Table 81. Role of fishery brokers in Northern Brazil, especially in the State of Para, from Interview Survey. (A) Phase 1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey.

(A)

Question to broker	Summary of answer				
	Town	Village		Hamlet	
	Belem	Soure	Processing company in Vigia	Cajueiro	Mosqueiro (vila)
Q1.[a]	Douraba 700 kg, Pescada branca 300 kg, Piramutaba 200kg, and Bagre 100 kg per day respectively	Bagre, Dourada, Filhote, Gurijuba, Pescada amarela, P. branca, and Piramutaba ; total 100 kg per boat, and total 1,000 kg/week from 22 boats	All kind of fish ; total 1,000 t/year from 40 boats	Bagre 50 kg, Dourada 50 kg, Filhote 50 kg, Pescada amarela 50 kg, and Piramutaba 50 kg per day respectively	Bagre, Dourada, Filhote, Pescada branca, and Piramutaba ; -
Q2.[b]	Fixed 3 boats	Fixed 6 boats ; fixed some boats ; fixed	Fixed	Fixed 5 boats	Fixed 5 boats
Q3.[c]	Market price and negotiation	Fixed price (Tabela) ; official price in market (Ver o Peso)	Market price	Not fixed	On the basis of the Tabela
Q4.[d]	Yes, various prices by them	Yes, various prices by size ; no, dependence on the price in Ver o Peso ; no in such cases	-	-	No
Q5.[e]	Yes	Yes, sometimes ; no ; no in such cases	-	-	-
Q6.[f]	I advance him money for oil, food, and etc. occasionally.	If it is small sum of money, I finance him.; I advance oil, food, and etc. for 1-2 days fishing ; I offer oil (5¢) and food sometime.	-	-	-
Q7.[g]	Ice-making factory, and etc.	Not fixed ; in Belem	Our making ice	Not fixed ; oil 10¢, farinha, and etc.	Not fixed ; oil 10¢, farinha, and etc.
Q8.[h]	Belem	Market in Soure ; Belem ; Ver o Peso	Sao Paulo and Minas Gerais	At first; Cajueiro, then Belem (more than half)	Market in Mosqueiro
Q9.[i]	Movement for systematization of broker now	4 brokers in Soure, but no organization ; no organization	No organization	-	-
Q10.[j]	Yes, about 2 times	No change ; yes	No, decrease to 60%	Yes	Yes, some increase
Q11.[k]	No change	No change ; in old times large and big, but no change during the past 2-3 years ; small and little	No change	Small and little	No change
No. of interviewees	1	3	1	1	1

a What kind of fish and how many fish do you buy ? ; b Do you fix fisherman you buy fish from ? ; c How do you decide the price of fish ? ; d Do you make different offer on fish by freshness or size even if it is same species ? ; e If you don't agree with fisherman as regarding fish price, does he sell fish to another brokers ? ; f In case of Q5, how will fisherman settle up his dept laying in fishery necessities before he go out fishing ? ; g Where do you buy oil, ice, and etc. ? How many is it ? ; h Where do you sell fish bought from fisherman ? ; i Are there the organization of fellow brokers ? ; j Do you think number of fisherman are increasing during the past 2-3 years ? ; k Do you think catch and size of fish change during the past 2-3 years ?

Table 81. Continued

(B)

Question * to broker	Summary of answer				
	Town		Village		Hamlet
	Belem	Santarem	Vigia	Processing company in Vigia	Mosqueiro (vila)
Q1.	Only sea fish for supermarket, 50 kg/day. Camorim, Dourada, Filhote, Gurijuba, Pargo, Pescada amarela, P. branca, Pescadinha go, Piramutaba, Sarda, Tainha, and etc. as total of 3 brokers ; 200-1,000 kg/day, 100-150 kg/day, and 200-300 kg/day	Curimata, Dourada, Filhote, Jaraqui, and Tambaqui ; 200 kg/day	Dourada, Gurijuba, Pescada amarela, P. branca, and Serra ; -	Cacao, Camorim, Dourada, Gurijuba, and Piramutaba ; -	Dourada, Gurijuba, Pescada amarela, P. branca, and Piramutaba ; 100-150 kg/day
Q2.	No ; yes ; yes, fixed 12boats ; yes, fixed 3-4 boats	Yes, fixed 5 boats	Yes, fixed 15 boats	No, different 10-15 boats	Yes, fixed 5 boats
Q3.	Market price ; actual price	Market price	Market price	Market price	Actual price in market
Q4.	No, same price ; no, always fresh ; yes, sometimes ; yes, at the asking price	No, same price	-	-	No, same price
Q5.	No ; yes ; no, arrived at an agreement always	-	Yes	Yes	No, arrived at an agreement
Q6.	I supply food and oil for him.	-	I lend oil, food, ice to him.	I advance to 10 boats.	-
Q7.	Market ; -	Market ; -	- ; (R$500 per trip)	-	Market ; -
Q8.	Supermarket ; market ; Ver o Peso, stall, carrying-car (caminhao), and etc.	My own shop	Belem and Castanhal	Belem in fillet	My own shop
Q9.	No, unnecessary	No	No	No	No
Q10.	Decrease to 2/3 ; increase ; increase in number of small boats, but decrease as a whole	No change or increase	-	Decrease	No change
Q11.	Decrease to 2/3 ; decrease to 70% ; smaller	Increase in catch and size	Decrease in catch year after year	Decrease after increase in catch, and decrease in catch of artisanal fishery	Decrease in catch
No. of interviewees	4	1	1	1	1

* The same one as Table81. (A)

Table 81. Continued

(C)

Question * to broker	Summary of answer		
	Town	Village	Hamlet
	Belem	Vigia	Cachoeira
Q1.	Dourada, Piramutaba, Pescada branca, Filhote, Gurijuba, and Pescada amarela; total 200 - 1,000 kg/day	Dourada, Piramutaba, Pescada branca, Filhote, Gurijuba, and Pescada amarela; total 300 - 2,000 kg/day	Dourada, Piramutaba, Pescada branca, Filhote, Gurijuba, and Pescada amarela; total 200 - 1,000 kg/day
Q2.	Yes, fixed 6 - 15 boats	Yes, fixed 5 boats	Yes, fixed 20 boats
Q3.	Market price	Market price	Market price
Q4.	Yes, prices by size	Yes, prices by size	Yes, prices by size
Q5.	Yes	Yes	Yes
Q6.	I advance to fishermen occasionally	No advance	No advance
Q7.	Ice making factory, and etc.	-	-
Q8.	Ver o Peso	Vigia	Ver o Peso
Q9.	No organization	No organization	No organization
Q10.	Yes	Yes	No, decrease
Q11.	Yes, small and little	Yes, increase	Yes, decrease
No. of interviewees	1	1	1

* The same one as Table81. (A)

Fishery products processors also purchased from fishermen in the same terms; some of them sold the fish to other States such as São Paulo and Minas Gerais, while others filleted them for the Belém market.

e-2) Advance payment to fishermen

Many brokers paid fishermen in advance when the latter needed money for fishing or obtaining supplies.

e-3) Fishery broker organizations

There were no organizations for fishery brokers, although steps toward the formation of such an entity were being taken in Belém.

e-4) Changes in fisheries according to brokers

According to the majority of responding brokers, the number of fishermen has increased, but catch size and fish size have remained unchanged or declined over the past 2–3 years. In contrast, Santarém brokers replied catch has increased and fish size has grown in the same period.

5.3.3. Size Composition of the Key Fish Species Landed

Data on size composition of the key fish species defined in Table 4 were obtained by using the measuring-card punching method at the various landing sites. Visited sites were the communities of Belém, Mosqueiro, Soure and Vigia (in the Amazonian Estuary) in the Phase 1 Rainy Season Survey; Belém and Bragança (estuary, or rather the Atlantic coast) and Santarém, Parintins and Iranduba (upstream) in the Phase 1 Dry Season Survey; and Belém, Colares, Soure and Vigia (estuary) in the Phase 2 Rainy Season Survey. The Belém landing site was divided into the subsites of Icoaraçi, where most of industrial fishing campanies are located, and Ver-o-Peso, the main fish marketplace.

None of the key species could have size composition data taken at every one of the landing sites listed above.

(a) Piramutaba *Brachyplatystoma vaillantii*

Figure 121 summarizes the data on size composition of piramutaba, obtained at 7 fishing communities in the three surveys.

a-1) Phase 1 Rainy Season

Size composition of piramutaba caught by industrial bottom trawler (cod-end mesh size, 10 cm) and artisanal gill nets (mesh size 6–15 cm, usually 14–15 cm) and landed at each community exhibited multiple modes. Length classes at predominant mode were between 32–36 cm in Icoaraçi and Vigia and 42–44 cm in Ver-o-Peso and Soure; other than that, the 32–34 cm mode in Ver-o-Peso was noteworthy. The mean fork length followed those modes closely, with 35–37 cm in Icoaraçi and Vigia and 40 cm in Ver-o-Peso and Soure.

a-2) Phase 1 Dry Season

Size composition of piramutaba caught by industrial bottom trawlers and landed at Icoaraçi showed a mode at 36–38 cm class. This was one class larger than the predomunant mode class in Icoaraçi in the previous Rainy Season, but there were no significant differences in mean fork length between seasons (Rainy, 36.7 cm; Dry, 36.3 cm).

Size composition of piramutaba caught by artisanal gill nets (mesh size 10–15 cm in Santarém) upstream from the Estuary and landed at Santarém and Iranduba exhibited multiple modes. Besides the predominant mode at 60–62 cm class, other noteworthy modes in Santarém were at the 48–50 cm and 88–90 cm classes. In Iranduba, predominant mode was at 40–42 cm class, with a lesser one at 62–64 cm class. Mean fork lengths were 59 cm in Santarém and 48 cm in Iranduba. The main difference in size composition between the Estuary and upstream is that small (under 30 cm) piramutaba were caught in the former and not in the latter, while large (over 60 cm) individuals were found upstream but not in the Estuary. Size composition of piramutaba from industrial bottom trawlers tended to be smaller than those from artisanal gill nets in both seasons.

Differences in distribution pattern and mean fork length were observed through discrepancies in size composition (Figure 30) between that reported by the Sea-Borne Survey during the Dry Season (and following methods similar to those of industrial fishery) and that obtained through the Landing Site Survey of the same period (Figure 121, B, at Icoaraçi). Distribution pattern of size composition was polymodal for the Sea-Borne Survey results and monomodal for those of the Landing Site Survey. Among multiple modes for the Sea-Borne Survey size composition, the mode at 34–36 cm class seems to roughly correspond to the predominant mode at 36–38 cm observed in the Landing Site Survey; however, the predominant mode at 14–16 cm class reported in the former survey did not find correspondence in the latter. This resulted in the mean fork length of 36 cm obtained from the Landing Site Survey being larger than that of 29 cm obtained from the Sea-Borne Survey. These differences were mostly caused by the significant catch at the covernet around the cod-end of the bottom trawl used in the Sea-Borne Survey. In other words, the covernet of the bottom trawl used in the survey caught small fish (with a mode at 14–16 cm class) who had evaded the cod-end, while industrial bottom trawls without a covernet would capture only a few of those small fishes.

a-3) Phase 2 Rainy Season

Size composition of piramutaba caught by artisanal gill nets in the Amazonian Estuary and landed at each community exhibited monomodal (Soure, Vigia) and polymodal (Ver-o-Peso, Colares) components. Mode in that of Soure and Vigia occured at 42–44 cm class, and dominant modes in that of the other two communities occured between 52–58 cm (Ver-o-Peso) and between 36–42 cm (Colares). Largest mean fork length was at Ver-o-Peso (57 cm), followed by Soure (45 cm), Vigia (43 cm) and Colares (38 cm). Except for Colares, the other communities presented larger mean fork lengths than in the previous year: the difference was particularly striking in Ver-o-Peso — 17 cm.

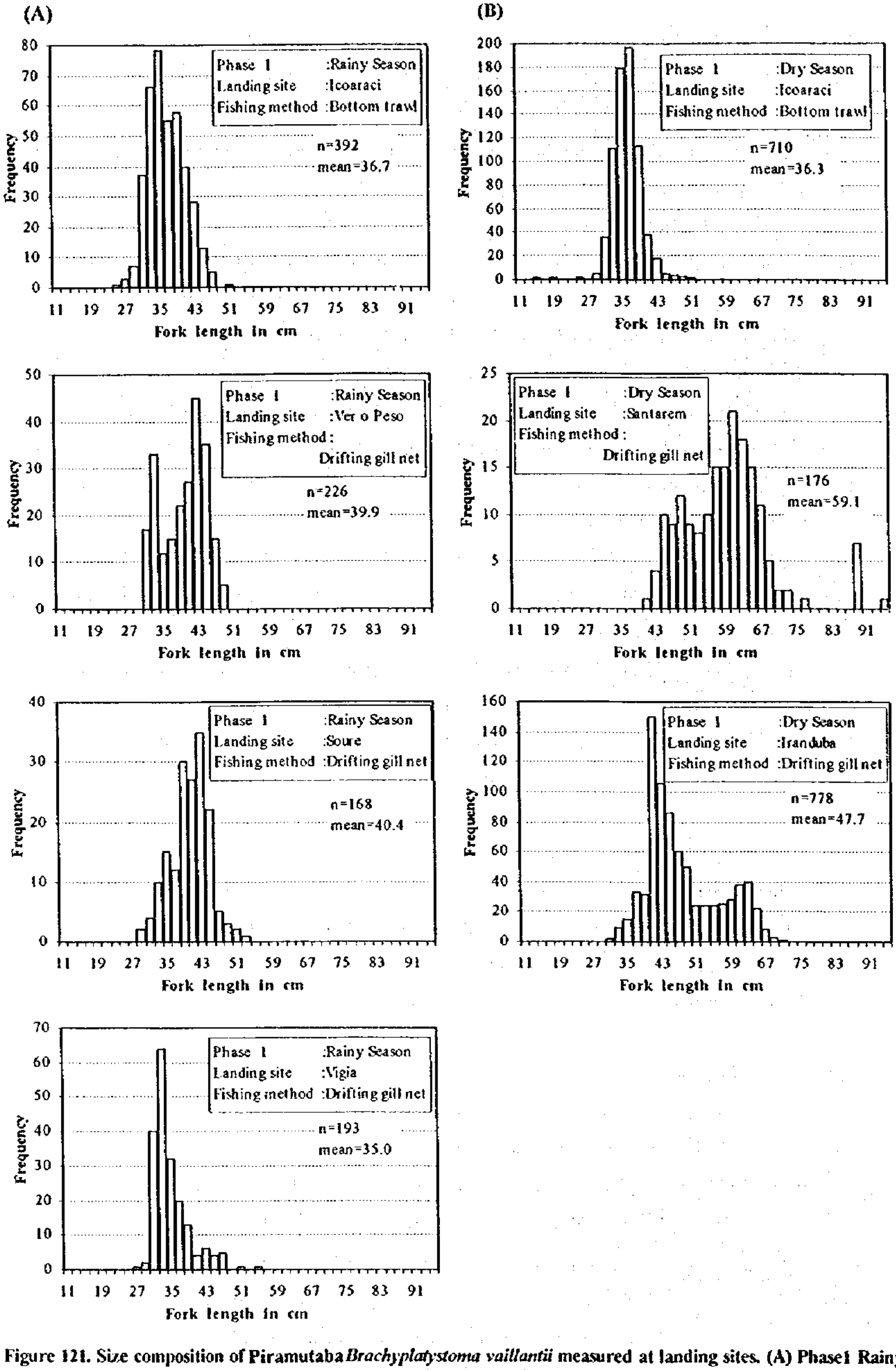
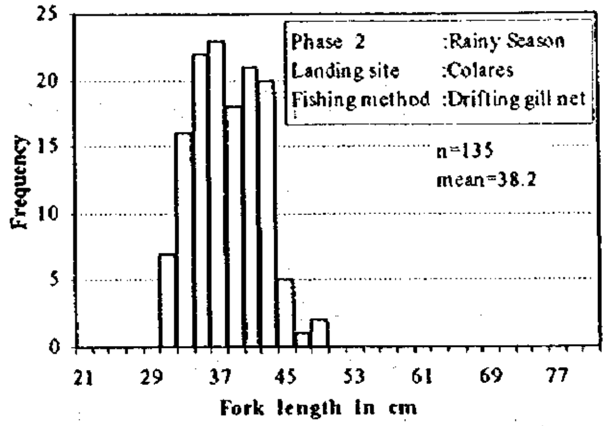
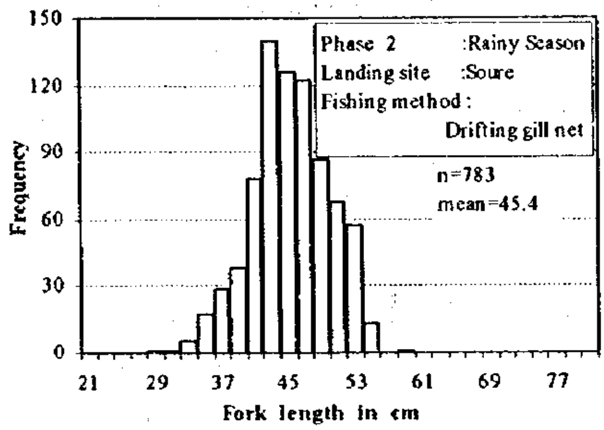


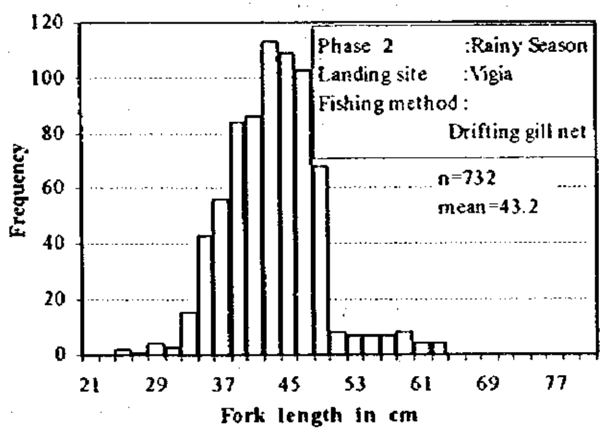
Figure 121. Size composition of Piramutaba *Brachyplatystoma vaillantii* measured at landing sites. (A) Phase1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey.

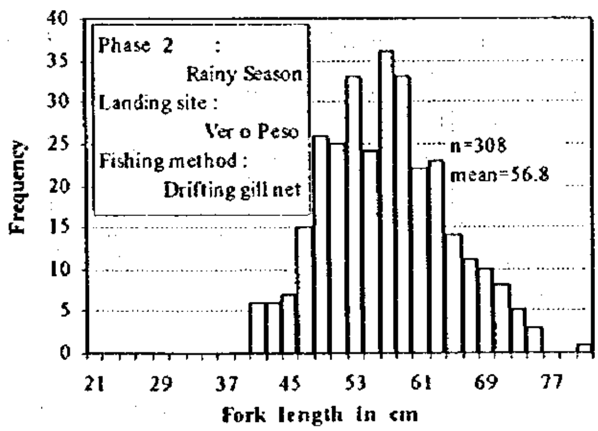
Figure 121. Continued

(C)









(b) Dourada *Brachyplatystoma flavicans*

Figure 122 summarizes the data on size composition of dourada, obtained at 7 fishing communities in the three surveys.

b-1) Phase 1 Rainy Season

Size composition of dourada caught by industrial bottom trawlers and artisanal gill nets in the Amazonian Estuary and landed at each community exhibited multiple modes, particularly in Mosqueiro. Predominant one among these modes occurred at 44–46 cm class in Icoaraçi, 56–58 cm class in Ver-o-Peso, 74–76 cm class in Mosqueiro and 32–34 cm class in Vigia. There were well-defined modes also of 60–62 cm class in Icoaraçi; and 40–42 cm, 50–52 cm, 64–66 cm, 82–86 cm and 94–96 cm classes in Mosqueiro. Mean fork length mostly reflected those modes, with a maximum of 69 cm in Mosqueiro, a minimum of 34 cm in Vigia, and 51 cm and 58 cm respectively in Icoaraçi and Ver-o-Peso.

b-2) Phase 1 Dry Season

Size composition of dourada caught by artisanal gill nets and landed at each community exhibited multiple modes. Predominant mode in Ver-o-Peso occurred at 66–68 cm class, that mode class is 10 cm larger than that (56–58 cm) recorded in the same place in the Phase 1 Rainy Season. Mean fork length (69 cm) was also 11 cm larger than in the Phase 1 Rainy Season. Most of the dominant modes observed in Santarém and Iranduba, upstream from the estuary, were distributed within the 76–88 cm classes in both communities; there, mean fork length was respectively 83 cm and 85 cm — some 15 cm larger than in Ver-o-Peso, in the Estuary.

b-3) Phase 2 Rainy Season

Size composition of dourada caught by artisanal gill nets in the Amazonian Estuary and landed at three communities had a monomodal (a mode at 46–48 cm class) distribution in Soure and polymodal in Ver-o-Peso (dominant modes at 54–56 cm and 66–68 cm classes) and Vigia (dominant modes at 56–58 cm and 64–66 cm classes). Mean fork lengths reflected these dominant modes, with the following values: Ver-o-Peso, 65 cm; Vigia, 60 cm; Soure, 46 cm. Compared with measurements in the same season of the previous year, mean fork lengths were from 7 cm (Ver-o-Peso) to 25 cm (Vigia) larger.

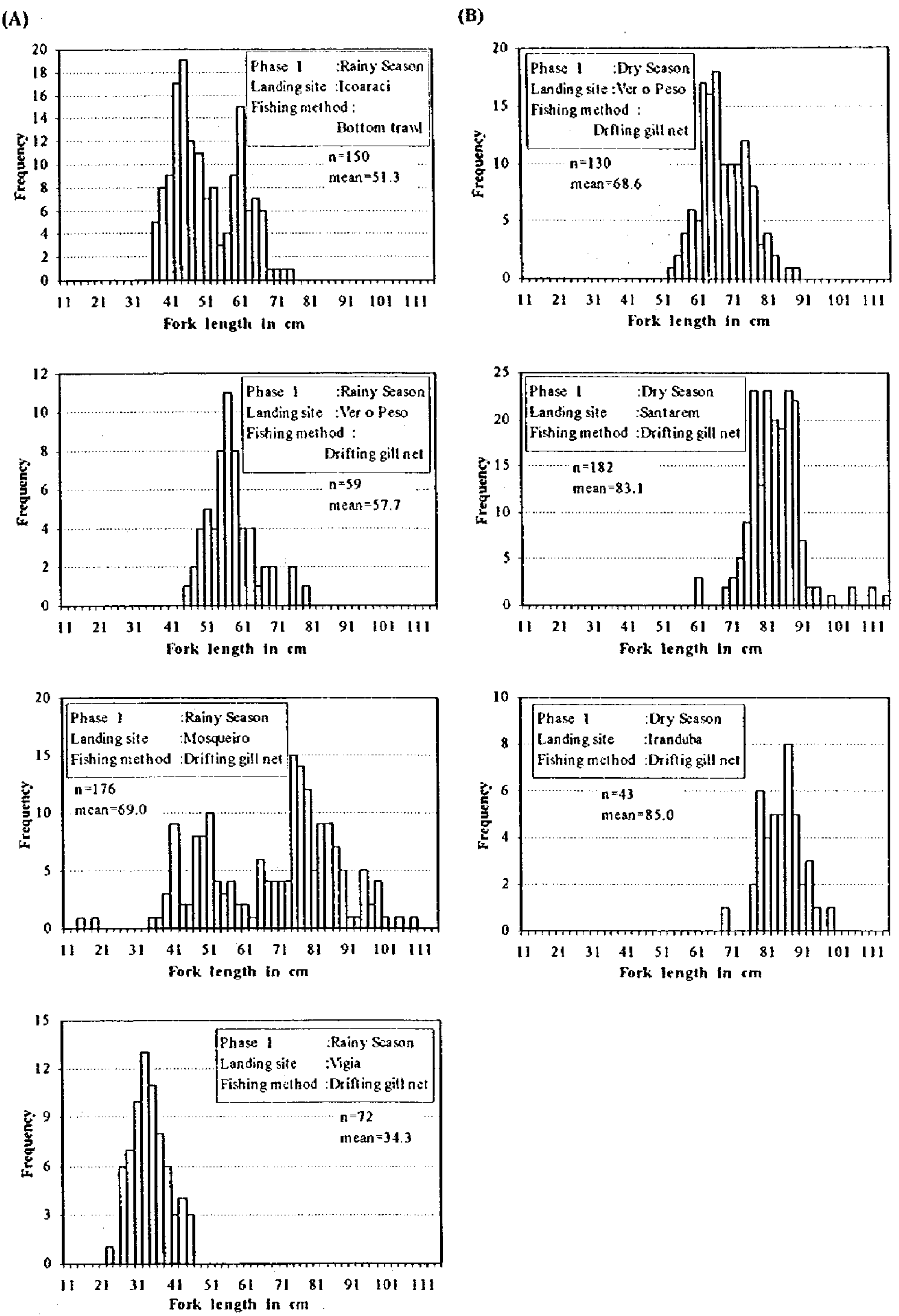
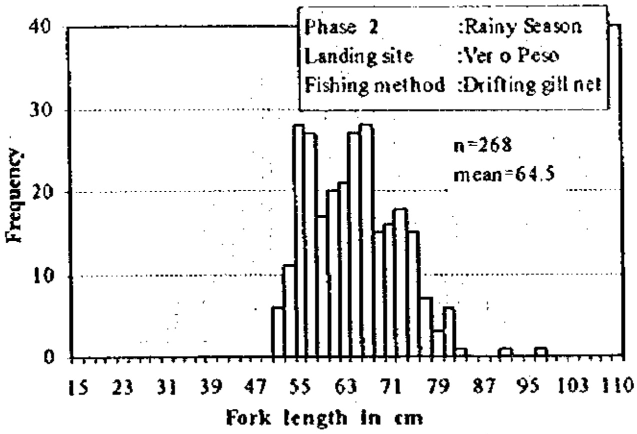
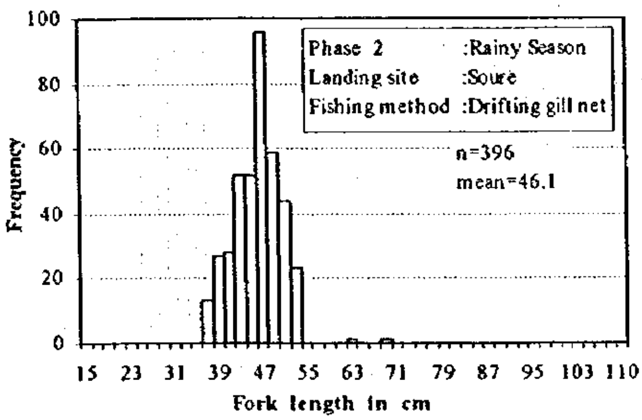
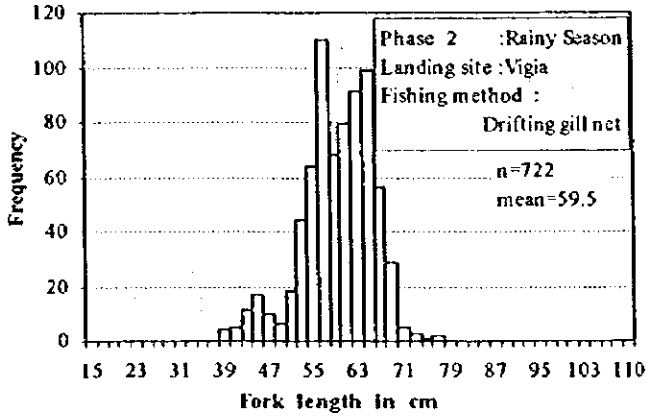


Figure 122. Size composition of Dourada *Brachyplatystoma flavicans* measured at landing sites. (A) Phase1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey.

Figure 122. Continued
(C)







(c) Filhote *Brachyplatystoma filamentosum*

Data on size composition of filhote, caught by artisanal gill nets and landed at Ver-o-Peso, were obtained in the Phase 2 Rainy Season Survey and are summarized in Figure 123.

Size composition of filhote was dominated by small fish with a mode at 52–54 cm class, although there were large fish with multiple modes between 90–122 cm classes.

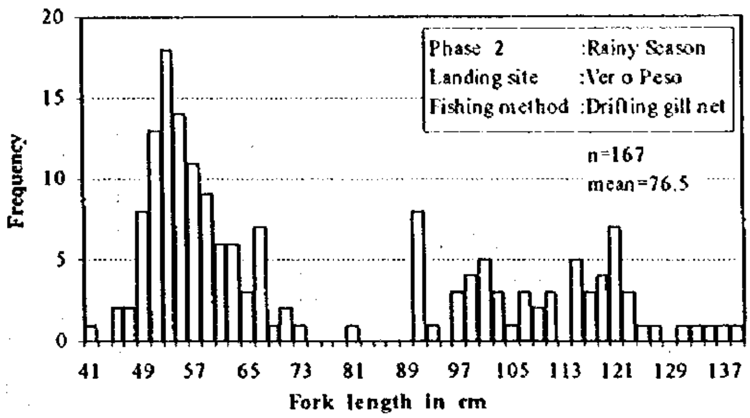


Figure 123. Size composition of Filhote *Brachyplatystoma filamentosum* measured at landing sites. Phase 2 Rainy Season Survey.

(d) Pescada branca *Plagioscion squamosissimus*

Figure 124 summarizes the data on size composition of pescada branca, obtained at 6 fishing communities in the three surveys.

d-1) Phase 1 Rainy Season

Size composition of pescada branca caught by artisanal gill nets in the Amazonian Estuary and landed at each community contained multiple modes; however, because of the presence of a dominant mode, the distribution can be considered monomodal. That modal class was of 36–40 cm in Mosqueiro, 44–46 cm in Soure and 28–30 cm in Vigia. A larger number of fish measuring over 50 cm were landed at Mosqueiro compared with the other two communities. Mean total length of pescada branca was largest in Soure (44 cm), followed by Mosqueiro (43 cm) and Vigia (31 cm).

d-2) Phase 1 Dry Season

Size composition of pescada branca caught by artisanal gill nets and landed at each community exhibited multiple modes. Dominant modes among these modes occurred between 38–44 cm classes in Ver-o-Peso (estuary) and 30–36 cm classes in Santarém and Parintins (upstream). Mean total length was larger in Ver-o-Peso (42 cm), reaching much less (34 cm) in both Santarém and Parintins.

d-3) Phase 2 Rainy Season

Size composition of pescada branca caught by artisanal gill nets in the Amazonian Estuary and landed at each community exhibited monomodal (Soure, a mode at 46–48 cm class) and polymodal

(Ver-o-Peso, Vigia) components. Dominant modes in polymodal composition occurred between 30–36 cm and 40–56 cm classes in Ver-o-Peso; in Vigia the modal classes were of 46–48 cm and 52–54 cm. Mean total length of pescada branca was largest in Soure (47 cm), followed by Vigia (46 cm) and Ver-o-Peso (43 cm). The values in Soure and Vigia were larger than those in the same season of the previous year; in particular, mean total length in Vigia was 15 cm larger than in Phase 1. In Ver-o-Peso, however, mean total length was the same as one year before.

(A)

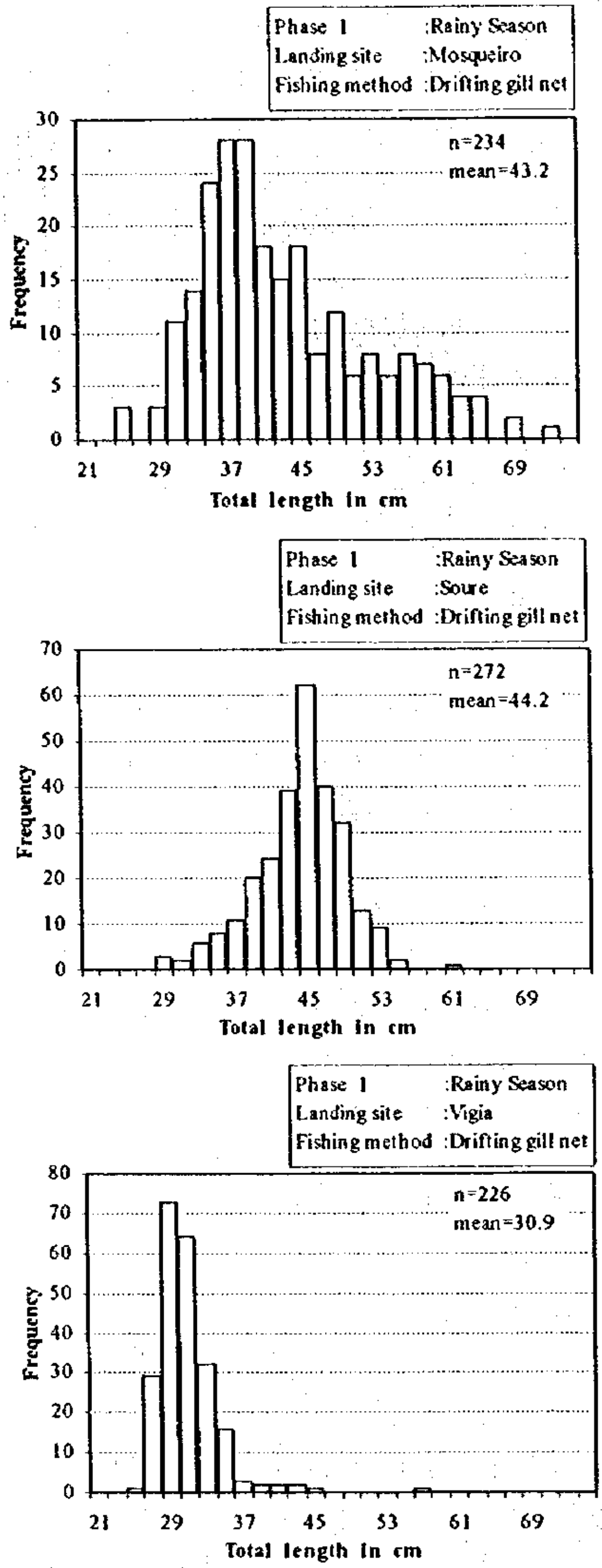
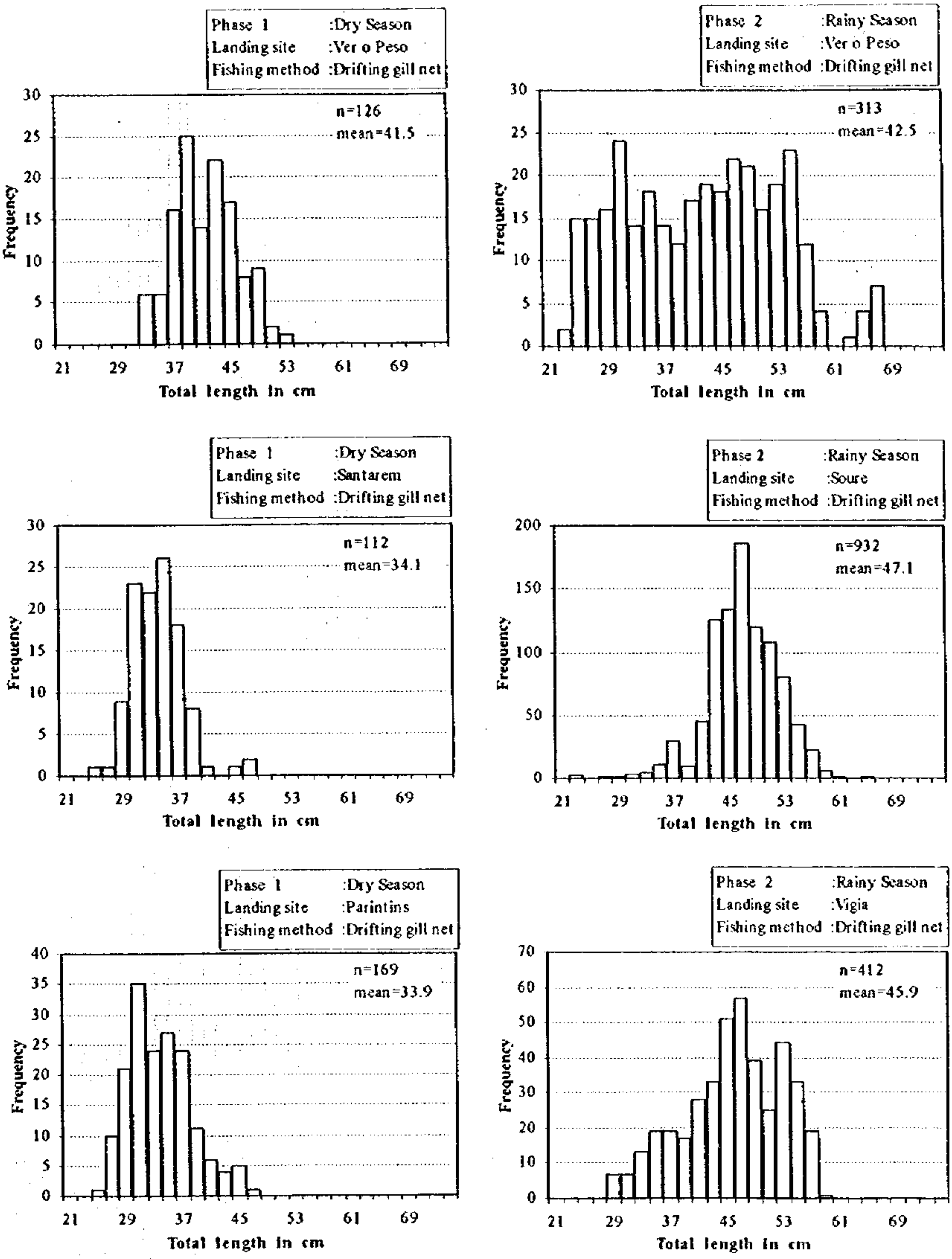


Figure 124. Size composition of Pescada branca *Plagioscion squamosissimus* measured at landing sites. (A) Phase1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey.

Figure 124. Continued

(B) **(C)**



(e) Pescada amarela *Cynoscion acoupa*

Figure 125 summarizes the data on size composition of pescada amarela, caught by artisanal gill nets and landed, obtained at Vigia (Phase 1 Rainy Season Survey), Bragança (Phase 1 Dry Season Survey) and Ver-o-Peso (Phase 2 Rainy Season Survey).

Size composition of pescada amarela at the three landing sites above exhibited multiple modes. Of these modes, dominant ones occurred between 82-88 cm classes in Vigia, 50-60 cm classes in Bragança and 100-118 cm classes in Ver-o-Peso. This pattern of dominant mode distribution was reflected in mean total length: 88 cm at Vigia, 55 cm in Bragança and 109 cm at Ver-o-Peso.

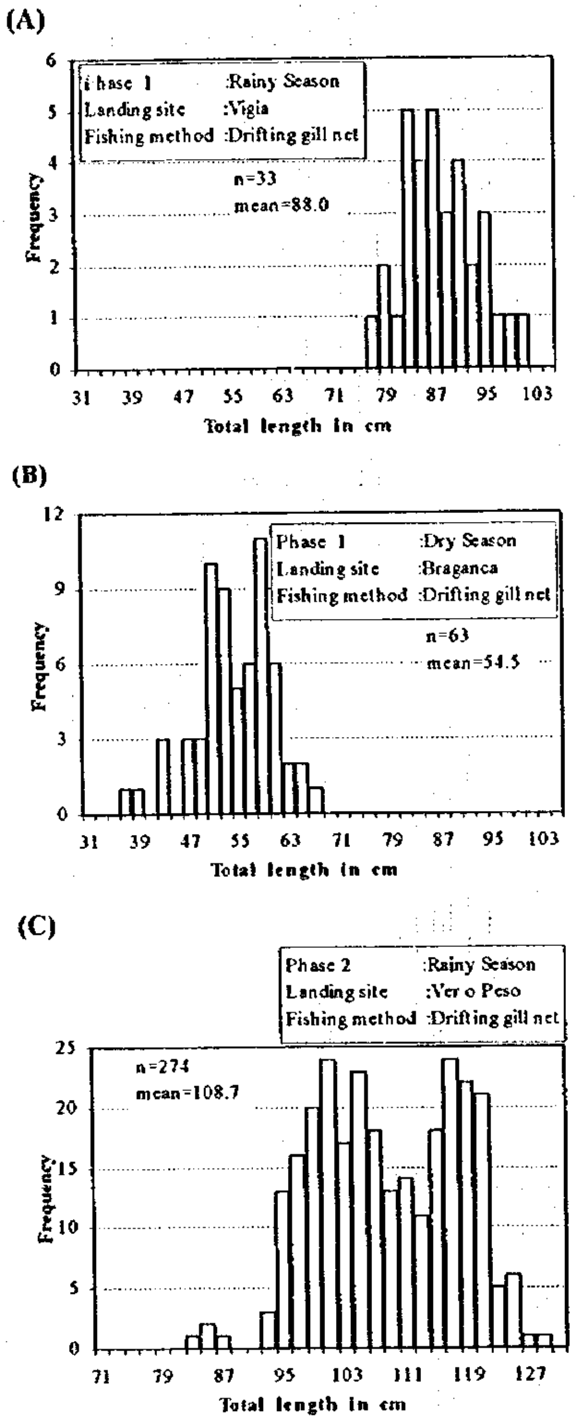


Figure 125. Size composition of Pescada amarela *Cynoscion acoupa* measured at landing sites. (A) Phase1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey

(f) Pescadinha gó *Macrodon ancylodon*

Figure 126 illustrates the data on size composition of pescadinha gó, caught by artisanal gill nets and landed, obtained in Bragança (Phase 1 Dry Season Survey) and Ver-o-Peso (Phase 2 Rainy Season Survey).

Size composition of pescadinha gó exhibited polymodal distribution in both communities. Of these modes, dominant modes were observed at three classes in Bragança (19–20 cm, 24–25 cm and 27–28 cm) and another three in Ver-o-Peso (29–30 cm, 32–33 cm and 34–35 cm). Mean total length of pescadinha gó was 23 cm in Bragança and 31 cm in Ver-o-Peso.

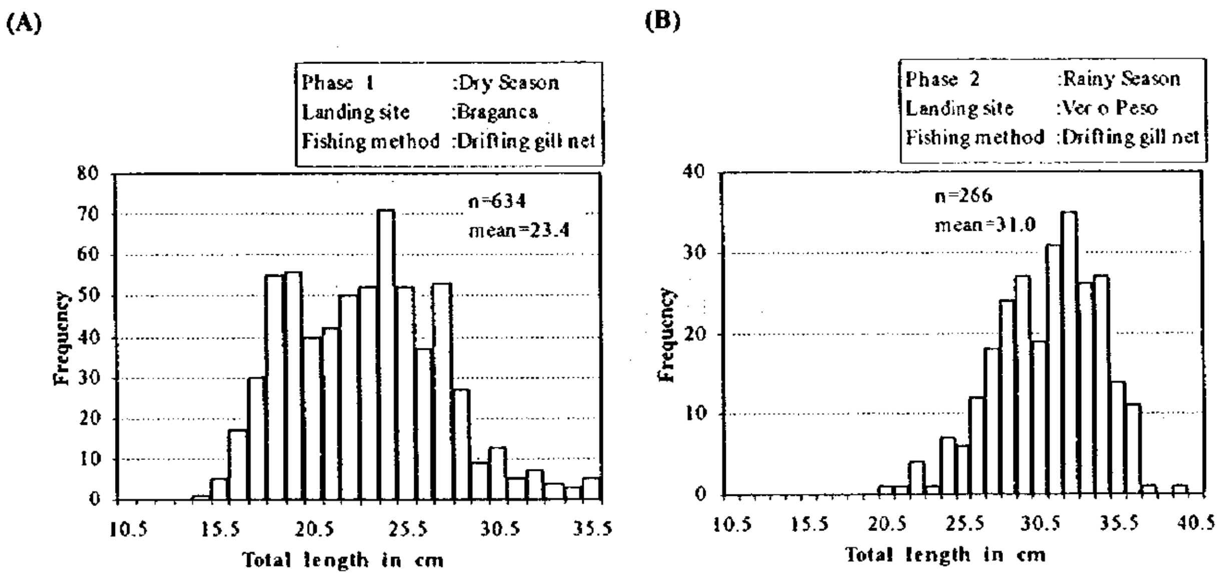


Figure 126. Size composition of Pescadinha gó *Macrodon ancylodon* measured at landing sites. (A) Phase 1 Dry Season Survey; (B) Phase 2 Rainy Season Survey.

(g) Gurijuba *Arius parkeri*

Figure 127 illustrates the data on size composition of gurijuba, caught by artisanal gill nets and landed, obtained in Vigia (Phase 1 Rainy Season Survey) and Ver-o-Peso (Phase 1 Dry Season Survey and Phase 2 Rainy Season Survey).

Size composition of gurijuba exhibited polymodal distribution in both communities. Predominant and dominant modes in Vigia occurred between 64–80 cm classes (predominant mode at 64–66 cm class); predominant modal classes in Ver-o-Peso were at 56–58 cm (Dry Season) and 80–82 cm (Rainy Season). Mean fork length of gurijuba was 69 cm in Vigia, and 61 cm (Dry Season) and 78 cm (Rainy Season) in Ver-o-Peso.

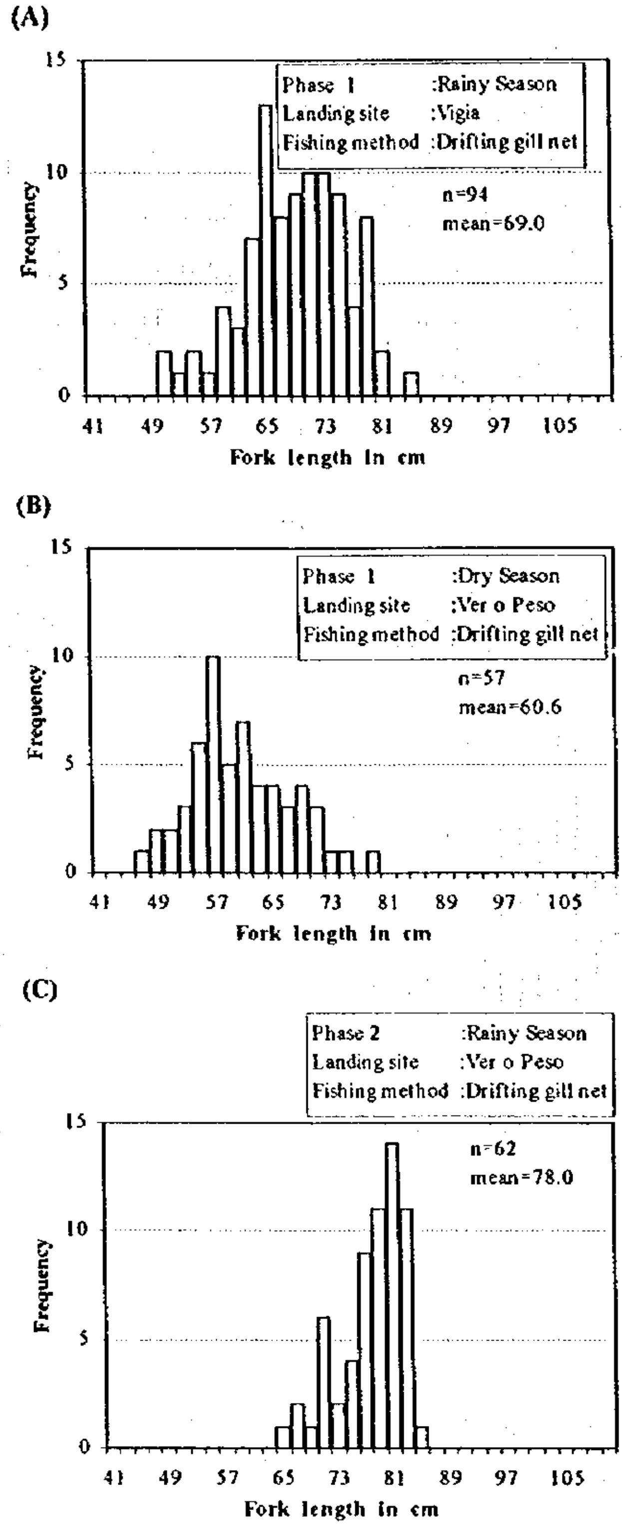


Figure 127. Size composition of Gurijuba *Arius parkeri* measured at landing sites. (A) Phase1 Rainy Season Survey; (B) Phase 1 Dry Season Survey; (C) Phase 2 Rainy Season Survey.

5.3.4. Problems Concerning Fishery Economics in the Amazonian Estuary

Economy in the Amazonian Estuary region still holds on to some pre-capitalistic industries. These include the raising of loose cattle in large properties that make up a major portion of the surrounding area, the direct extraction of forestry products from the tropical rain forest, or the practice of subsistence-level, small-scale fisheries mainly centered on the management of fishery household with fishing boats. At the same time, a rapid expansion of commerce and light industry has taken place in towns like Belém, following the country's economic growth. But the course of that development was such that relatively few of the great landowners promoted to take others farmlands in their properties, while the collapse of farm villages made farmers — especially waterside settlers dependent on floodplain agriculture — accelerate their migration toward dry lands or urban centers. That resulted in a broad qualitative difference of income in the region and the inner cities.

Urban economic development brought about an enormous increase in demand for fishery products. Bolstered by this heightened demand, artisanal fishery based on fishing villages scattered around the Amazonian Estuary region either changed their production goal from subsistence-level to business-level or reinforced their existing commercial fishery. On the other hand, in the late 60s, in response to the official fisheries promotion policy, fishery companies were established in urban centers as export businesses and continued to mass-produce fishery products centered on fish species make comparatively huge schools.

Some questions inherent to fishery economics as currently practiced in the Amazonian Estuary are summarized below under six major headings (a–f). They were mainly extracted from data previously reviewed in sections 5.3.1. to 5.3.3., particularly from interview survey results and local observations made by team researchers.

(a) Fisheries production

a-1) Factors of production

Fisheries production depends on the organic combination of three factors: (1) resources, (2) labor and (3) capital. These factors can each have diverse properties and contents, and so their combination also exhibits the multiple forms. Of the latter, the following two fishery categories were identified for the Amazonian Estuary region: artisanal fishery — small-scale, practiced by the fishermen themselves — and industrial fishery. These categories were divided upon whether or not they fulfilled the conditions established in Article 11 of the Presidential Decree No. 221 of February 28, 1967, qualifying for a tax reduction to favor investment. Industrial fishery did fulfill those conditions, and those individuals and legal persons who did not would be in artisanal fishery. For this reason, artisanal fishery comprises two forms of administration — fishery household management centered on familial labor and capitalistic management centered on hired labor. The respective assets of these two forms of administration are one small boat for fishery household management and one or a few small to mid-size boats for capitalistic management, and the target resources of artisanal fisheries are those located in the river, in the floodplain and in the estuary. In contrast, the target resources of industrial fishery are in the estuary proper (except along the coast), and their assets are large fishing vessels, landing facilities, processing plants and the like.

The most important problem currently facing the Amazonian Estuary region is the depletion of resources in estuary commonly exploited by both fishery categories — in particular piramutaba stocks, which used to be relatively abundant among the commercially important species. Although the intensification of commercial fishing activities by artisanal fishery is partly to blame for this depletion, the latter is mostly due to the massive catches obtained through trawl fishing by industrial fishery. To increase piramutaba yield, industrial fishery companies invested heavily, applying excessive catch effort and catching as much fish as they were legally allowed to, and ultimately causing this stock depletion. This reduction in piramutaba stocks came to affect two of the three factors regulating fisheries production, and even became an issue among industrial fishery companies. Excessive competition and massive investment in equipment related to the exploitation of piramutaba stocks eventually brought about increasing debts, weakening of the foundations of management and reduction of hired labor.

a-2) Fisheries production and resources

Target species for both the artisanal and industrial fisheries in the Amazonian Estuary region were the freshwater piramutaba *Brachyplatystoma vaillantii,* dourada *B. flavicans,* filhote *B. filamentosum* and pescada branca *Plagioscion squamosissimus,* and the marine bagre *Arius* spp. (including gurijuba *A. parkeri*), cação *Carcharhinus* spp., sciaenids including pescada amarela *Cynoscion acoupa* and pescadinha gó *Macrodon ancylodon,* sarda *Pellona* spp., serra *Scomberomorus brasiliensis,* xaréu *Caranx* spp. and other, mainly demersal fishes. These species are characterized by the following features: they are carnivorous, mostly piscivorous, ranking high in the food chain, larger in size than others ranking below but less abundant; and their distribution in the Amazon River Mouth area is widely variable, depending on the seasonal variation in volume of freshwater flowing out of the river. However, there are many aspects of those fishes still to be clarified, such as their migration, spawning run and life history; nor are there annual data on catch per effort that, provided no much change has taken place in terms of gear efficiency or fishing ground area, could produce a biomass index. Although calculations were attempted to obtain CPUE values for different fishing methods from the results compiled from the Interview Survey, the lack of comparative past data — except for those related to industrial fishery — precluded the knowledge of the current conditions of those fish stocks.

a-3) Operational categories of fisheries production

One can consider several operational categories of fisheries production: (1) coastal fishery, (2) offshore fishery, (3) shallow-sea aquaculture, (4) inland waters fishery and aquaculture, and so on. Only two of them, however, were verified by the interviews to apply for the Amazonian Estuary region: coastal and inland waters fisheries.

Coastal fishery is practiced both by artisanal fishery mainly using boats under 10 tonnage and by industrial fishery using vessels of about 100 tonnage, giving rise to mutual conflicts because they both aim for the same target species (large demersal fishes as mentioned before) and their respective fishing grounds overlap. Most of the former category employ gill net fishing, while the latter all resort to bottom trawl net fishing. Inland waters fishery (aquaculture is not practiced at all in the area covered in the interviews) is the domain of artisanal fishery employing gill nets: their main fishing grounds are in Marajó Bay and in the main course of the Amazon River, depending on the season. On the other hand, fishing operations in lakes and swamps in the upper course of the Amazon, including in floodplain lakes, could not be verified. Therefore, operational categories of fisheries are not much diversified in the Amazonian Estuary region, and in consequence the diversity of target species is also limited.

(b) Work in fisheries

b-1) Fisheries work force

There are many categories of workers in the work force involved in fisheries production. However, one of the most pressing problems in the Amazonian Estuary region is that most of the fishery workers have no production assets of their own and are employed laborers offering manpower, for instance, about 70% of the fishing boat crew members interviewed in Vigia were employed laborers, and have no other jobs. Furthermore, there are many underemployed workers within the fishery work force including particularly people migrated from rural areas, so there is a substantial tendency towards a surplus of labor and manpower of little value. Among fishery workers, the ones engaged in sea-borne tasks are men mostly between 30 and 40 years of age, while women work at the processing plants of industrial fishery companies.

In 1990, the estimated fisheries work force in the State of Pará included about 100 thousand people, of which 97% were engaged in artisanal fishery and the rest in industrial fishery (IBAMA, 1994). There has been practically no studies in a regional scale that included the Amazonian Estuary region on the actual conditions and future trends that could show this tendency toward a labor surplus.

b-2) Familial labor and hired labor

Much as fisheries management has its household management and capitalistic management components, the fisheries work force can be divided into familial laborers and hired (employed) laborers. Familial labor comprises a manager or his family of workers investing in his own fishery, but details such as what proportion do familial laborers occupy in the labor force of artisanal fishery, whether do they actually engage in seasonal hired work — or, instead, to what degree do they invest hired laborers in their own fisheries — are unknown.

Hired labor represents manpower employed by capitalistic fishery — in the Amazonian Estuary region, artisanal and industrial fisheries by fishery capital, and artisanal fishery by outside capital. It accounts for a large proportion of the fisheries work force, most of which should be employed by artisanal fishery. Among these households engaged in fisheries that depend on the income of wages, the majority would be extracted due to the disintegration of fishery household management. Also, it is believed that the actual materialization of employment depends on special conditions of fisheries labor, and land and blood ties generally prevail. However, so far there are no studies that could support with certainty the results from these interviews.

b-3) Work conditions

Work in fisheries comprises a series of procedures: (a) round trip to fishing grounds, (b) fishing preparations, (c) actual fishing, (d) landing upon return, (e) selling, and (f) preparations for the next trip; of these, the actual fishing, being the most important, is finished up in a short time. Some special problems related to work conditions are that: (i) all those procedures are carried out by only a few people; (ii) seasons have a strong influence on the choice of live stocks; (iii) work schedule is irregular, with long restricted hours; (iv) operating directly under the Equator, daytime temperature is very high; and (v) on-board living conditions and working environment are poor.

Employment conditions are variable. If year-round fishing operations are possible, then there are year-round jobs; but if there is an established fishing season, more positions are available in that period. There are also many contracts drafted in uncertain or unstable terms of employment.

Wages system differs in the two fishery categories. Industrial fishery has a share system that guarantees payment of minimum wages: the landings revenue is divided between the boat owner and the crew at an established rate, and the crew's share itself is distributed among the captain, boatswain, engineer, deck hands, etc. at another preset rate according to his respective duties and responsibilities. In artisanal fishery, fuel, ice, food and other operationally necessary expenses are subtracted beforehand from the landings revenue, and the remainder is divided per the aforementioned share system.

This share system is not without problems: fishing operations can be unreasonably overstrained in order to raise the landings revenue, and wages are unstable, fluctuating as the landing earnings do. Whenever the latter are low in consequence of poor fishing, the crew has to partially take the burden for the loss. Specifically, in artisanal fishery, jobs are unstable and depend on good landings completely, there being no guarantee of minimum wages if there is no fishing — which, if extended over time, will result in the aggravation of the debts of hired laborers and their being brought into the subordinative employee of the boat owner.

(c) Fisheries management

c-1) Fishery household management

Household management originally was not a profit-seeking fishery business, but a subsistence fishing profile. Being based on small boats (including non-powered canoes), its productivity levels stay low; also, fishermen's homes are populous, and the income of one person in such a household is much lower than that of an urban worker. Since a fisherman's income does not rise, he cannot accumulate capital and therefore is unable to increase production and thus his earnings as he upgrades the horsepower, size or equipment of his boat and introduces the new fishing technology. Lack of stability in household management led to a lowering of confidence and items they offer as security for bank loans are lowly appraised, and furthermore, long-term, low-interest government loans are still inchoate. In this situation, there are people in the household who depend on fishery brokers even for operational funds, not a sound state of affairs at all.

c-2) Capitalistic management

Encouraged by reduced-tax and tax-exempt investment incentives *(incentivos fiscais)* as defined by the 1997 Presidential Decree No. 221, industrial fishery companies have invested positively in equipment and strove for management expansion. They concentrated their catch effort on piramutaba and shrimp, increased productivity and the changes in management generally happened in favorable conditions. However, a number of problems — the recent decline of stocks; the increasing costs of fuel, gear, supplies and personnel — came along with cracks in the physical constitution of fishery capitalistic management: elevation of capital-intensive debt rate, poor capital turnover rate, high fixed rates. All those troubles came out at the same time and weakened the foundations of management, causing a social problem. Another aspect related to fisheries capital, the management situation of artisanal fishery, could not be estimated from the interviews, although it is thought it should have been facing problems similar to those borne by industrial fishery.

Participation in fisheries of capital from outside sources was examined: it was mainly commercial capital of fishery brokers, whose management form is unique in fishery economics and extends over both phases of fisheries — production and distribution. In some cases the brokers themselves were boat owners and made use of hired laborers, thus taking part in fisheries production; in others, they acted as financiers who would pay in advance for the direct expenses of their fixed fishermen — fuel, ice, food, gear etc.— and also brokers proper who purchased the fishery products mainly from artisanal fishermen and sold those to markets. Some ones among brokers sold in their own stores the fishery products they purchased, thus being small-time merchants. For better or worse, brokers have seized dealing on fishery products of artisanal fishery; they were opposed by some artisanal fishermen who had accumulated debts as a result and ended up subjected to them — which put their self-management in trouble. Another type of participation in fisheries of capital from outside sources was that represented by ventures from urban investors. They have taken part in fisheries by building their own boats and hiring cheap surplus labor found around towns. They were responsible for the chaotic increase of the number of fishing boats in operation — that is, the chaotic increase of catch effort.

c-3) Management of fisheries processing

Processing of fishery products is mostly done by employed laborers in the processing divisions of industrial fishery companies; there are, in fact, industries comprising only such a division. Apart from large scale management above mentioned, there is a small scale management, from a processing subsidiary in a fisherman's house to an independent home industry. Industrial fishery companies have used mainly piramutaba (nine processing companies in the State of Pará in 1994) and shrimp (two processing companies in the State of

Pará in 1994) as their raw material and produced fishery products centered on frozen products through a relatively complex operation requiring advanced techniques and sound capital. Management of either a fishery household or a small-scale company would concentrate in the production of mainly products from seasonally determined raw materials, including hand-crafted salted dry snacks and delicacies of the seasons. Management of fisheries processing in industrial fishery companies have been developing to export their fishery products for the purpose of gaining the foreign currency, while that in artisanal fishery and small-scale processing company had to make up for any decline in freshness of their products, aiming to preserve them so as to fulfill the demand of regions where fresh fish would not be available. The big problem today in processing management in industrial fishery is the decline of processing itself, mainly due to the decrease of piramutaba and shrimp stocks, which determined a serious shortage of raw materials. Other reasons behind this decline are: a scarcity of appropriate species for processed products, little diversity of products, and inexperience in processing non-food products such as animal feed, fodder, fertilizers.

(d) Distribution and price

d-1) Distribution mechanism

The mechanism of distribution for fishery products in the Amazonian Estuary region is centered on markets and fishery industries. Markets can be producer-centered ones near landing sites or consumer-centered ones in towns, and there is no wholesale auction system intermediating fishery products between the artisanal fishermen entrust that system with their fishery products and the broker or buyer. The lack of this system rises from the fishery product itself: as such, fish is highly susceptible to deterioration, particularly under the equatorial heat. In many fishing villages in the Amazonian Estuary region, the distribution process had no other way but to be separated between landing site and consuming site, and this function came to be in fact performed by fishery brokers with commercial capital, who formed monopolies of buyers and controlled each market's fishery products business. In this way, markets are merely like assembly body of the retailers.

Among fishery products distributed in markets, most are fresh items (generally kept cold in ice, under precarious quality control); frozen and processed items get almost no distribution, except for salted dry products which are fairly well-distributed. Practically all those products are food items, virtually none are bait for fisheries, fodder for livestock or fertilizers for agriculture, or are used in ways other than human consumption. This fact gives a picture of how rudimentary are those markets. In general there is no much information at the retailer level, but urban supermarkets have recently begun adopting their own system of evaluation and sales of fishery products; and, in fishing villages near tourist resorts, artisanal fishermen have been making direct sales of shrimp and crabs, either fresh or salted and boiled.

Industrial fishery companies typically have a fishing division (companies without one do have fishing vessels under contract) and a processing division, and thus they are engaged in the fisheries production chain from catch to processing. They also have a distribution system that allows them to export processed products, or ship them to other places within the country. However, as mentioned above, there are not many fish species that constitute raw material for processing, nor is there much variety in processed products.

d-2) Pricing

Pricing of fishery products has three levels: (1) producer market level, (2) consumer market level and (3) retail store level (consumer level). With the exception of industrial fishery products, as described above, the distribution of fishery products is totally controlled by the broker, who can be said to be the party that establishes prices at the market level. Consumer purchase prices of fishery products in the entire Amazonian Estuary region are established based on their respective wholesale prices at Ver-o-Peso, the central market of Belém — that is, the prices fishery brokers negotiate with retailers within the market. These wholesale prices cover the broker's distribution costs, and the consumer prices cover the retailer's sale costs. Wholesale prices are not established based on auctions, as mentioned above, but depend on negotiations between brokers and retailers with respect to the balance between supply and demand. On that, some prices are asked according to fish species, but the ultimate criterion for pricing is weight, as the freshness or size difference of a given fish has little influence. Wholesale prices thus established are, depending on the broker, spread over the entire estuary region, becoming the basis for pricing at all markets. Furthermore, on those grounds, retail prices for the entire estuary region are established, creating a baseline for the Pará State Office of Economics to set up retail prices (consumer prices) for fresh fish in its official food pricing system. Producer market prices (the fisherman's selling prices to the broker) are very important for artisanal fishery managers: they are determined after deducting the broker's distribution costs — so, the farther away from the consumer market the lower they are, widening the gap between them and the consumer prices. For that reason, production costs of artisanal fishery in villages far away from urban centers can sometimes exceed yields, and this deterioration in management is the main cause for the migration of fishermen and their boats from fishing villages toward urban centers.

Produced by industrial fishery, piramutaba fillet has been sold to North America at an export price firmly established around US$ 2.20 / kg FOB for a number of years. On the other hand, the outgoing price of fillet for the domestic market is on the rise (also US$ 2.20 / kg in the Phase 2 Rainy Season), which caused a prompt decline in the willingness to export.

One could compare retail prices of meat and fish — frozen broiler 1.90, fresh pork 3.00, prime beef 2.00, regular beef 1.50, bacon 2.50, with dourada 3.00, pescada branca 2.80, pescada amarela 5.00, piramutaba 1.80 (units, US$ / kg; source, Mercado do Guamá, March 17, 1997). But fish are sold in rounds, including head and tail, making comparisons with meat rather poor and their price relatively high. Also, after 1995 retail prices for meat were practically frozen; in contrast, retail prices for fresh fish have indeed risen about 30% in two years. Originally, in the estuary region, there was a strong preference for fish: a single household would generally consume 4–5 kg of fresh fish per week, but now popular species like dourada and pescada amarela became out of reach for the masses. This situation is not only regional, but can also be observed in all Brazil: following the country's recent economic expansion, coupled with a rise in interest for healthy nutrition, there has been a trend towards increasing fresh fish consumption. Traditionally cherished regional fish species became much sought after, and there has been an increase in demand for locally common fish like piramutaba or even imported frozen pollack. This relative price hike for fish compared to meat will have a profound effect on the future demand for fishery products.

(e) Cooperatives - Finance

Presently, in the Amazonian Estuary region, fisheries cooperative associations, carrying out the function of measuring improvements in social or economic standings of their associates through economic undertakings such as credit, purchase and sale business, supervising over fishing grounds and having fishery rights, have not been formed yet, nor are there fishermen's production associations or fish processors' cooperative associations. But a number of private fisheries-related organizations were indeed formed: national-scale fishermen colonies, the industrial fishery companies association (Syndicate of Industrial Fishery), a vessel owners association, a captains and engineers association, and a fisheries cooperative union (COVIP — Cooperativa Vigiense de Pesca, legally a limited company, the only association dealing with cooperative investment). In 1997 there were 56 open-participation fishermen colonies — the ultimate level of organization in fisheries administration — in the State of Pará, but currently many of them in the estuary region are either idle or stagnant.

Fisheries require expensive investments such as fishing boats, and because of petty management artisanal fishery cannot but meet their liabilities when procuring funds. And, as explained before, in circumstances when funds can be obtained from the financial system, management is unstable and does not inspire much confidence. There have been insufficient in government or its agency financing institutions, any low-interest financing organization and guarantee system for making up for this loss of confidence, and so on as yet.

(f) Fishing villages

Today, the main problems afflicting fishing villages in the Amazonian Estuary region can be summarized in three groups respectively centered on: (1) the backwardness of some living environments; (2) the lack of consolidation of an infrastructure for fisheries production; and (3) the migration of fishery workers into and out from the region. These problems have reciprocal consequences one with another and show a complex picture.

The most pressing problem in group (1) is the insufficiency of medical facilities, and also of socio-educational facilities such as public welfare facilities, community centers and libraries. Also, especially in villages in the outskirts of towns, there is a danger of contamination of fishing grounds as industrial and urban sewage and waste are left flowing through, and disposal of industrial refuse and trash is overlooked. In the lower river course, sewage, waste and trash treatment facilities are deficient.

Particularly important in group (2) are the future consolidation of fishing ports, which will not simply be limited to their construction, but will have to promote their public use by the villagers. That would have an effect on the construction of sites for public use and roads and other structures related to the villagers' daily life. Also, cold storage facilities for an effective utilization of resources and the mechanism of distribution for fishery products such as shipping facilities will have to be implemented.

Problems in group (3) concern the outflow of fishermen, which is influenced by potential relocation benefits into the city outskirts (particularly if relocating would make fish product prices more advantageous) or by labor demands in urban centers. Conversely, the inflow rises from a surplus urban population, or dislocated farmers of the region — underemployed laborers that looked around city for their ultimate place of life. In most cases, the outflow occures in fishing villages far away from towns, while the inflow appears in fishing villages around city: the former face underpopulation, the latter can lead to overpopulation. Few fishing villages can count on self-supporting household and capitalistic managements; and since hired fishermen are majority, these villages are like a meeting ground for workers in capitalistic fisheries.

Table 82. Some problems concerning fishery economics (fishing and distribution) in the Amazonian Estuary.

Heading	Problem
Fisheries production	• Low equipment assets and fisheries productivity in artisanal fishery • Decline in stocks of piramutaba, an important fish caught in quantities • Catch concentrated on stocks of relatively large demersal fish • Said fish highly ranked in food chain and less abundant than other lower-ranking animals in the chain • Said fish allowed by their life histories to adapt to live within the confines of the Amazon River Mouth region, which become their fishing grounds • Fish distribution over fishing grounds varying with seasonal environmental changes, particularly river water dynamics which is linked to rainy and dry seasons • Incompleteness of information on migration, fish run and life history of key species for fisheries • Lack of statistics on catch, landing and effort of artisanal fishery (a thorough data system still to be implemented) • Intensification of competition within industrial fishery companies for stock procurement and conflict between artisanal and industrial fisheries • Low diversity of fisheries, mainly concentrated on two kinds — gill net and bottom trawl net fisheries
Work in fisheries	• Majority of fishery workers are full-time professionals • Many fishery workers are laborers hired by the capitalistic fisheries • Relatively few self-managing workers • Many underemployed laborers among fishery workers, particularly formers from rural areas to urban centers • Migration of young workers out of fishing villages due to increase of labor demand in cities • Low value of labor (surplus worker) • Fishery worker movements are difficult to understand • Instability of employment relations (fishing season-term jobs, contracts in uncertain terms, etc.) • Peculiarities of work conditions (on board work, seasonal work, irregular working hours, etc.) • Controlling employment relations • Reduction of hired labor following decline in foundations of management in industrial fishery

Table 82. Continued

Heading	Problem
Fisheries management	• Instability of fisheries management leading to low confidence in financing • Shortage of government loans and the like • Stocking or loan system for brokers and vessel owners (advance payment of funds) • Failure of fishery household management system • High capital-intensive debt rate - poor capital turnover rate - high fixed rates (general characteristics of the physical constitution of capitalistic management) • Increase in fishery cost due to sudden price hikes of fisheries supplies such as nets and fuel • Increase in fisheries as a speculative venture (entry of funds outside from fisheries) • Qualitative crudity of fish processing
Distribution and price	• Monopoly of commerce of fishery products by brokers • Lack of improvement in distribution mechanisms, particularly in the wholesale system • Precariousness of quality control • Distribution is overwhelmingly of fresh fishery products, leaving little room for durable items such as frozen or processed products • Distribution is overwhelmingly of food products, with few avenues for products not destined for human consumption, such as bait, fodder or fertilizers • Export prices of piramutaba are fixed • Low diversity of export items • Relatively high prices of fishery products
Cooperatives - Finance	• Lack of cooperatives related to fisheries (fisheries cooperative associations, fishermen's production associations, fish processors' cooperative associations, and the like); legislation still to be established • Government and its agency financing institutions still to be established • Lack of low-interest financing organizations and of a guarantee system for making up for loss of confidence in fisheries • Stagnancy in the movement of existing fishermen colonies
Fishing villages	• Relatively backward living environment, with a shortage of medical and public welfare facilities, community centers and libraries • Insufficient countermeasures against contamination of fishing grounds, particularly lack of treatment facilities for industrial and urban sewage, waste, trash and refuse in fishing villages within city limits • Lack of consolidation of an infrastructure for fisheries production, especially of items related to the villager's daily life, such as fishing ports, sites of public use and roads around them • Lack of cold storage facilities and distribution systems such as shipping facilities • Migration of young workers from fishing villages to urban centers without leaving successors • Absorption of a surplus urban population, especially noticeable in fishing villages within city perimeters • Few self-supporting fishermen, a majority of hired laborers

6. EVALUATION OF EXPLOITED FISHERY RESOURCES

6.1. Present Status of Exploited Fishery Resources

In order to evaluate the present status of fishery resources in the Amazonian Estuary, it is necessary to have a clear picture of the actual situation of fisheries in that region. What follows is a summary of the results from the Landing Site Survey from the standpoint of fisheries production.

There, fishery resources have been caught and utilized by small-scale artisanal fisheries and by industrial fisheries. Artisanal fisheries make use of small fishing boats, targeting mainly coastal fish species with their gill nets. Their productivity is relatively low and their catch is sold to fishery brokers. The basic fisheries infrastructure in the artisanal fishermen's villages is insufficiently consolidated and there is not enough information that could concretely show the entire picture of these fisheries.

On the other hand, most industrial fisheries have a fishing division and a processing division. Their fishing divisions are using hired professional fishermen aboard 100 ton-class powered steel vessels, catching mainly piramutaba *Brachyplatystoma vaillantii* with bottom trawl nets both offshore and in the same waters exploited by the artisanal fisheries. In their processing divisions, hired laborers mainly produce fishery products centered on frozen products by using the landed fish as their raw material. These industries have official approval and their fishery activities are well documented.

Conflict between artisanal and industrial fisheries has arisen regarding the catch and utilization of resources.

Catch statistics for artisanal fisheries in the Amazonian Estuary are not known at present. Fortunately, the results of Landing Site Survey allowed to estimate the total catch of the 56 fishermen colonies in the State of Pará for the year 1996 as approximately 39,210 tonnes (Table 83).

IBAMA reported the total catch of industrial fisheries for 1996 as 13,204 tonnes (Figure 128). Comparing catches of both fisheries for that year, it can be seen that the artisanal fisheries catch was at least three times the industrial fisheries catch. That alone would show the importance of artisanal fisheries from the standpoint of catch.

Since, however, catch statistics of artisanal fisheries are unavailable, the present status of resources exploitation should be made clearer through the analysis of the relatively complete annual data on catch and fishery statistics of industrial fisheries.

6.1.1. Catch Statistics of Industrial Fisheries

IBAMA has published bottom trawl catch statistics by industrial fisheries over a period of 25 years, from 1972 to 1996 (Figure 112). According to these, total catch by bottom trawl increased from 7,771 tonnes

Table 83. Artisanal fishermen colonies in the State of Pará, from Interview Survey (1996).

Colony No.	Name of Colonies	Population	Main fishing areas	Water mass regions	Main target species	No. of Boats	Annual catch (tonnes)
Z - 1	Soure	17,481	Marajo bay	Brackish/River	Piramutaba/Dourada		
Z - 2	Salvaterra	75,633	Marajo bay	Brackish/River	Piramutaba/Dourada		
Z - 3	Vigia	29,611	Marajo bay	Brackish/River	Dourada/P. amarela	501	9,792
Z - 4	Sao Caetano de Odivelas	11,673	Marajo bay/Atlantic	Ocean/Brackish	Pescada branca	227	
Z - 5	Curuca	12,974	Atlantic NE	Ocean/Brackish	Pescadinha go/P. amarela	310	1,874
Z - 6	Marapanim	15,096	Atlantic NE	Ocean/Brackish	Pescadinha go/P. amarela	345	1,516
Z - 7	Maracana	15,252	Atlantic E	Ocean/Brackish	Pescadinha go/P. amarela	162	1,322
Z - 8	Sao Jao do Pirabas	12,266	Atlantic NE	Ocean/Brackish	Pescadinha go/P. amarela	237	
Z - 9	Mosqueiro	18,343	Marajo bay	River/Brackish	Pescada branca		
Z - 10	Icoaraci	280,591	Marajo bay	River/Brackish	Piramutaba/Dourada	448	11,012
Z - 11	Monte Alegre	46,951	Lower Amazon	River	Tucunare/P. branca		68
Z - 12	Altamira	69,279	Lower Xingu	River	Tucunare/P. branca		
Z - 13	Barcarena	34,583	Lower Tocantins	River	P. branca/Piramutaba		
Z - 14	Abaetetuba	95,250	Lower Tocantins	River	Mapara		1,040
Z - 15	Igarape Miri	26,562	Lower Tocantins	River	Mapara		
Z - 16	Cameta	44,844	Lower Tocantins	River	Mapara		
Z - 17	Braganca	63,809	Atlantic E	Ocean/Brackish	Pescadinha go/P. amarela	329	
Z - 18	Augusto Correa	10,875	Atlantic E	Ocean	Pescadinha go/P. amarela	336	1,802
Z - 19	Obidos	42,307	Lower Amazon	River	Surubim		
Z - 20	Santarem	224,783	Lower Amazon/Tapajos	River	Surubim		4,006
Z - 21	Viseu	15,335	Atlantic SE	Ocean	Pescadinha go/P. amarela	243	1,821
Z - 22	Ganhoao	15,660	Marajo/Lower Amazon	River/Brackish	Pescadinha go/P. amarela		
Z - 23	Colares	8,338	Marajo bay	River/Brackish	Pescadinha go/P. amarela	112	
Z - 24	Ponta de Pedras	16,500	Marajo bay	River	Dourada		
Z - 25	Santa Cruz do Arari	4,774	Marajo Island	River	Tamuata		
Z - 26	Cachoeira do Arari	13,246	Marajo Island	River	Tamuata		
Z - 27	Espirito Santo Tauna	2,822	Marajo bay	River	Tamuata		
Z - 28	Alenquer	44,877	Lower Amazon	River	Surubim/Dourada		91
Z - 29	Salinopolis	22,670	Atlantic E	Ocean	Pescadinha go/P. amarela	125	2,097
Z - 30	Maraba	123,668	Upper Tocantins	River	Tucunare/P. branca		326
Z - 31	Prainha	21,422	Lower Amazon	River	Piramutaba		65
Z - 32	Tucurui	80,426	Mid Tocantins	River	Tucunare/P. branca		
Z - 33	Almeirim	14,275	Lower Amazon	River	Piramutaba/Dourada		85
Z - 34	Baiao	11,061	Lower Tocantins	River	Mapara		
Z - 35	Bagre	12,609	Lower Para	River	Piramutaba		
Z - 36	S.Sebastiao Boa Vista	14,926	Marajo Island	River	Tamuata		
Z - 37	Curralinho	9,176	Lower Para	River	Mapara		
Z - 38	Mocajuba	15,884	Lower Tocantins	River	Mapara		
Z - 39	Conceicao do Araguaia	54,900	Araguaia river	River	Jaraqui/Tucunare		
Z - 40	Aranai	-	Marajo Island	River	Tamuata		
Z - 41	Oriximina	41,154	Lower Amazon	River	Piramutaba		393
Z - 42	Juruti	23,262	Lower Amazon	River	Piramutaba/Dourada		
Z - 43	Jacunda	43,012	Mid Tocantins	River	Tucunare/P. branca		
Z - 44	Itupiranga	37,011	Mid Tocantins	River	Tucunare/P. branca		
Z - 45	Apinages	12,584	Upper Tocantins	River	Tucunare/P. branca		
Z - 46	Limoeiro do Ajuru	16,475	Lower Tocantins	River	Mapara		
Z - 47	Portel	29,452	Lower Para	River	Piramutaba		
Z - 48	Boa Vista	17,132	Atlantic E	Ocean/Brackish	Pescadinha go/P. amarela	257	1,900
Z - 49	Magalhaes Barata	7,331	Atlantic E	Ocean	Pescadinha go/P. amarela		
Z - 50	Gurupa	13,533	Lower Amazon	River	Dourada/Surubim		
Z - 51	Peixe Boi	3,515	Lower Amazon	River	Dourada/Surubim		
Z - 52	Aveilo	4,448	Lower Amazon	River	Dourada/Surubim		
Z - 53	Breu Branco	-	Mid Xingu	River	Dourada/Surubim		
Z - 54	Barreia dos Campos	-	Lower Amazon	River	Dourada/Surubim		
Z - 55	Sao Jeraldo do Araujo	-	Lower Amazon	River	Dourada/Surubim		
Z - 56	Itaituba	116,402	Mid Tapajos	River	Tucunare/P. branca		
TOTAL		2,016,043				3,632	39,210

(7,771 tonnes for piramutaba) in 1972 to a maximum of 33,482 tonnes (32,123 tonnes for piramutaba) in 1977; afterwards, it declined over the years and in 1992 it reached 9,492 tonnes (7,324 tonnes for piramutaba), a reduction of 28% of the maximum catch value ever obtained. However, since the industry introduced in 1993 the practice of multiple-trawler fishing, catch has risen again, with a total of 13,204 tonnes (11,641 tonnes for piramutaba) in 1996. Statistics for 1997 have not been published yet as of June 1998.

In the abovementioned period, the percentage of piramutaba comprised from 77% (in 1992) to 100% (in 1972, 1973 and 1974) of those statistics. The item "Others" includes dourada *Brachyplatystoma flavicans*, mero *Epinephelus itajara*, gurijuba *Arius parkeri*, filhote *Brachyplatystoma filamentosum* and other species.

As explained before, since industrial fishery statistics indicate piramutaba is the most important target fish for the industry, the investigation of the present status of fishery resources exploitation can be focused on this species.

For that, it would be necessary to deduce piramutaba catch by industrial fisheries in 1997. An estimate catch of 7,370 tonnes was calculated for that year's catch from the annual statistics of piramutaba catch in 1977–1996 (Figure 128).

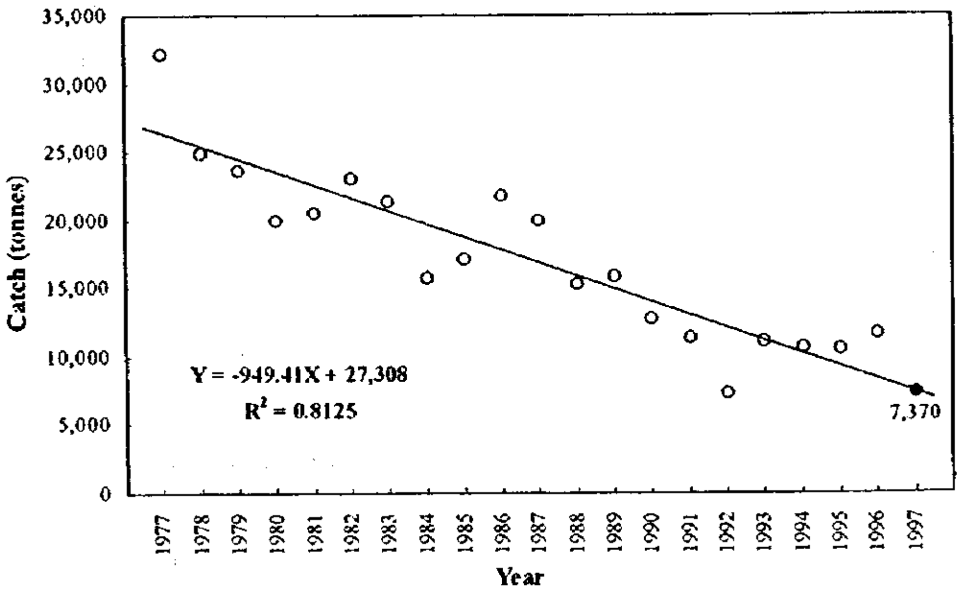


Figure 128. Annual variation of Piramutaba catch by industrial fisheries.

6.1.2. Resources Survey

The resources survey was conducted with the same vessels and methodology in the 1996 Dry Season (August to September) and 1997 Rainy and Dry Seasons (respectively, March to April and August to September).

Catch at each trawl station had two separate counts. One was for cod-end (mesh size 100 mm) and the other considered catches by cod-end plus covernet (mesh size 35 mm). The stock size calculated from the catch by cod-end is called the catchable stock size, and is the basis for resources management. The one that can be deduced from the catch by cod-end and covernet would include recruiting populations and is termed recruitment stock size.

Resources management takes into consideration current fishery regulations, and all further discussions should be based on catchable stock size as deduced from cod-end data.

Catchable stock size of the seven key fishes are shown in Table 84. A number of points can be observed:

(1) Estimated total stock size was as follows: 33,660 tonnes for the 1996 Dry Season, 45,610 tonnes for the 1997 Rainy Season and 67,270 tonnes for the 1997 Dry Season. Seven key fishes represented the following percentages of the total stock size: 20%, 44%, 20% in the respective seasonal surveys.

(2) In each season, stocks of piramutaba, dourada, filhote, as well as of pescada-branca *Plagioscion squamosissimus,* were mainly distributed in the 5–10 m stratum. In contrast, stocks of pescada-amarela *Cynoscion acoupa,* pescadinha-gó *Macrodon ancylodon* and gurijuba were found in depths from 5 to 50 m, being mainly distributed in the 10–20 m stratum.

(3) Mean stock size for the three surveys was, in decreasing order, 5,820 tonnes for piramutaba, 4,050 tonnes for gurijuba, 2,340 tonnes for dourada and 740 tonnes for pescada-amarela. The other key species had a low stock size: 400 tonnes for pescadinha-gó, 70 tonnes for pescada-branca and 30 tonnes for filhote.

(4) Estimated seasonal stock sizes of piramutaba were 1,990 and 3,320 tonnes for the respective Dry Seasons and 12,150 tonnes for the Rainy Season. Seasonal stock sizes of dourada were 1,200 and 2,560 tonnes for the respective Dry Seasons and 3,250 tonnes for the Rainy Season. In both cases, those stock sizes were higher in the Rainy Season, as piramutaba and dourada live in river waters. In other words, in the Rainy Season the freshwater portion in the survey area expands toward the offshore due to precipitation, widening the distribution area and increasing the density for both species. The increase in stock sizes of piramutaba and dourada in the 1997 Dry Season was due to the fact that density (kg/km^2) of both species in the 5–10 m stratum was higher than in the 1996 Dry Season. Estimated seasonal stock sizes of gurijuba were 2,710 and 5,820 tonnes for the respective Dry Seasons and 3,630 tonnes for the Rainy Season. The increase in gurijuba stock size in the 1997 Dry Season can be explained by the fact that density in the 5–20 m depth range was higher than in the 1996 Dry Season.

Table 84. Catchable stock size of the seven key fishes. Upper , Phase 1 Dry Season Survey (7 Aug.-30 Sept., 1996; 110 stations); ***Middle , Phase 2 Rainy Season Survey (7 March - 28 Apr., 1997; 120 stations);*** **Lower , Phase 2 Dry Season Survey (2 Aug. - 26 Sept., 1997; 120 stations).**

Stratum (m)	Area (km^2)	Stock size in tonnes								
		Piramutaba	Dourada	Filhote	Pescada branca	Pescada amarela	Pescadinha go	Gurijuba	Others	Total
5 - 10	17,200	1,340	1,100	20	20	60	30	670	8,160	11,400
		10,730	*2,550*	*50*	*150*	*70*	*110*	*1,180*	*8,790*	*23,630*
		3,250	2,310	10	40	350	30	2,360	13,970	22,320
10 - 20	15,700	650	100	0	0	270	220	1,880	16,060	19,180
		1,420	*700*	*0*	*0*	*340*	*150*	*2,140*	*9,520*	*14,270*
		70	250	0	0	790	260	2,810	33,870	38,050
20 - 50	9,300	0	0	0	0	140	30	160	2,750	3,080
		0	*0*	*0*	*0*	*70*	*240*	*310*	*7,080*	*7,700*
		0	0	0	0	140	140	650	5,970	6,900
Total	42,200	1,990	1,200	20	20	470	280	2,710	26,970	33,660
		12,150	*3,250*	*50*	*150*	*480*	*500*	*3,630*	*25,390*	*45,600*
		3,320	2,560	10	40	1,280	430	5,820	53,810	67,270
Coefficient of variation (%)		37	24	70	66	38	24	18		
		8	*23*	*44*	*40*	*33*	*21*	*17*		
		46	27	87	46	26	21	14		

6.2. Evaluation of Exploited Fishery Resources

A comprehensive evaluation of resources requires a thorough view of both the qualitative and quantitative aspects of catchable stock. The former includes biological parameters such as growth, maturation, spawning and natural mortality, the latter refers to the stock size. However, as explained later, the available data on those biological parameters are quite incomplete at present. In the following sections the catchable stock size of piramutaba is evaluated, mostly focusing on the quantitative aspects.

6.2.1. Catch and Catchable Stock Size

The current status of piramutaba stocks was evaluated based on catch and catchable stock size. As mentioned before, catch by industrial fisheries in 1996 amounted to 11,641 tonnes according to fishery statistics, and the estimate for 1997 based on the catch variation in 1977–1996 is of 7,370 tonnes. The corresponding catchable stock sizes were 1,990 tonnes for 1996, from the Dry Season and 7,740 tonnes for 1997, calculated from a mean value between Rainy and Dry Seasons.

Comparing catch and catchable stock size, it can be observed that the difference between both values is a theoretically impossible contradiction — namely, in 1996 and 1997 the industry would have caught respectively 5.8 times and 1.0 time the catchable stock size of piramutaba. With respect to this, the catchable stock size in 1996 is calculated only from the Dry Season, and the catch of piramutaba in 1997 is an estimated value calculated from catch variation of the past 20 years.

On the other hand, for the estimation of stock size, the distribution area of piramutaba — particularly in the offshore area of the Southern Channel of the Amazon River and area shallower than 5m water depth — was not thoroughly covered by the survey, and fishing gear efficiency was assumed as 1.0. Thus, certain prerequisite conditions for stock estimation were not met, leading to an underestimated value of stock size.

In contrast, a primary factor of overestimation, the herding effect of the fishing gear, has been ignored. The estimated stock size of piramutaba shows a large variation between the Rainy and Dry Seasons, as the water discharge of the Amazon River rises or falls.

One of the indicators of accuracy in stock size estimates is the coefficient of variation, which should be around 10% to be of any practical value for stock management. For all six key fish species except gurijuba, the coefficient of variation ranged from 20% to 90%. Another such indicator, the confidence interval of 95% for stock size estimates of key fish species, had a wide amplitude. Therefore, stock size estimates in this survey for key fish species other than gurijuba (coefficient of variation = 14–18%) cannot be said to be very accurate.

Despite the existence of uncertain issues as described above on the actual relationship between catch and stock, it is clear that in recent years industrial fisheries has caught many times the stock of piramutaba and, it is possible to have exerted an damaging fishing pressure over their stocks.

6.2.2. Catch per Unit Effort (CPUE)

Catch per unit effort (CPUE) is one of the numerical means for expressing stock condition. IBAMA statistics offer, besides catch, data on fishing effort such as number of operational vessels, number of fishing trips and number of days at sea. Based on those statistics of number of days at sea, the CPUE of piramutaba was calculated for the period from 1975 to 1996, its variation being illustrated in Fig. 129. CPUE has declined fro 3.2 tonnes/day in 1975 to 2.6 tonnes/day in 1996.

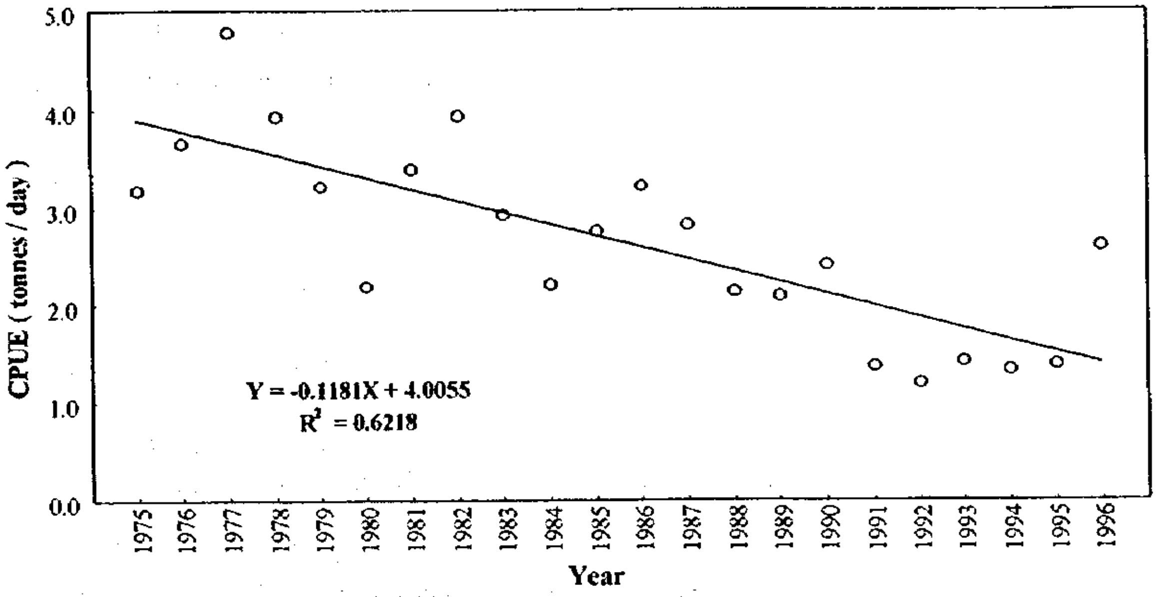


Figure 129. Annual variation of CPUE for Piramutaba by industrial fisheries. (Note: 1970s to 1992, two-trawler fishing; from 1993 on, three- or four-trawler fishing).

Examining this yearly reduction in more detail, some aspects can be observed:

(1) Based on a 25 year history and experience of exploitation, industrial fisheries have concentrated on the selective fishing of piramutaba;

(2) As they are caught, piramutaba are selected on board to meet commercial size requirements;

(3) More than the officially licensed number of 48 vessels are operating in piramutaba fisheries (Figure 113, A);

(4) Piramutaba fishing vessel setups from the early 70s until 1992 had been a pair of trawlers dragging one net. However, for reasons of cost reduction and compensation for a decline in catch, the setup was changed in 1993 to three trawlers and two nets or four trawlers and three nets;

(5) Navigation instruments, school-detecting sonar and other equipment have been installed aboard fishing vessels, recently resulting in relative improvements in catch efficiency.

As the above items (1), (4) and (5) represent an improvement in the quality of fishing effort, one can think that the reequipment and rescaling of the fishing fleet by the industry in the period from 1975 to 1980 resulted in a decline of CPUE in recent years. Standardized studies of effort affecting catch efficiency are necessary for the correct assessment of the annual variation of CPUE. A solution would be the search for a revised coefficient of CPUE that would take into account the parallel operation in the same region of the fishing fleet in the 1975–1980 period (two-trawler setup) and in present times (three- or four-trawler setup).

Although not covered by this study, a revised value of CPUE considering recent improvements in fishing effort by the industry should indicate a relative decline in piramutaba stock.

6.2.3. Summary

To allow a comparison of these estimated stock size results with those in other areas, Table 85 lists the results of demersal fish resources surveys conducted in various parts of the world, with different survey vessels, survey regions, survey period, survey area, and number of survey stations. There, the mean density of potentially occurring demersal fishes, a standard adopted for all surveys, was relatively low for the Amazonian Estuary: 0.8 and 1.6 tonnes/km^2 in the Dry Season and 1.1 tonnes/km^2 in the Rainy Season.

Surveys have shown that in subarctic and temperate zones there are few species, each of them abundant, while in the tropics there are many species but little abundance — a fact described as "the phenomenon of rich north vs. poor south". Fish stocks in the neotropical Amazon River Mouth Area reflect this rule in that there are many species indeed, while it cannot be said they are potentially abundant.

On the problem of species abundance with respect to the food chain, the stock size of fishes ranking high in the chain should be less than of lower-ranking ones. The key species studied in the present survey were all piscivorous, and their low number of individuals could be also due to their high position in the food chain.

As described above, fishery resources in the Amazon River Mouth Area cannot be said to be abundant in comparison to other regions in the world. Piramutaba stocks are targeted by the industry and if one sees the question from several different angles, the conclusion is that they have been situated in need of closely monitoring.

As the Landing Site Survey revealed, fishermen said in interviews on the recent changes in fisheries in the Amazonian Estuary that there has been "increase in fishing effort (that is, in the number of vessels), decrease in catch, and no variation — or even a decrease — in size of the fish caught".

Reflecting upon this information, for instance, a reduction of fishing effort is necessary in piramutaba fishery in the Amazonian Estuary.

6.3. Procedures for Further Surveys and Research

An evaluation of resources requires at first some biological information on target resources — data such as age composition, sex ratio and stock size. The next step is to advance toward a diagnosis of the resources by establishing their growth curve, maturation age, reproduction, natural mortality rate, mortality

Table 85. Results of resources surveys aimed at demersal fish species.

Area	Period	Survey area (km^2)	Stations	Stock size (tonnes)	Mean density ($tonnes/km^2$)	Depth zone (m)	Main species
Bering Sea	May - Sept., 1979	658,740	950	9,003,400	13.7	14 — 1,080	Pollock, Yellowfin sole, Pacific cod, Flounders
Aleutian Islands	June - Nov., 1980	119,426	319	1,799,200	15.1	1 — 900	Cods, Rattails, Flatfishes
Agulhas Bank of	Nov. - Dec., 1980	66,813	146	276,186	4.1	< 183	Cape hake, Panga, Cape horse mackerel
South Africa	Nov. - Dec., 1981	70,241	186	347,149	4.9	< 183	Cape hake, Panga, Cape horse mackerel
	June, 1982	70,241	136	316,668	4.5		Cape hake, Panga, Cape horse mackerel
New Zealand E,F	March - May, 1982	343,532	220	279,200	8.1	201 — 800	Hoki, Barracudas, Blue whiting
	March - April, 1983	61,071	114	636,500	10.4	201 — 600	Hoki, Barracudas
Greenland East, West	June - Nov., 1988	277,860	180	920,500	3.3	201 — 1,400	Greenland halibut, Atlantic cod, Res fishes
	April - Nov., 1989	277,860	142	298,000	1.1	201 — 1,500	Greenland halibut, Res fishes, Grenadiers
Sea of Marmara	June - Aug., 1991	51,835	172	49,669 *	1.0	20 — 500	Hake, Red mullet, Atlantic horse-mackerel
Aegean Sea and	Dec.,1991 - Jun., 1992	51,835	86	26,674 *	0.5	20 — 500	Hake, Red mullet, Atlantic horse-mackerel
Mediterranean Sea	April - June., 1992	51,835	140	28,406 *	0.5	20 — 500	Hake, Red mullet, Atlantic horse-mackerel
	Sept. - Nov., 1992	51,835	155	21,229 *	0.4	20 — 500	Hake, Red mullet, Atlantic horse-mackerel
South China Sea	—	—	—	3,771,000	4.0	— 50	
	—	—	—	—	2.0	51 — 500	
Amazonn and Tocantis	Aug. - Sept. 1996	42,200	111	33,660	0.8	5 — 50	Sea catfish, Piramutaba
River Mouth	March - April, 1997	42,200	120	45,600	1.1	5 — 50	Sea catfish, Piramutaba
	Aug. - Sept., 1997	42,200	120	67,270	1.6	5 — 50	Sea catfish, Piramutaba

* : Recruitment stock size

rate due to catch and so on. The combined analysis and evaluation of all these data would make possible a solid policy for the management of those resources.

This was the first systematic resources survey aimed at demersal fishes of the Amazon River Mouth Area and, as such, it did not bring out much information that could be directly utilized for stock evaluation. However, precious data were obtained on biological aspects and on the stock size for the seven key fish species. In order to evaluate the present survey, the questions were organized below around some useful points.

The trawl survey method has the advantage of allowing to estimate stock size simultaneously to collecting biological data on the target resources. The resources survey should be designed in a way of getting a good coefficient of variation, which is directly related to the accuracy of the estimate and depends on the distribution density of the target species and the number of trawl stations. Through analyzing the coefficients of variation and confidence intervals for the estimated stock sizes for each species by season or by stratum obtained from the present survey, an efficient plan of survey period, area and depth zone by target species can be established and it allowed for a quite accurate estimate of stock size.

Body length data of target species were extremely important in order to clarify growth and age composition. Size composition of catch in covernet and cod-end reflected well the natural conditions of the target stock. However, the catch landed at fishing ports, fish markets and companies by artisanal or industrial fisheries may not reflect a natural size composition because that had been previously selected fishing ground, fishing method and mesh size, and marketable size. Therefore, any study of size (age) composition based on the landed catch demands much caution.

Age determination of seven key fish species was tried focusing on the rings formed on hard structures — vertebral centra and otoliths. However, as those rings turned out not to be formed periodically, age could not be determined through them. A cohort analysis based on size frequency distribution — as determined by the Sea-Borne Survey — was performed, but this method did not yield positive results either. For an evaluation of the current status of resources and the implementation of a management policy, knowledge on growth and age of target species is essential. Now it is necessary to drive a continuous effort toward age determination.

It is also essential to clearly know the age at maturation and the reproduction of fish species. This knowledge can be a trend indicator for the stock, as in many fishes a lowering of standards in the stock is accompanied by a change toward an earlier age at maturation.

Information on feeding habits is extremely important for elucidating the flow of energy in a community. For subarctic regions, where organisms are comparatively less diverse with a single species being abundant, there are ecological models such as that of Ursin (1979) or Laevastu & Larkins (1981) for the interpretation of community structure. Those models are based on feeding habits. Therefore, it should be hereafter necessary to identify food organisms and evaluate their weight to allow for a quantitative analysis.

The biological parameters described above are closely associated with environmental changes in the Amazonian Estuary through the rainy and dry seasons. It is important to consider the present survey as a blueprint for the steady continuation of data gathering.