu numbers in floodplain lakes. This direct count methodology was compared to independent estimates of pirarucu population sizes from mark-release-recapture studies in floodplain lakes (at low water) and proved to be very accurate for fish larger than 1 m TL (Castello in press). Once the accuracy of this method had been established, it was then employed to monitor pirarucu stocks and to calculate sustainable landing quotas in the Jarauá Sector.

POLITICAL INTEGRATION OF THE PCP IN THE JARAUÁ SECTOR

Each organizational sector of the RDSM operates as a separate entity with its own local coordinator responsible for organizing bimonthly meetings. These meetings provide a forum to discuss and resolve community-related issues and disputes. This organizational structure is modeled on the rural community projects of the Catholic Church. Working at the sector instead of community level helped to distribute the benefits of the PCP to more people and also to increase the number of people trained to undertake duties for the PCP. In the beginning management was set up in an informal manner and consisted of a technical coordinator (held by an IDSM technician) and a community coordinator (elected by the participating fishermen). A formal terms-of-agreement document was drafted in which the fishermen agreed to support the PCP work by maintaining the infrastructure (boat and floating fish processing base), guarding the lakes selected for rotation, and enforcing the rotation system. The final, formal, organizational structure and the necessary delegations of responsibility were left for the fishermen to develop.

As the discussions evolved, the communities opted to register the PCP as part of a formal production association (Associação de Produtores do Setor Jarauá), marketing not just fish but also agricultural produce and artisanal products, such as pottery and basketwork. A decision was made to extend the PCP infrastructure to the storage and transport of agricultural and artisanal products. The formation of a production association also allowed the formal inclusion of women. The presence of women was significant from the administrative point of view because it increased the possibility of finding people with skills to assume such tasks as record keeping and accounting. Most fishermen are illiterate, whereas literacy rates are higher among women. By the time the production association was formally registered in July 2001, the associates had already assumed most of the administrative and technical duties originally assumed by extension workers and community assistants from IDSM. Several women were elected to administrative posts, among them secretary and accountant. Currently, technicians from IDSM support the association mainly by establishing contacts with fish buyers outside Tefé (because of communication difficulties from the RDSM).

The legal registration of the production association permits marketing outside the state of Amazonas. In 2001 a contract was signed to supply a chain of restaurants in Brasilia with a major part of the annual pirarucu quota at an excellent price of 8.00 Brazilian Reais (R\$) per kilo (exchange rate in 2001 was approximately \$US 1 = R\$ 2.3–2.7). The restaurant chain in turn was able to provide its customers with environmentally friendly pirarucu purchased legally and derived from managed fisheries in an area protected for biodiversity conservation.

ECONOMIC, SOCIAL, AND ECOLOGICAL RESULTS

The results of the PCP's first three years of operation have proven very satisfactory from the economic, social, and ecological points of view (table 9.1). In 1999 most of the harvested pirarucu were sold in Tefé. For the first batch of fish brought from the RDSM to Tefé in 1999, the possibility of sending the fish by passenger boat for sale in Manaus was investigated. However, the sale price would not have justified the expenses (freight costs and expenses for somebody to accompany the produce to its final destination). At that time it was impossible to find a buyer in Manaus who was willing to pay a premium for legally commercialized pirarucu. The trade in illegal pirarucu has continued more or less unabated throughout Amazonas state despite the IBAMA 1996 ban on commercialization. IBAMA enforcement of this ban has completely failed and most traders are not in the least bit worried about breaking the law.

In 1999 400 kg of pirarucu from the PCP were sold to a food processing company in Manaus at R\$ 4.00/kg. The rest was sold in Tefé via an intermediary who agreed to pay the going rate for Manaus (R\$ 3.00–3.40/kg). The food processing company in Manaus placed another order, but by the time it was received, the an-

TABLE 9.1 Production Statistics for the First Three Years of Operation of the Fisheries Commercialization Program of the Jarauá Sector, Mamirauá Sustainable Development Reserve

	1999	2000	2001
Number of participating fishermen	42	46	67
Number of species commercialized	7	13	12
Total production (tons)	6.2	9.9	15.0
Pirarucu production (tons)	3.0	3.5	5.3
Average sale price for pirarucu (R\$/kg)	3.85	6.00	7.96
Total sales (R\$)	16,903	29,209	56,687
Mean income per fisherman (R\$)	402	635	846

Note: Data refer only to the three-month production season of late September through early December (including trimester incomes). Exchange rates for US\$1 are approximately: 1999 (R\$1.6–2.0), 2000 (R\$1.7–2.3), 2001 (R\$2.3–2.7).

TABLE 9.2 Total Capture (TC, in kg) and Average Sale Price (ASP, in R\$) for the Fish Species Commercialized by PCP from 1999 through 2001

SPECIES	SCIENTIFIC NAME	1999		2000		2001	
		TC (kg)	ASP (R\$)	TC (kg)	ASP (R\$)	TC (kg)	ASP (R\$)
Pirarucu	<i>Arapaima gigas</i>	3000.0	3.60	3377.0	6.00	5285.0	7.96
Aruanã	<i>Osteoglossum bicirrhosum</i>	—	—	1042.0	0.22	4380.0	0.46
Tambaqui	<i>Colossoma macropomum</i>	2166.6	2.34	2524.0	2.07	2921.00	2.87
Pirapitinga	<i>Piaractus brachyomus</i>	—	—	—	—	40.0	1.00
Caparari	<i>Pseudoplatystoma tigrinum</i>	73.4	1.89	754.8	1.92	401.0	2.33
Surubim	<i>Pseudoplatystoma fasciatum</i>	—	—	30.5	1.46	5.0	0.60
Dourada	<i>Brachyplatystoma flavicans</i>	—	—	217.5	1.39	96.0	2.15
Filhote	<i>Brachyplatystoma filamentosum</i>	—	—	219.0	1.44	551.5	2.43
Pirarara	<i>Phractocephalus hemiliopterus</i>	—	—	116.0	0.71	211.0	0.56
Pacamum	<i>Paulicea lutkeni</i>	—	—	21.0	0.85	—	—
Pescada	<i>Plagioscion squamosissimus</i>	11.5	0.85	—	—	2.0	0.80
Tucunaré	<i>Cichla monoculus</i>	879.0	0.92	1188.5	0.93	565.0	2.19
Acará-açu	<i>Astronotus ocellatus</i>	84.0	1.00	230.5	0.52	586.0	0.64
Acará-branco	<i>Chaetobranchius flavescens</i>	—	—	84.5	0.69	—	—

annual quota of 3 tons had already been reached. The next year, with a renewal of IBAMA authorization for PCP pirarucu landings, the same company purchased the entire PCP quota of pirarucu at R\$ 6.00/kg. The other species captured in 1999 and 2000 were sold mostly in Tefé. The complete list of fish species exploited by PCP is presented in table 9.2.

Socioeconomic monitoring in one of the communities of the Jarauá Sector, São Raimundo do Jarauá, showed that, despite the restrictions in fishing (all fishes were captured in accordance with minimum size regulations and closed seasons established by law and by the Mamirauá Management Plan) and despite the overall reduction in pirarucu landings, there was no attendant reduction in annual family incomes. On the contrary, average family incomes increased from around R\$ 1,900 in 1995 to R\$ 2,700 in 1998/1999 and to R\$ 4,100 in 2000. Using as a reference point a *cesta básica* (a standardized shopping basket of household supplies used by Brazilian social scientists for economic surveys), the buying power of São Raimundo do Jarauá doubled from 1995 to 2000 (table 9.3). Unfortunately, due to the way the data were collected, it was not possible to calculate the proportion of the annual wage derived from fishing. However, we believe that the contribution of fishing was significant because no other major revenue-generating activity was introduced in Jarauá during this period.

All fish commercialized by the PCP were above the legal minimum size limits

TABLE 9.3 Mean Annual Family Incomes from a Socioeconomic Monitoring Survey at the Community of São Raimundo do Jarauá

	1994-95	1998-99	2000
Number of families	16	20	19
Mean annual family income (R\$)	1,939	2,721	4,142
Cost of a <i>cesta básica</i> (R\$)	43.68	44.14	46.98
Buying power (number of <i>cestas básicas</i>)	44	61	88

Source: Edila Moura

TABLE 9.4 Mean Total Lengths (TL) for Species Exploited by the PCP for Which Size Limits Have Been Established by IBAMA

SPECIES (MINIMUM TL)	1999	2000	2001
	Mean ± SD (n)	Mean ± SD (n)	Mean ± SD (n)
Pirarucu (150 cm)	162.9 ± 21.5 (126)	157.8 ± 10.3 (143)	165.8 ± 13.4 (188)
Tambaqui (55 cm)	61.3 ± 5.1 (455)	59.2 ± 4.0 (610)	63.4 ± 4.6 (582)
Caparari (80 cm)	89.5 ± 8.4 (12)	86.5 ± 6.8 (147)	88.0 ± 8.4 (69)
Surubim (80 cm)	—	86.0 ± 9.4 (6)	85.8 ± 7.0 (5)
Aruanã (44 cm)	—	—	68.1 ± 4.9 (495)
Tucunaré (25 cm)	—	—	36.4 ± 3.0 (134)

Note: TLs for pirarucu were estimated from lengths of filleted flanks.

established by IBAMA (table 9.4). These sizes contrast with the situation immediately before the PCP project began when 95% of landed pirarucu from the Jarauá sector were below the legal size limit (fig. 9.2). There was also an encouraging increase in the diversity of commercialized species (table 9.1), indicating that fishermen were beginning to divert fishing efforts toward previously underexploited species (table 9.2).

Stock assessments in the sustainable use zone of the Jarauá Sector showed a 300% increase in the number of pirarucu between 1999 and 2001 (table 9.5). These assessments utilized the direct count methods described earlier (Castello in press) and discriminated between juvenile fish (1 to 1.5 m TL) and adult fish (1.5 m TL). The number of adult pirarucu counted in the 1999 stock census was used to calculate the quota submitted to IBAMA-Amazonas for the subsequent low-water season of 2000. The requested quota represented the removal of approximately 30% of the number of adults counted. This percentage corresponded to a total of 3 tons of mantas, or around 120 adult fish (assuming a mean capture size of 1.55 m, 40 to 50 kg of total weight per fish, and 20 to 25 kg of saleable meat per fish). A stock census

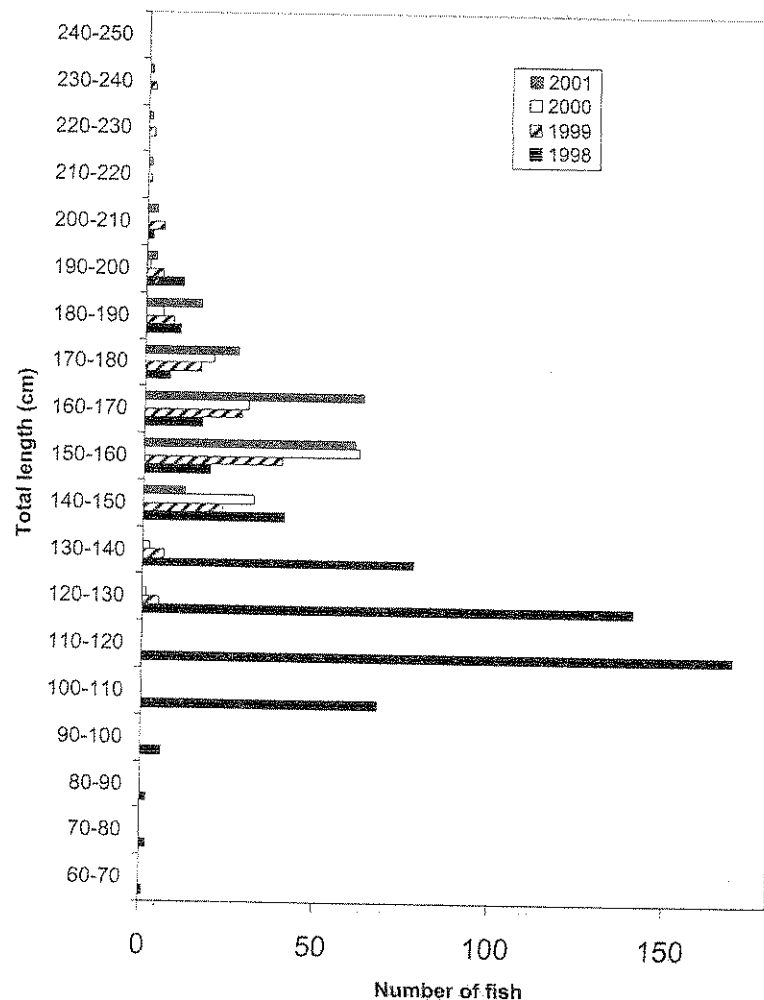


FIGURE 9.2 Histogram of size classes for pirarucu captured by communities in the Jarauá Sector of the Mamirauá Sustainable Development Reserve in the low water periods (September through December) of 1998-2001.

(based on the same methodology) in the low-water season of 2000 was used to plan the quota for the subsequent harvest in 2001. For 2001 a quota of 8 tons, corresponding to around 300 fishes, was submitted to IBAMA.

Before the 2001 season began, the fishermen proposed to relax the lake rotation system rules in favor of choosing lakes on a year-to-year basis. Fishing and access conditions to any given lake vary considerably from year to year, making it difficult to stick to a rigid schedule. In fact, some lakes are almost impossible to enter during very dry low-water periods. Such was the rate of increase of pirarucu stocks in

TABLE 9.5 Estimates of the Number of Pirarucu in Floodplain Lakes of the Jarauá Sector of the Mamirauá Sustainable Development Reserve from 1999 to 2001

YEAR	JUVENILES (1-1.5 M)	ADULTS (> 1.5 M)	TOTAL
1999	2,149	358	2,507
2000	2,984	994	3,978
2001	5,901	1,441	7,342

Note: Data from censuses involving a new direct counting technique (see text).

the sector that the fishermen thought it might be possible to capture the established quotas by fishing in the floodplain channels alone and without ever needing to enter the lakes. IBAMA agreed with the changes in management but unjustifiably refused to allow an increase in the pirarucu quota to the 8 tons requested for the 2001 low-water season; the quota was based upon the pirarucu stock assessment method. Instead, only 5 tons was granted. This tonnage corresponded to around 200 adult pirarucu.

In contrast to previous years, the IBAMA harvesting permit for 2001 established not only a quota for the total weight of mantas but also a limit to the total number of fish that could be landed. This alteration in the proceedings resulted in considerable changes in the way in which fishing was organized in 2001. On the basis of the numbers of fish, the pirarucu quota became more concrete and manageable. It began to be treated as a share and split among the associates according to specific rules. Also, each shareholder tried to make the best use of his share.

In 1999, the first pirarucu fishing season, no criteria were established by the PCP members for the distribution of pirarucu quotas. Those fishermen who benefited most were the best equipped (in terms of canoes, ice boxes, and tackle) and those with cash to finance fishing trips. In 2000 the PCP members decided to divide equitably the total pirarucu quota among the four communities, taking into account the number of fishermen in each community. In 2001, with the production association already legally registered, criteria were established by the directors to distribute the fish to associates according to their relative contribution to the different aspects of management required to sustain the fishery. These contributions included participation in lake-vigilance excursions, respecting the fishing rules (such as minimum sizes and closed seasons), and participating in meetings. The production association leaders viewed these criteria as a way to increase the number of people involved in fisheries management. During an open meeting the distribution of the quota (in numbers of pirarucus instead of weight) was then established at between zero and three fish per associate.

This new system of quota distribution was well received by the associates and is

expected to be maintained for the future. The results from 2001 demonstrate that each fisherman made the best of the quota he received by selecting and culling larger fishes that would give a better financial return. The average pirarucu yielded 28.2 kg of mantas in 2001, as compared with 23.8 kg in 1999 and 24.5 kg in 2000. The average size of captured pirarucu reached 1.6 m in 2001 (fig. 9.2), its highest level since the onset of the PCP.

FINAL CONSIDERATIONS

In just three years of operation, the Fish Commercialization Program of the Jarauá Sector has proven to be a viable model for the management of várzea fisheries. During this time many operational problems were identified and resolved. One of the greatest sources of difficulties was the complex infrastructure and the maintenance of a boat. For example, the Port Authority requires specific training for boat crews, including at least one skipper and one mechanic. Four fishermen volunteered to take the required courses offered by the navy and gained the necessary diplomas and documents. Another problem was that the administrative affairs of the PCP require the dedicated full-time attention of at least two people. The association consequently provided two salaried positions for two organizers and paid a salary from R\$ 150 to 250 per month (depending upon the number of active fishermen since each contributed with a share of R\$ 5 to make up the salary). In the end a small number of people assumed multiple tasks, including administration, boat piloting, and participating in sales trips. In the future more people are expected to become involved and the workload to be spread more comfortably.

Administrative delays at IBAMA proved to be one of the greatest sources of difficulties in the development of the Jarauá PCP. Large amounts of complex paperwork attended almost every stage of the proceedings and the resulting permits and documents were sometimes issued late. In 2001, for example, IBAMA permits for capture and commercialization of pirarucu arrived at the end of October, already two months into the low-water fishing season. This delay left only one month for the fishing quotas to be met, in contrast to the two to three months of the previous two years. The short fishing season made it impossible for the association to meet the quota, and only 188 of the 200 authorized pirarucu were caught.

The most important contribution of this experimental Fisheries Commercialization Program is that it proves the feasibility of exploiting high-value species at good prices while at the same time allowing stocks to increase through a program of combined management, vigilance, and monitoring. The community-based production association was able to manage its own affairs with initial—and thereafter occasional—technical assistance from the outside, demonstrating that communities can incorporate new systems and build upon them.

The general model developed in Jarauá may be a powerful tool for the management and conservation of fishery resources in other parts of the Amazon basin. The direct counting method for assessing pirarucu stocks was also considered to be vital

to the success of this program. This tool represents the integration of traditional knowledge with scientific methodology, and helped tremendously with the introduction of fisheries management principles to the communities. This method is already being successfully taught to fishermen from other areas of the Amazon basin, such as the Santarém region in the Brazilian state of Pará, the Pacaya-Samiria National Reserve in Peru and Guyana. In fact, it is currently under consideration by the Guyanese government as a tool in the country's strategy to promote the recovery and sustainable use of the pirarucu stocks.

The positive results of the PCP in the Jarauá Sector have attracted much interest from fishermen in other sectors of the Mamirauá Reserve and of the adjacent 2.3 million-ha Amanã Sustainable Development Reserve. Several communities of these other areas have requested technical assistance to develop similar programs. Nonetheless, the PCP system in the Jarauá Sector was expensive to set up and took a long time to be implemented by and integrated with the communities. We conclude that the ideal solution would be to implement similar but less complex, low-cost systems adapted to local ecological and socioeconomic conditions. These initiatives could, for example, rely on hiring boats for the transport of fish rather than investing in the purchase and maintenance of vessels. Replicating simplified and less expensive systems based upon the Jarauá model of fisheries production and management would allow more communities to benefit in a shorter time frame.

In 2001 a simpler fisheries production program was initiated in the Tijuaca Sector of the Mamirauá Reserve. The initial results were promising, but delays in the liberation of IBAMA capture and commercialization permits for pirarucu meant that in its first year of operation the Tijuaca PCP only had time to land 40 of a total quota of 120 pirarucus before the season closed. In 2002 two other simplified programs will be launched, one targeting the Fishermens Association of the nearby town of Maraã (around 160 members) and the other assisting the seven communities in the Coraci Sector of the Amanã Reserve (benefiting around 400 people). Both projects have been submitted to IBAMA and are currently being appraised.

Since 2001 IBAMA-Amazonas streamlined its internal procedures. The permits for the Jarauá sectors (500 pirarucus or approximately 15 tons of mantas) and Tijuaca (120 pirarucus or approximately 3 tons of mantas), with the full quotas requested by the fishermen through the stock assessment method, were issued in late June 2002. We expect that the results for Maraã and Coraci projects (120 pirarucus each) will be out well before the beginning of the fishing season, allowing time for the fishermen to plan ahead for their first pirarucu management experience.

The Jarauá fisheries management system, which began in 1999 with merely 3 tons of pirarucu, is now ready to harvest 15 tons of legally caught and sized fish. On the basis of ongoing monitoring of pirarucu stocks, we expect that the total production of the four ongoing systems will double next year. This significant increase is expected because only a fraction of the full potential of the Maraã and Coraci systems will be harvested in 2002. On the basis of the direct counting method, the fishermen from Maraã, for example, could start harvesting 400 fish in the first year.

However, they preferred to begin on a smaller scale and review the situation afterwards. In the case of Coraci the first quota was based on a stock assessment survey using the direct count method in a representative subset of the available lakes made in 2000. After this survey, and in the expectation of having a pirarucu management system for this area, the fishermen decided to completely ban fishing for commercialization purposes. They wanted pirarucu stocks to recover and to start harvesting them in a different, sustainable manner. In a four to five year time frame and with the addition of new community fisheries management systems, we expect that the total production of wild pirarucu in the Mamirauá and Amanã reserves will reach 100 to 150 tons per year.

Today, the Mamirauá Institute is working on the development of a large-scale model for the implementation of this new generation of simplified community-based fisheries management programs around the várzeas of the Brazilian Amazon. Simplicity, technical practicability, and the ability to mould new initiatives around preexisting local conditions are fundamental principles for the successful planning and implementation of such initiatives. The role of technicians will be mostly limited to training fishermen in procedures for stock assessment (for pirarucu and other species), methods for setting quotas, basic management principles, fish processing techniques, and association management. The commercialization of the harvests, and the day-to-day running of production associations will be the responsibility of the associates themselves. Due to communication difficulties, communities at great distances from markets are placed at a considerable disadvantage in establishing commercial contacts. These cases would probably need the intervention of technicians from such organizations as IDSM. Likewise, the technical reports required from community fisheries programs by IBAMA would probably need to be compiled by experienced fisheries technicians for most communities.

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Community Ownership and Live Shearing of Vicuñas in Peru

EVALUATING MANAGEMENT STRATEGIES AND THEIR SUSTAINABILITY

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In 1994, after years of being listed under Appendix I of the CITES convention, vicuña (*Vicugna vicugna*: Camelidae) populations in Peru were reclassified as an Appendix II species. Under this classification Peru obtained permission to export fiber from animals captured in their wild state, partially shorn, and then released. In 1995 the Peruvian government passed Law # 26496, "System of regulation of property, commercialization and sanctions for the hunting of vicuñas, guanacos, and their hybrids." The purpose of the law was to give Andean *campesinos* a direct interest in the conservation of the vicuña and to motivate them to participate in conservation efforts. This law includes the following components:

1. It gives usufruct rights of vicuñas to communities if such animals are found within community boundaries and also the rights to a portion of profits from the sale of vicuña fiber
2. It gives the communities the responsibility of management and "rational" use of the vicuña
3. It enacts legal penalties for poaching that range from two to twenty-five years imprisonment, depending on the gravity of the crime committed (El Peruano, July 11, 1995).

This law represents a new focus for conservation efforts of the vicuña in Peru. *Campesino* communities are legally recognized entities, which by and large, are made up of Andean indigenous peoples. As of 1998, 5,666 campesino communities were legally registered, and 3,956 have legal title to their land (Velasquez 2001). With the granting of exclusive usufruct and management rights to communities, the vicuña has in effect ceased to be a totally public resource. The capture, live-shearing, and release program (called the *chaku* in Quechua) offers many possibilities for the sustainable utilization of the vicuña in Peru and other South American