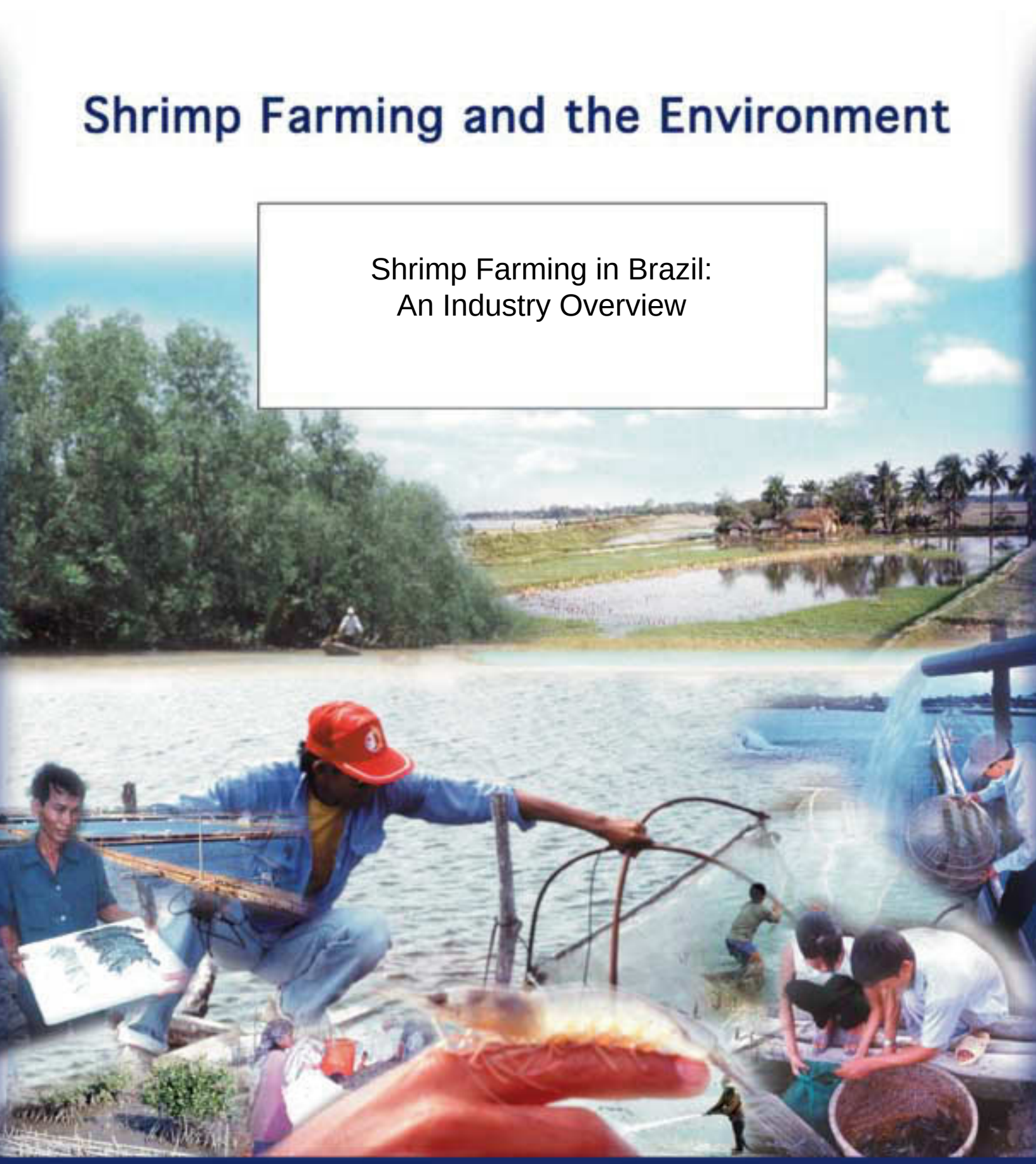
Shrimp Farming and the Environment

Shrimp Farming in Brazil:
An Industry Overview



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SHRIMP FARMING IN BRAZIL: AN INDUSTRY OVERVIEW

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Preparation of this document

The research reported in this paper was prepared under the World Bank/NACA/WWF/FAO Consortium Program on Shrimp Farming and the Environment. Due to the strong interest globally in shrimp farming and issues that have arisen from its development, the consortium program was initiated to analyze and share experiences on the better management of shrimp aquaculture in coastal areas. It is based on the recommendations of the FAO Bangkok Technical Consultation on Policies for Sustainable Shrimp Culture[1], a World Bank review on Shrimp Farming and the Environment[2], and an April 1999 meeting on shrimp management practices hosted by NACA and WWF in Bangkok, Thailand. The objectives of the consortium program are: (a) Generate a better understanding of key issues involved in sustainable shrimp aquaculture; (b) Encourage a debate and discussion around these issues that leads to consensus among stakeholders regarding key issues; (c) Identify better management strategies for sustainable shrimp aquaculture; (d) Evaluate the cost for adoption of such strategies as well as other potential barriers to their adoption; (e) Create a framework to review and evaluate successes and failures in sustainable shrimp aquaculture which can inform policy debate on management strategies for sustainable shrimp aquaculture; and (f) Identify future development activities and assistance required for the implementation of better management strategies that would support the development of a more sustainable shrimp culture industry. This paper represents one of the case studies from the Consortium Program.

The program was initiated in August 1999 and comprises complementary case studies on different aspects of shrimp aquaculture. The case studies provide wide geographical coverage of major shrimp producing countries in Asia and Latin America, as well as Africa, and studies and reviews of a global nature. The subject matter is broad, from farm level management practice, poverty issues, integration of shrimp aquaculture into coastal area management, shrimp health management and policy and legal issues. The case studies together provide an unique and important insight into the global status of shrimp aquaculture and management practices. The reports from the Consortium Program are available as web versions (http://www.enaca.org/shrimp) or in a limited number of hard copies.

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Reference:

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[1] FAO. 1998. Report of the Bangkok FAO Technical Consultation on Policies for Sustainable Shrimp Culture. Bangkok, Thailand, 8-11 December 1997. FAO Fisheries Report No. 572. Rome. 31p.

[2] World Bank. 1998. Report on Shrimp Farming and the Environment – Can Shrimp Farming be Undertaken Sustainability? A Discussion Paper designed to assist in the development of Sustainable Shrimp Aquaculture. World Bank. Draft.

Abstract

The purpose of this study is to assess the development of the shrimp farming industry in Brazil, identifying past obstacles and key incentives for its expansion. The shrimp industry has taken longer to develop in Brazil than in other countries. Despite favorable conditions, it is only recently that successful efforts are consolidating. This report analyzes the main factors that have inhibited the development of the industry and describes the sector's current characteristics.

The shrimp farming industry is developing rapidly today. The stability of the Brazilian economy since 1994, together with the establishment of commercial shrimp hatcheries and aquafeed companies from Taiwan and the US, has provided further incentives for new investments in the sector. Most farms have implemented semi-intensive methods with *P. vannamei* and *P. subtilis* and adopted innovative management techniques

At the moment, there is an absolute absence of any scientific research from Brazilian governmental bodies concerning PL production in hatcheries or raising shrimp in ponds. All the progress made to date has come from producers' own on-site research or the expertise of international consultants. The members of the producers' association (ABCC) agreed to pay a "research tax" levied on the feed sold to farmers. These private funds support research projects proposed by ABCC's members that have industrywide relevance. It is odd that on the one hand the public sector in Brazil is highly effective in taxing all kinds of economic activities, and on the other hand incapable of building a public research infrastructure that would strengthen the industry.

One issue to be resolved is the use of marine land as collateral for credit, since most farms are situated on marine land. Normally the actual land where a shrimp farm is built represents the highest-value component of the farm. Banks or other lenders will demand additional collateral if the owners lack the land's title, since they consider "occupancy of marine land" not equivalent to having a definitive title to the real estate. It would greatly enhance the borrowing capacity of shrimp farmers if the federal government can resolve this issue.

Content

Abbreviations and Acronyms

ABCC	Associacao Brasileira de Criadores de Camarao (Brazilian Association of Shrimp Producers)
BNCC	Banco Nacional de Credito Cooperativo
BNDES	National Bank for Social and Economic Development
CBA	Comphahia Brasileira de Aquacultura
CONAMA	National Council for the Environment
FAO	Food and Agriculture Organization of the United Nations
FNE	Development Fund for the Northeast
Ha	Hectare
IBAMA	National Agency for the Environment
kg	Kilogram
MMT	Million Metric Tons
NACA	Network of Aquaculture Centres in Asia-Pacific
PL	Postlarvae
R$	Brasilian Real (US$ 1 = R$ 2.64 in June, 2002)
RGN	Rio Grande de Notre State
SUDENE	Northeast Development Agency
SUDEPE	Superintendencia de Pesca (Agency for Fisheries and Aquaculture)
TJLP	Long Term Interests Rates
WB	The World Bank
WWF	World Wildlife Fund

Introduction

Aquaculture is the fastest-growing food production system in the world, having expanded at an estimated annual rate of 10% since 1984. In 1997, the industry contributed 28% of total global aquatic production, generating 36 million metric tons (36 MMT) of some 300 species of finfish, shellfish, and aquatic plants. Together, these products were valued at US$50.3 billion. Despite its low overall volume (2.6% of the total), penaeid shrimp is the most important cultured product in monetary terms, accounting for 12%, or $6.1 billion, of the total estimated value generated by the aquaculture sector[3] in 1997 (Nunes, 2000). Historically, cultivation of marine shrimp originated thousands of years ago in the Mediterranean region, and was practiced as well in 15th-century (A.D.) Indonesia. The industry has modernized appreciably in recent decades and is now established in over 50 countries located in tropical and sub-tropical areas around the globe. With increasing demand leading to greater economic value, farmed penaeid shrimp production has grown 82 % since 1984. The sector now constitutes almost half (47%) of the world market, with over 86% of its total volume accounted for by only four species (*Penaeus monodon*, *P. vannamei*, *P. chinensis* and *P. merguiensis*).

The purpose of this study is to assess the development of the shrimp farming industry in Brazil, identifying past obstacles and key incentives for its expansion. The shrimp industry has taken longer to develop in Brazil than in other countries. Despite favorable conditions, it is only recently that successful efforts are consolidating. This report analyzes the main factors that have inhibited the development of the industry and describes the sector's current characteristics. Figure 1 shows the main shrimp farming sites in Brazil.

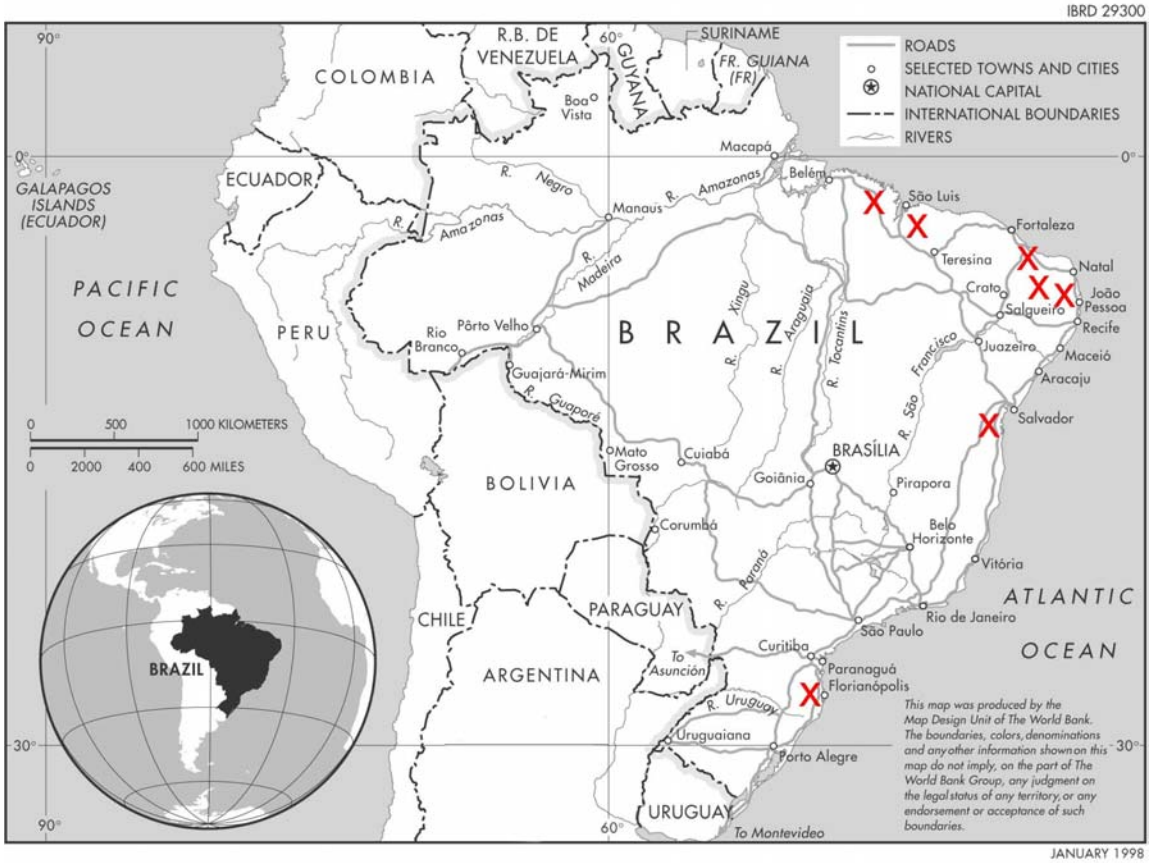

Figure 1.Map over Brazil with X marking the important and major shrimp farming areas (Rosenberry 2001)

[3]Alberto Nunes, of Research & Consulting in Marine Shrimp Farming. http://meusite.osite.com.br/ajpn/portug2.html

History of the Shrimp Industry in Brazil[4]

The first attempt to farm saltwater shrimp in Brazil occurred between 1972 and 1974, when Ralston-Purina and a team of researchers from the Rural University of Pernambuco conducted production trials on the island of Itamaraca with different species of *Penaeus* shrimp. The clear winner of the trials was *Penaeus vannamei*. Because this species was not endemic to the coastal waters of Brazil, Purina decided to start its pioneer shrimp farm in Panama, and later named it Agromarina de Panama. Despite Brazil's potential benefits (in land availability and climate), it was much easier to start the venture in a country where *P. vannamei* was readily available for the laboratory (both wild post-larvae (PL) and broodstock). During subsequent years, Agromarina´s farm and hatchery research proved that commercial shrimp farming was possible.

Unfortunately, Brazilian technicians and universities involved in this original evaluation did not have access to information about productivity differences by species. This valuable information could have guided choices about shrimp species used in the first aquaculture projects in Brazil and accelerated development of the industry.

Between 1972 and 1975, the government of the state of Rio Grande do Norte, under governor Cortez Pereira's leadership, promoted the development of the industry. Delegations traveled to other countries to access the best shrimp farming technologies for the region. Government commissions were installed, programs were set up, and a state agency, EMPARN, was created to supply future farmers with seeds. But the state government changed in l978, and promises made earlier to support the shrimp farming industry were not fulfilled. The species chosen was *P. japonicus*, probably because its laboratory reproduction was well understood at that time.

On a parallel track, CIRNE, a large Brazilian salt producer also based in Rio Grande do Norte state (RGN), in 1975 launched a shrimp production unit, first utilizing small ponds for trials, and later on large earthen ponds for commercial production. The species used was *P. japonicus*, reproduced in a hatchery on-site. Stocking density was low (between 0.5 and 1.0/m^2), and feed was supplied naturally by mixing freshwater from the Açu River, which provided organic matter and kept salinity low, with crystal clear seawater. The shrimp ate micro-crustaceans and polychaetes, and pond bottoms were covered with macroalgae. Despite the low productivity per hectare (numerous predators lived in the ponds, which ranged up to 50 ha and were never drained completely), the project was profitable. In l984 it became a separate company called CBA (Companhia Brasileira de Aquacultura). However, soon bad management, heavy theft, and changing climatic conditions forced the operation to close. In 1986, the parent company, then profiting from higher salt prices, decided to reabsorb the shrimp operation and use the land to produce salt, closing down the oldest Brazilian shrimp farm.

Between 1982 and 1984, the Federal government, through its agency SUDEPE (Superintendencia de Pesca, or Agency for Fisheries and Aquaculture) and the state bank BNCC (Banco Nacional de Credito Cooperativo), started a financing program with more than US$22 million, with Inter-American Development Bank as their international partner. Of a total of 16 projects financed, only a few survived. Heavily subsidized loans were granted to existing and "spontaneous" producers, and to large corporations attracted by the generous terms. The program imposed a number of technical requirements as a condition of receiving loans, two of which proved to be disastrous for the industry. One was the obligation to use the species *P. japonicus*, and the other was that projects must build their own hatcheries on-site.

[4]This section was prepared with the input of Werner Jost, director of Camanor, and a key player in the industry for the last 15 years.

Penaeus japonicus proved to be, at least in the conditions of the Brazilian Northeast, a very delicate animal, demanding high-protein feed and yet having a low survival rate. In addition, hatcheries need clean saltwater, while farms are normally situated in estuarine areas, where water is naturally high in organic matter and less saline than ocean water. Only the largest early project, Maricultura da Bahia, using the political clout of its parent company, OAS, received permission to use *P. vannamei* through an international technical assistance package. Results were reasonably positive from the beginning, and the company was considered the best shrimp farm in productivity and hatchery production during the 1980s. Unfortunately, the sponsors of the project adopted a secretive attitude vis-à-vis the rest of the industry and therefore neither Maricultura da Bahia's technology nor its use of *P. vannamei* spread in Brazil.
Some other projects, like CRUSA, in the State of Piauí, had a large parent company (Klabin) behind them. These parent companies had the financial strength to develop technical solutions, such as importing technologies and different species from the rest of the world. CRUSA conducted trials with different species including *P. subtilis*, which slightly improved results but not enough to cover operating costs. Poor results led the group to discontinue its shrimp production activities after a few years of operations. Therefore, between l985 and l990, only a few projects survived in Brazil, including the large Maricultura da Bahia, and some of the smaller farms that fought for survival but lacked the financial capacity to break the vicious cycle of low production and accumulating losses. Farmed shrimp productivity stood between 50 and 200 kg/ha/cycle. The objective of 1,000 kg/ha/year seemed a dream far away. Most of the farms went bankrupt, generating bad publicity and making it even more difficult to obtain financing for the remaining projects. Until l989 there was no reliable supply of shrimp PL, leaving smaller farms without stock for long periods. Some of them tried to capture and use wild animals from the adjoining estuaries to maintain minimum production levels.

The federal government, after its unsuccessful initial support, retreated, and the state government did not give any support either (e.g., for PL supply or technology). The country's macroeconomic instability also had a negative impact on the incipient industry. During that period, the meetings of the ABCC (Associação Brasileira de Criadores de Camarão–Brazilian Association of Shrimp Producers), with its handful of members, seemed more like mourning sessions than business meetings to solve industry problems. The government of Rio Grande do Norte had intended to provide company "incubator" assistance (for example, supplying PL and technology) through a state agency called EMPARN. Inefficiency and bureaucratic barriers, however, prevented this idea from taking off.

In l987, a small farm started a commercial hatchery named Aquatec in Rio Grande do Norte. It was the first laboratory focused on the production and supply of PL to third-party farmers. Up to that time, all existing hatcheries were integrated with grow-out farms; when they experienced production problems (a regular occurrence) PL was scarce for their own consumption as well as for supplying other farms. Thus, Aquatec started to supply *P. subtilis* and *P. schmitti* to a market that had high demand.

In l992 it became clear to the owners of Aquatec that switching to *P. vannamei* was necessary to improve productivity to an economically sustainable level. Some small quantities of *P. vannamei* sold by Maricultura da Bahia proved again that the results with this species were significantly better. Aquatec imported a batch of broodstock from Panama, which showed excellent results in the hatchery from the beginning. The farms then tended to stock at 1–2 PL/m^2, with only the most audacious using 4 PL/m^2 which was called "semi-intensive". The producers took some time to adapt to *P. vannamei*, whose habits were different from native species'. Even with such low densities, positive results started to appear immediately—and from l993 on, well-organized farms were showing profits. Post-larvae supply was not always constant, because the production technology was still being developed. Importing broodstock was extremely complicated for logistic reasons, and growing broodstock within Brazil still posed formidable challenges.

The use of *P. vannamei* was revolutionary for the Brazilian shrimp industry. Stocking density started to increase, reaching 30 PL/m^2 in l998. New farms were built and old ones reactivated. Production doubled during the next few years. Even with the evident advantage of using *P. vannamei*, many industry leaders still insisted on a "Brazilian solution" that used *P. subtilis*. They argued that with a better diet they could get the same production levels as with *P. vannamei*, ignoring that a better diet would cost more and that *P. vannamei* had substantial advantages over the native species. For example, they have resistance to temperature and salinity fluctuations and to low oxygen levels, and are less aggressive, which allows for stocking at higher densities. The discussion extended over some years and postponed important industry decisions.

With the implementation of the Real Plan in 1994 (an economic package put forward by the Brazilian government to stabilize the economy) and the subsequent overvaluation of the currency, Brazilian shrimp lost its competitive edge in international markets. The industry focused for the first time on internal market opportunities. However, distribution channels were still primitive and concentrated in only a few major cities, São Paulo and Rio de Janeiro (Ceasa, Ceagesp). The distributors had no administrative structure or capital, so a downturn in the market delayed shipment payments. Paradoxically, most farms lost large amounts of money in the domestic market, while productivity continued to increase and supply of shrimp grew.

In 1999, a currency devaluation reopened the door to international markets. Moreover, international shrimp prices rose substantially, due to disease outbreaks in Pacific coastal farms in other Latin American countries. Revenues to exporters became very attractive. As a consequence, domestic prices rose sharply and even small farmers started to sell directly to the processing plants, switching away from local intermediaries. Shrimp farming became extremely lucrative, initiating a boom in farm development investments.

Current Status of the Industry

The shrimp farming industry is developing rapidly today. The stability of the Brazilian economy since 1994, together with the establishment of commercial shrimp hatcheries and aquafeed companies from Taiwan, Province of China and the US, has provided further incentives for new investments in the sector. Most farms have implemented semi-intensive methods with *P. vannamei* and *P. subtilis* and adopted innovative management techniques. In certain areas, yields exceed 2 MT/ha/cycle, with three to four production cycles per year. On Brazil's Northeast coast, which concentrates 97% of all farmed marine shrimp produced in Brazil, there are over 100 farms, including large and small-scale operations.

Production

Production has doubled every year for the past 5 years, resulting from the expansion of pond area and increased density (Figure 2). Starting from an extremely extensive production method in l992 (1–2 PL/m^2), stocking densities have increased to 30 PL/m^2, raising productivity to 2,500 kg/ha/cycle in the more sophisticated farms. Even small-scale farmers using shallow ponds, simple technology, and insufficient pumping capacity stock at 15–20 PL/m^2 and have harvest yields ranging between 1,000 and 2,000 kg/ha/cycle. The industry's average production per hectare per year is around 2,000 kg/ha, which by Latin American standards is very high, matched only by a few other countries like Colombia and Venezuela, which have many fewer market participants.

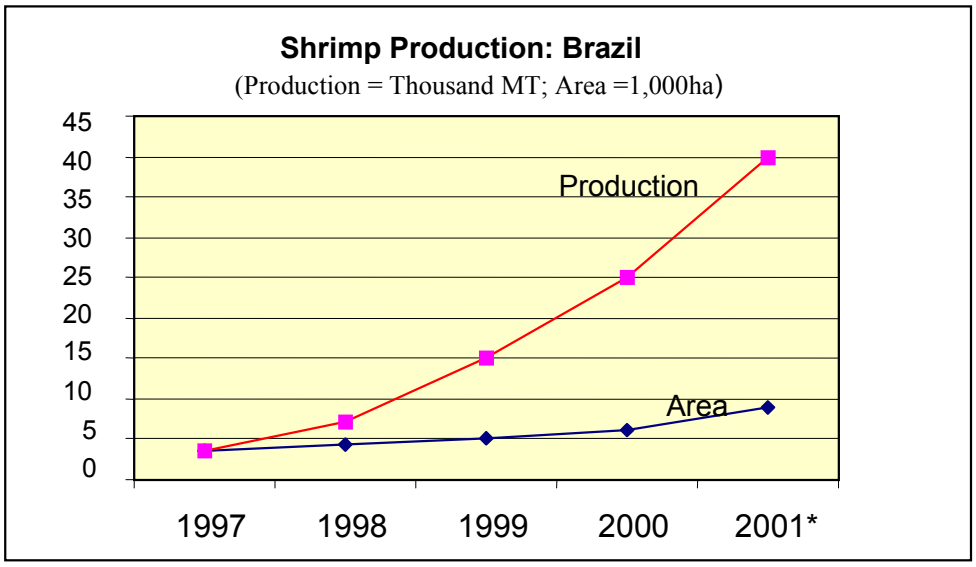

Figure 2. Data showing the production in relation to area for shrimp farmning in Brazil.

The search for better technology and improved yields has continued since the early years. The absence of *P. vannamei* during the 1980s provided inadvertent benefit because the low yields of the native species could be improved only by developing good management practices. These practices have continued even after the introduction of *P. vannamei*. Starting in 1994, the use of feeding trays spread quickly around the country and is now an industry standard. Tilling the soil and correcting the pH by applying lime are common practices these days. Even small farmers now apply technologies to their first crop that took the larger companies years to develop and apply. Aeration is also widely used in semi-intensive farms (stocking density about 30 PL/m^2).[5]

Table 1. Brazilian's farmed shrimp production, 1997–2001

Year	1997	1998	1999	2000	2001*
Area (ha)	3,548	4,320	5,200	6,250	9,000
Production (MT)	3,600	7,260	15,000	25,000	40,000

Source: Brazilian Association of Shrimp Producers (ABCC). *ABCC projections.

According to ABCC (2000), the states of Bahia, Rio Grande do Norte, and Ceará account for most of the country's production of farmed shrimp, estimated at 24,000 MT for 2000. Large farms developed in the state of Bahia, while small producers developed in Rio Grande do Norte. The appearance of the commercial shrimp hatchery Aquatec in l989 allowed rural fish producers in the latter state to switch to shrimp production and considerably increase their incomes. The opposite happened in the state of Bahia, where large farms produced their own PL and were never interested in selling them to potential customers, whom they viewed as competitors (Table 2 and 3).

[5]It is interesting to see how the meaning of "semi-intensive" has changed over time: in l992, a stocking rate of 4 PL/m^2 was considered a semi-intensive system, whereas now it is used for 25–30 PL/m^2. Furthermore, stocking densities of 40, 50, or even 60 PL/m^2 are being tested in various places.

Table 2. Distribution of Brazilian shrimp farm area and shrimp produced, by region, 2000

Region	Area (ha)	% of total area	Production (MT)	% of total production
North	70	1.12	140	0.56
Northeast	5,890	94.24	24,270	97.00
Southeast	40	0.64	40	0.16
South	250	4.00	550	2.20
Total	**6,250**	**100.00**	**25,000**	**100.00**

Source: Brazilian Association of Shrimp Producers (ABCC).

Table 3. Projected Brazilian shrimp production, by state, 2000

State	Area (ha)	Production (MT)
Rio Grande do Norte	1,752	7,000
Bahia	1,510	6,900
Ceará	982	4,960
Pernambuco	670	2,630
Piauí	425	1,082
Paraíba	420	1,300
Santa Catarina	200	400
Pará	70	140
Maranhão	64	160
Paraná	50	150
Sergipe	47	188
São Paulo	40	40
Alagoas	20	50
Total	**6,250**	**25,000**

Source: Brazilian Association of Shrimp Producers (ABCC).

A major breakthrough for the industry was gaining the ability to produce PL within the country. The imported broodstock from Panama had good production results, but supply was uncertain, and the costs of acquiring the animals, transporting them, and paying the import duties were high. The first domestic trials with farm-raised broodstock were unsuccessful, since the animals suffered from disease and had low survival rates (and even low nauplii production rates). This caused severe shortages of PL between l995 and l998. Farmers were forced at one point to import a Boeing 707 filled with nauplii, PL, and broodstock from Ecuador. Over several generations, the performance of the farm-raised animals improved and the country no longer had to import *P. vannamei* broodstock. Today the top hatcheries produce 100,000 nauplii per female and experience up to 10% mating rates per day. As demand for PL continues to grow (new farms open up, and stocking density increases), supply of PL is always tight. Several hatcheries are being built but if demand outpaces total production, PL supply will be limited for some time in the future.

Market Information

The number of companies producing saltwater shrimp, in its various stages, has increased dramatically during recent years. Currently the industry has about 380 participating firms. Farms can be divided into three categories: small (up to 30 ha), medium (between 30 and 100 ha) and large (above 100 ha). The distribution of companies of different sizes across geographic areas is shown in Table 4 (Refer to Figure 1 for geographical locations).

Table 4. Locations of Brazilian shrimp producers operating in 2000, by size of operation

State	Small		Medium		Large		Total	
	Companies	Area	Companies	Area	Companies	Area	Companies	Area
Pará	–	–	3	70	–	–	3	70
Maranhão	–	–	1	64	–	–	1	64
Piauí	6	30	3	145	01	250	10	425
Ceará	28	150	5	232	03	600	36	982
Rio G. do Norte	140	940	4	140	05	672	149	1,752
Paraíba	86	130	–	–	02	290	88	420
Pernambuco	22	210	–	–	01	460	23	670
Alagoas	2	20	–	–	–	–	2	20
Sergipe	2	14	1	30	–	03	3	47
Bahia	32	130	2	110	04	1,270	38	1,510
São Paulo	–	–	1	40	–	–	1	40
Paraná	–	–	1	50	–	–	1	50
Sta. Catarina	25	200	–	–	–	–	25	200
Total	**343**	**1,824**	**21**	**881**	**16**	**3,545**	**380**	**6,250**
Percent of total	**90.26**	**29.18**	**5.52**	**14.09**	**4.21**	**56.72**	**100**	**100**

Source: Brazilian Shrimp Producers Association (ABCC).

Table 5. Brazil's most prominent shrimp-farming companies

Company Name	State	Pond Area (ha)	Laboratory
MariculturaValença da Bahia	BA	900	X
Atlantis Aquacultura	PE	500	X
Lusomar	BA	400	X
Compescal	CE	400	–
Camanor – Aquatec	RN	260	X
SECOM, Aquic. Com. e Ind.	PI	250	X
Marine Maricultura do NE	RN	220	X
CRUSA	PI	200	–
Pesqueira Capanema	CE	180	–
Acaraú Aquacultura	CE	180	X
Aquamaris	PB	180	X
LUNA	PB	100	X
Tecnarão Tecnologia de Camarão	RN	100	X
Marpisa Marisco do Piauí	PI	80	X
CINA Comp. do NE de Agr. e Cam.	CE	60	–

Sources: Alberto Some; Werner Jost.

Domestic Market

Although verified information is not available, the states of São Paulo, Rio de Janeiro, Minas Gerais, and Bahia are thought to be the largest shrimp consumers in Brazil. Until 1999, most of the farmed shrimp produced in Brazil was sold within the country. Since the devaluation of the Brazilian currency in January 1999, exports have increased rapidly; exports are now estimated to account for more than 50% of farmed production. According to the Ministry of Agriculture, during the coming years, around 75% of the shrimp produced will be exported. For domestic sales, shrimp producers are increasingly acting as direct suppliers

for their clients, such as supermarket chains, stores, hotels, and restaurants. Wholesalers handle approximately 30% of the market.

Table 6. Shrimp production, workers employed, and domestic and export sales, 1999–2003

Description	Current	Projected			
	1999	2000	2001	2002	2003
Production (MT)	15,000	30,000	51,000	84,000	105,000
Direct Employees (number)	5,000	10,000	17,000	28,000	35,000
Indirect Employees (number)	20,000	40,000	68,000	112,000	140,000
Domestic Sales (US$1,000)*	93,583	62,500	106,250	175,000	218,750
Export Sales (US$1,000)**	20,625	123,750	210,375	346,500	433,125

Source: Ministry of Agriculture and Supply, Fishing and Aquaculture Department, September 1999.

*Domestic Market Price: R$ 15/kg. **Export Price: FOB US$ 5.50/kg.

Foreign/Export Markets

The main shrimp importing countries have always been Japan and the US, with the latter taking over in recent years. In 1998, Japanese shrimp imports declined to 240 million MT, while US imports grew to 315 million MT. The drop in Japanese imports created substantial problems for the main exporters to the Japanese market, mainly located in Asia. Shrimp exports to Europe continue to grow, with Spain the largest market, followed by France and the UK. Danish shrimp imports are mainly re-exported.

Economic Aspects of Shrimp Farming

Compared with other Latin American countries, Brazil has high-cost inputs for shrimp farming (labor, equipment, and other inputs).

Labor Costs

Direct labor expenses are high, despite appearing lower than in many other countries (the minimum wage is currently about US$90 (R$ 155) per month. However, social contributions (e.g. taxes, benefits, medical, social security, vacation, 13th month, meals, etc.) tied to the basic wage are high (about 80%). Additional hidden costs are required by rigid labor laws, which limit day-to-day operations at shrimp farms. Complying with the labor laws requires daily application of such expertise, diverting management resources from other important administrative tasks.

Shrimp farmers cope in different ways with these bureaucratic obstacles. Since government enforcement capabilities are limited, small farms just continue their operations unnoticed, escaping official inspection visits (fines applied from them are often not paid anyway). Larger operations, usually organized as public companies, are much more exposed to the action of government agencies. In many cases, connections with high-level people inside the bureaucracy solve any problems. Companies that operate under high ethical standards have a difficult time but must learn how to deal with the situation. This legal context makes labor issues in particular rather time-consuming and expensive.

Workers in rural areas generally have little education and must be trained for years to work effectively in a complex organization. Managers are normally brought in from urban centers, and command high salaries, especially since few of them like living in distant rural areas, where shrimp farms are usually situated. Because the Brazilian aquaculture industry spent a long time just struggling for survival, there was inadequate emphasis on training, and few people were trained as technicians. With so many projects started at the same time, there has been a shortage of qualified labor recently.

Other Costs

Machinery and equipment are generally more expensive in Brazil than in other Latin American countries. Taxes in Brazil are high and a lot of them are hidden, meaning that at each step of the industrial process, taxes are charged again (COFINS, PIS, CPMF), making the final product quite expensive. Imports are much more heavily taxed than in other countries (import tax, value-added tax, and industrial tax). The same applies to feeds, the main imported production input for a shrimp farmer. Fishmeal has to be imported from Chile and Peru and is heavily taxed at the border. Feed is sold for about US$0.65/kg, and PL at about US$3.60 per thousand (surprisingly, the cheapest PL in the Western Hemisphere).

In general, production costs are high in Brazil, which is the reason that shrimp farmers have from the beginning tried to raise productivity and use technology to bring production costs down. The production cost for one kg of shrimp is around US$2.15 (R$4.00), a little lower for smaller farms and slightly higher for big farms that comply with all the regulations.

Table 7 summarizes the typical costs of producing each kilogram of shrimp, not including the cost of capital. These are average costs for a medium-sized (about 100-ha) farm that is efficiently organized and complies with all regulations.

Table 7. Production costs per kg of shrimp

Item	Specification		Cost/ kg shrimp
PL	60% survival	US$ 3.60 /thousand	US$ 0.50
Feed	FCR: 1.3*	R$ 1.20/kg	US$ 0.87
Fixed costs	Labor, transport, energy and maintenance		US$ 0.73
Total			**US$ 2.10**

Source: Werner Jost, personal communication. * FCR: Feed Conversion Ratio

Profit Margins

The Brazilian shrimp industry has benefited from high international prices in 2000 (US$7/kg for 80–100 count of head-on shrimp), registering gross profit margins of up to 70% for integrated farms with their own processing plant. Since the export infrastructure emerged only recently, competition among processing plants is still minimal.

Farms that are not integrated with processing plants are also enjoying high margins (sometimes higher than 70%), and have encountered demand in excess of supply. Under these conditions the industry is experiencing its largest expansion ever. Producers are trying to expand their capacity, and new investors are prospecting and setting up projects at a fast pace.

It is expected that in the long run, markets will adjust to average prices of the last 10 years (around $5/kg for 80–100 count, head-on). This would represent margins of around 50% for integrated producers. The smaller producer, on the other hand, will depend on the level of demand that processors provide in the future.

Assuming that input costs stay stable in dollar terms, that the international market price does not fall much below the long-term average, and that the exchange rate remains at current levels, producing shrimp in Brazil will continue to be a profitable business.

Shrimp Disease

After the widespread introduction of *P. vannamei* in 1992, additional shipments of broodstock and PL have been imported to Brazil to supply hatcheries. As a result, a number of diseases that were common in the countries of origin of the imported shrimp were introduced to Brazil. In l994, for example, Brazilian shrimp farms were struck with Taura Syndrome, which probably arrived with a batch of specific pathogen-free (SPF) animals from Hawaii. From the hatchery it spread throughout the production regions, creating losses of up to 80% in some farms. Producers managed to reduce the impact through good pond management methods, and within a few generations of broodstock, the animals adapted to Taura, and losses were reduced dramatically. However, the virus will continue to cause illness in some animals and especially under stressful conditions. It is known to attack, for instance, ponds stocked with *P. vannamei* originating from Venezuela, which are not resistant to the disease. Another disease that appeared in the early 1990s was NHP, which can be treated effectively by mixing oxytetracycline with the feed. Broodstock have not shown resistance to NHP up to the present.

Outbreaks of WSSV (White Spot Syndrome Virus) in the main centers of farmed shrimp production have taken a high toll on the industry in countries like Peru, Ecuador, Panama, Honduras, and others. Fortunately, Brazil has not been hit by the disease. The slow development of the Brazilian industry ended up protecting it from contamination by this virus. (The distance between the coastal areas of Brazil and the large aquaculture farms on the Pacific Coast (several thousand kilometers) has provided a natural barrier to importing live animals over land, and other shipments are easier to monitor—though air and sea freight pose some risks too.) When the outbreak of WSSV was reported in the main production centers of the Pacific, Brazil had already implemented closed reproduction cycles and was thus no longer dependent on imports of PL or broodstock from outside.

Fortunately, shortly after the confirmation of the outbreak of White Spot in Latin America, Brazilian authorities issued a ban on all imports of live or frozen crustaceans, and this has proven an effective precaution. The frozen products were included as well because it is believed that WSSV was introduced via imports of frozen shrimp from Asia to US and Latin American processing plants. Some industry participants believe they should protect themselves further from a possible WSSV outbreak, which could result from illegal imports or even intentional sabotage of the expanding Brazilian industry, which is now competing effectively in some international markets. WSSV could find its way into the environment through the discharge of wastes, as well. Brazilian farmers should invest in biosecurity measures and adapt pond designs and management practices to soften any possible impact of WSSV on production.

Industry Associations

Most shrimp producers in the country are affiliated with ABCC (Associação Brasileira dos Criadores de Camarão, or the Brazilian Association of Shrimp Producers), which is active in 85–90% of shrimp farming areas and has national influence. Other smaller producer associations exist, but with only limited regional influence, such as Cooperativa de Pequenos Produtores de Camarão and CooperCam, in the state of Rio Grande do Norte; and Associação de Pequenos Produtores de Camarão de Cumbê (The Cumbê Association of Small Producers of Shrimp).

NGOs are not yet very active in the sector in Brazil, but some of them participate in organizing and conducting seminars and conferences, such as Instituto Internacional de Ecologia (International Ecology Institute), based in São Carlos, state of São Paulo. In addition, the University of São Paulo supports various disease control activities.

Legislation

Fiscal Regulation (Taxes)

In general, taxes are high in Brazil. The largest tax components are applied to production and sales. The resulting high production costs make products expensive for the domestic market and less competitive in international markets.

The shrimp industry faces a value-added tax of 17 %, which has always been a heavy burden. Even selling to a processing plant for later export was considered a domestic transaction that had to charge the VAT. Producers often relied on black-market sales to avoid these taxes. Most small farmers operated in informal (underground) markets, and therefore did not pay these taxes. This created a problem for larger companies, which could not compete with such large cost differences.

In l994, the Rio Grande do Norte government granted a sales tax exemption to shrimp farmers in the state. This incentive was then adopted by other states in the Northeast region. The industry has also benefited from the sales tax exemptions recently granted for exports from Brazil, implemented by the current (Cardoza) federal administration. (Brazil was one of the few countries to charge value-added tax on exports.) Exemptions have also been made for the CONFINS (3% of sales revenue) and PIS (0.5%) on sales intended for export. The shrimp producer must also pay 2.8% of sales revenue in taxes for the pension system (INSS), CPMF (0.3 % on financial transactions), and taxes on profits (around 30%) which can be lowered with a partial tax exemption from the Development Agency of the Northeast (SUDENE).

Federal Regulation

Engaging in commercial fisheries activity requires obtaining a professional fishing license from the National Agency for the Environment (IBAMA). More specifically, to promote aquaculture, Article 50 of the Brazilian Fisheries Code (Law Decree 221/1967) establishes:

"Appropriate public authorities shall provide incentives to create aquacultural offices in federal, state, and municipal levels of government; these offices shall also furnish technical assistance for private aquaculture initiatives."

Articles 51 and 52 of the above code provide that a registry of professional and amateur aquaculturalists shall be maintained by the appropriate authority, and that enterprises selling aquacultural products must pay an annual fee to this authority.

In addition, IBAMA has published several internal regulations *(portarias)* over the years. One of these, IBAMA's Regulation 136 (October 14, 1998), establishes specific rules for aquaculturalists' licensing, including:

- Listing the documents that must be presented when requesting a license,
- Requiring annual renewal,
- Requiring that any changes in the conditions under which the license was granted need to be previously authorized by IBAMA, and
- Requiring that if the aquacultural enterprise ceases operation, notice shall be given to IBAMA.

The provisions of Article 8 of Regulation 136 also require that any animals raised in an aquacultural project *must be accompanied by documents issued at point of origin when transported or sold* during the fishing off-season, or when such animals are smaller than the parameters allowed by law for the sale of wild caught animal. Furthermore, IBAMA's Regulation 145-N/98 establishes specific rules for the introduction, reintroduction, and transportation of aquatic species including fish, crustaceans, and molluscs for aquacultural purposes, following the definition of aquaculture included in the Brazilian Fisheries Code.

Regulation 145-N/98 also defines concepts such as movement of animals, transportation, reintroduction, and exotic and native species.

Regulation 145 also defines Geographical Reference Units as areas containing a watershed or the lines between two points of the Brazilian coast. Accordingly, freshwater resources are: the Amazon Basin, the Araguaia/Tocantisn Basin, the Northeast Basin, the São Francisco Basin, the East Basin, the Alto do Paraná Basin, the Paraguai Basin and the Uruguai Basin. In addition, Regulation 145-N/98 delineates marine areas of the Northeast Coast and Southeast Coast.

Regulation 145's Article 3 forbids the introduction of marine animal species to freshwater bodies. In order to introduce any aquatic species of crustaceans, molluscs, or others, an applicant must send IBAMA an Application for Introduction and Experimental Cultivation that includes the following pieces of information:

- Identification of the party planning to receive and cultivate the species, with proof that they hold a license and have paid the appropriate fees,
- The place and methods to be used for the experimental cultivation of the species,
- Identification of the species being introduced, its scientific classification, place of origin, and main characteristics,
- Number of animals being introduced and their stage of growth, and
- Evidence of both potential domestic and export markets, and data on worldwide distribution of such species and its economic importance.

If the application is approved for the planned experimental cultivation period, the appropriate authority will grant a License for Commercial Cultivation of said species. Specific requests for any reintroduction or transportation of species are to be forwarded to IBAMA as well. Any infringement of these laws invites the application of penalties described in the Brazilian Environmental Criminal Code (Law 9605/98).
Provisional Measure 2049-23/00: Brazilian Ministry of Agriculture and IBAMA

With the enactment of Provisional Measure 2049-23/00 of September 27, 2000, matters related to development and other policy for the fisheries sector as a whole, including aquaculture, were transferred from IBAMA to the jurisdiction of the Brazilian Ministry of Agriculture (Article 14.I.b), which is now responsible for:

- Organizing and maintaining the General Fishers' Registry,
- Granting authorization to practice commercial fishing activities and aquaculture,
- Establishing measures aimed at achieving sustainable fisheries development,
- Furnishing the Ministry of the Environment with all data on the granting of licenses, permits, and authorizations for fishing and aquacultural activities, and
- Passing 50% of the Monies collected from taxes and service fees to IBAMA to support its inspection activities.

To date, the Ministry of Agriculture has issued no regulations to organize these activities and tasks, creating an aura of ambiguity. However it is highly likely that the Ministry of Agriculture will simply revise IBAMA's Regulations 136 and 145-N.

Land Tenure

Brazil does not recognize any corporate or individual ownership of marine land, defined as those adjoining sea waters and coastal mangroves as well as freshwater bodies and ponds along coastline and up to 33 meters inland (The definition uses the average high-water mark from the year 1831).

Access to coastal and mangrove lands in Brazil is provided by Decree 2490 from 1940, which states that individuals or corporate entities can obtain only lease rights to such land. That is, an interested party can gain access for specific uses but cannot ever acquire proprietary rights to marine land.

Any such lease is to be granted by the federal government *solely* to native or naturalized Brazilians, and exclusively comprises:

- Marine lands, both inland and on islands under the jurisdiction of the Federal government.
- Mangrove areas along the Brazilian shore.
- Lands located along riverbanks and ponds, up to the tideline.
- The clearing of leased mangroves may not exceed 0.50m height beyond the high-tide mark.

In addition, Decree 2490 provides that an initial request for the concession of the lease shall be forwarded to the Federal Inheritance Policy Agency (Secretaria do Patrimonio da Uniao, or SPU) and shall contain all elements necessary to identify the land, its dimensions, borders, and the potential beneficiaries of the lease. The interested party does not need to present maps of the areas applied for, but solely the "occupation tax" receipt from whoever has paid it in the past.

The appropriate authority will verify whether the relevant land had any other lease applications pending before it decides whether to grant a new lease. The order of preference for granting leases is as follows:

- The federal government itself.
- People currently paying the occupation tax for the land.
- People with commercial establishments that depend upon access to the land.
- Squatters in cases where such lands and mangroves form a contiguous zone to private farms or other properties.
- Those who have already leased the relevant land before.
- Squatters in lands belonging to the State.
- National fisheries that agree to create an industrial fisheries business.

Once the preferential issue is sorted out, then an official hearing is simultaneously opened to hear arguments from: the municipality in which the land/mangrove forest is located, the Brazilian Ministry of Defense, the Marine National Command, the Ministry of Agriculture—when such lands/mangroves are in a rural location—and the Ministry of Aviation.

Such authorities must decide on the matter within a 20-day period, at which point silence is assumed to mean approval of the requested consent. After this, a notice is published locally announcing a request for public consideration of third parties for a period of 30 days. If no objections are received, the relevant area is demarcated by the appropriate authority and a value for the land is determined. An annual tax, known as a *foro***,** is calculated as 0.6% of the appraised value of the land.

Once the lease agreement is finalized, it is signed by the interested parties. Language includes the following points.

- The *foro* shall be paid every year by March 31st, otherwise a 20% penalty of the amount due is charged.
- Late payment of the *foro* for 3 consecutive years entitles the federal government to take the land back from the tenant.
- Leased land cannot be passed on or sold without the prior informed consent of the federal government.
- The National Treasury Department has the option of charging a 5% fee on the transfer of the land.

The concession of coastal lands and mangroves is finally registered with the Brazilian Account Tribunal, which releases the official lease agreement document to the interested party.

Possibility of Foreigners Acquiring Land Tenure in Coastal Areas or Mangrove Forests

As explained above, the acquisition of land tenure in coastal areas/mangroves requires a lease agreement between the appropriate authority (the SPU) and a Brazilian citizen. There is no obstacle, however, to corporate entities acquiring existing lease agreements. It follows that a foreign corporate entity may acquire such a lease agreement by creating an enterprise in the country, regardless of whether foreign sources provide 100% of the needed capital. Brazilian laws on corporations provide that the manager of such a Brazilian corporation must reside in the country, however.

Environmental Laws

Developing shrimp aquaculture in mangrove forests requires environmental licenses from the appropriate authorities at the federal and state levels. In fact, Annex I of the National Council for the Environment (CONAMA) Resolution 237/97 on environmental licensing lists the management of aquatic resources as well as the introduction of exotic species as activities with *potential adverse environmental effects* and thus requiring environmental licenses.

Mangroves are Permanently Protected Areas, as provided in the Forestry Code (Law 4771/65). It follows that for any kind of development that aims to clear mangroves, a license must first be obtained from the appropriate authority. Article 18 of the National Policy for the Environment (Law 6938/81) establishes the National Agency for the Environment (IBAMA) as the authority that can grant licenses for development in mangrove areas.

For the purposes of Article 18 of the Forestry Code, modified in Decree 89.336/84, the Permanently Protected Areas listed in its Article 2 are transformed into "ecological reserves or stations" and are now also protected by Law 9985/00, which recently established the National System of Conservation Units. Mangrove areas are also protected by the National Law on the Management of Coastal Areas (Law 7661/88).

In addition, construction of aquaculture ponds requires another environmental license from the appropriate state-level authority, usually the state's agency for the environment. This particular license is granted depending on the particular characteristics of the project. An Environmental Impact Assessment is also required, as required by relevant legislation (among others, Federal Constitution, Art. 225 and paragraphs; Law 6938/81; Conama Resolution 004/85 and 237/97).

Finally, with the recent enactment of the National Policy on the Use of Water Resources (Law 9433/97), it is highly likely that all states will be enacting their own laws regarding concessions for the use of local water bodies and water resources in the near future. Some Brazilian states have already enacted state-level environmental legislation; these are listed below.

State Environmental Regulations: Summary Box

State of Alagoas	State Constitution–Chapter V on Environmental Protection, Art. 217–221
State of Bahia	State Constitution–Chapter VIII on Environmental Protection, Art. 212–271
State of Maranhão	State Constitution–Chapter IX on Environmental Protection, Art. 239–250
State of Pará	State Constitution–Chapter VI on Environmental Protection, Art. 252–259
State of Pernambuco	State Constitution–Chapter IV on Environmental Protection, Art. 204–216 State Law on Environmental Licensing (Law 11.516/97)
State of Piauí	State Constitution–Chapter VII on Environmental Protection, Art. 237–246
State of Rio Grande do Norte	State Constitution–Chapter VI on Environmental Protection, Art. 150–154
State of Sergipe	State Constitution–Chapter IV on Environmental Protection, Art. 232–234
State of Ceará	State Constitution – Chapter VIII on Environmental Protection, Art. 259–271 State Law on Environmental Licensing (Law 11.411/87)

Relevant Legal Aspects: Summary Box

Fiscal	Value-added tax, 17 % Sales tax exemption in Rio Grande do Sul (from 1994 on) Sales tax exemption for exports CONFINS exemption of 3% of sales PIS exemption of 0.5% on sales leading to exports Tax burden: producers pay 2.8% for the pension system; 0.3% of all financial transactions; 30% of profits
Federal Regulation on Fishers' Registry	Brazilian Fisheries Code (Law 221/67): Professional Fishers' Registry. National Council for the Environment (IBAMA), Resolutions 136/98 and 145-N/98 Provisional Measure 2049/00 (IBAMA and Ministry of Agriculture)
Environmental	Federal Constitution, Article 225 Forestry Code (Law 4771/65): Made mangroves permanently protected areas National Policy for the Environment (6938/81) National Council for the Environment Resolution 237/97 on environmental licensing National Law on the Management of Coastal Areas (Law 7661/88) National Policy on the Use of Water Resources (Law 9433/97)
Land Tenure	Law Decree 2.490/40 on the acquisition of coastal and mangrove lands

Necessary Legal Steps for Developing New Shrimp Farms: Summary Box

Licenses required	Construction of ponds (with local or state agencies for the environment) Introduction, reintroduction, and transportation of species (with appropriate federal authorities) Commercial cultivation (with appropriate federal authorities) Transportation of shrimp (with appropriate federal and state authorities)
Registration	In the General Fishers' Registry
Land Tenure	Coordination with the appropriate authorities (Term of Lease), Payment of annual tax (the *foro*)
Use of Water Bodies	National Policy on the Use of Water Resources (Law 9433/97): In the near future it is highly likely that all Brazilian federated states will enact specific laws on local water concessions.

Financial Instruments Available to the Industry

Capital has always been scarce in Brazil. Apart from private sources, long-term capital for investment is provided by state-owned banks, mainly the National Bank for Social and Economic Development (BNDES) and the BNB (Banco do Nordeste Brasileiro) as agents of the special development fund for the Northeast (FNE). Interest rates in late 2000 were about 15% per year in local currency.

A full written proposal is required, which is then analyzed and approved by the bank or their agents, a process that takes around 6 months. In the case of shrimp producers, because projects are to be located on federal marine land, the required loan guarantees must normally come from outside the project, creating a substantial obstacle for producers.

An alternative source of finance is the Northeast Development Agency (SUDENE), which in the 1970s and 1980s offered innovative terms for financing. Today, however, its funds are scarce, obtaining approval is time-consuming and costly, and the disbursement of funds is stretched out over some years. Development banks have proven a difficult option for current farms looking to expand, mainly because of the length of time it takes for project approval. Many producers prefer to set aside and reinvest their own funds for growth, even if this process tends to slow down growth. Commercial banks, practically speaking, do not lend money for long-term projects. They prefer to loan short-term financing for working capital, at interest rates of 3–10% per month.

Special Development Fund for the Northeast (FNE)

The credit terms that FNE, BNDES, and SUDENE offer to the shrimp-producing sector are summarized below.

Annual Interest Rates

Rural operations	Industrial and agroindustrial operations
9% for micro-producers, cooperatives and associations.	9%. for micro companies.
10.5% for small producers, cooperatives and associations.	11% for small companies.
14% for medium-size producers, cooperatives and associations.	15% for medium-size companies.
16% for large producers, cooperatives and associations.	16% for large companies.

Compliance Reduction

Companies can benefit from reduced interest rates if payments of principal and interest are paid on time. These reductions are set at 25% for companies located in the semi-arid region of the Northeast and 15% for the remaining areas. The compliance reduction can be increased by 5% if the payments are always made on time.

Types of Loans, Maximum Terms and Finance Limits

Fixed and semi-fixed growth and working capital is associated with up to 35% of the amount financed. The maximum grace period is 4 years, and loans are amortized over a maximum of 12 years. The limits placed on such loans are 50 to 100% of the needed amount according to size, region and competitiveness of the project.

National Bank for Social and Economic Development (BNDES)

Purpose, Payment Periods, Finance Charges and Limits

BNDES provides fixed and semi-fixed investments, and working capital associated with up to 30% of the amount financed. The period for loan repayment is determined based on each project's payment capacity. BNDES applies finance charges as follows.

- TJLP, or Long-Term Interest Rate: currently 9.75% annually (October–December 2000);
- Basic charges: 2.5% per year (standard level), or 1% per year for micro and small companies and companies located in regional program areas (e.g., PNC, the Northeast Competitive Program);
- Financing agent margin: to be negotiated between the financial institution and the client; up to 4% in the guaranteed operations of FGPC, the Guarantee for Competitiveness Promotion Fund.

The limits that BNDES may impose are summarized as follows.

- Minimum loan value: R$1,000,000 (US$513,000 in November 2000).
- Machinery and equipment: a maximum of 80% of the project's total funding, or, in the case of micro and small companies and start-up companies located in regional program areas, up to 90%.
- Other items to be financed: up to 60% of the project's total funding, or, in the case of micro companies, small companies, and start-up companies located in regional program areas, up to 80%.

Northeast Development Agency (SUDENE)

FINOR

SUDENE is the regional agency that selects projects and disburses funding from FINOR, the Northeastern Development Fund. Companies applying for resources from FINOR should fulfill the following conditions.

The project should have a 20% minimum long-term finance participation from third-party institutions, provide adequate financial resources to ensure its payment capacity, and have a compatible internal rate of return:

- The minimum investments are R$500,000 (US$255,000 in November 2000) for investments in the states of Maranhão, Piauí, Rio Grande do Norte, Paraíba, Alagoas, and Sergipe; and R$750,000 (US$385,000 in November 2000) for investments in the remaining states of the northeastern region.
- The project's leading managers, institutions, and company groups must demonstrate managerial experience and/or financial capacity compatible with the projects' goals.

- The project should not be led, directly or indirectly, by SUDENE´s current workers, its partners, clients, or immediate family members.
- Applicants should not owe any money to TINSS, or the National Institute for Social Security, in federal taxes or to FGTS –Workers' Guarantee Fund.

Projects held under Article 5 of Law Nº 9.532/97

Range	FINOR's Maximum Participation (%)	Minimum Own Participation (%)	Minimum Long-Term Third-Party Participation (%)
A	40	30	30
B	35	30	35
C	30	35	35
D	25	35	40

For shrimp projects established under Article 5, the following maximum limits on FINOR financing and total area are imposed.

- R$3,500,000 (US$1,800,000 in November 2000) for saltwater shrimp breeding.
- R$1,800,000 (US$923,000 in November 2000) for freshwater shrimp breeding.
- R$2,000,000 (US$1,025,000 in November 2000) for saltwater shrimp grow-out.
- R$1,200,000 (US$615,000 in November 2000) for freshwater shrimp grow-out.
- 250 hectares total area for saltwater shrimp breeding projects.

Projects held under Article 9 of Law Nº 9.532/97

Range	Maximum FINOR Participation (%)	Minimum Own Participation (%)	Minimum Long-Term Third-Party Participation (%)
A	50	25	25
B	45	25	30
C	40	30	30
D	35	30	25

For shrimp breeding projects held under Article 9, the following maximum limits on FINOR financing and total area are imposed.

- R$7,000,000 (US$3,590,000 in November 2000) for saltwater shrimp breeding.
- R$3,600,000 (US$1,846,000 in November 2000) for freshwater shrimp breeding.
- R$4,000,000 (US$2,051,000 in November 2000) for saltwater shrimp grow-out.
- R$2,400,000 (US$1,230,000 in November 2000) for freshwater shrimp grow-out.
- 500 hectares total area for saltwater shrimp breeding projects.

The projects governed by Article 9, depending on their location, purpose, objectives, and merits, can be implemented without physical size and FINOR's participation limits. As an example, the Atlantis Aquacultura and Neturno projects obtained R$16 million and R$8 million of FINOR funding, respectively.

Purpose, Payment Periods and Incentives

The purpose of FINOR is to provide fixed and semifixed investments and working capital. The maximum grace period for payments is 2 years; amortization period is set at 10 years. In addition to the fiscal incentives mentioned above, SUDENE facilitates startups and growth of existing companies with the following incentives.

Income Tax Reduction
Start-up companies: industrial or agricultural companies established within SUDENE's jurisdiction can take advantage of an income tax reduction policy for a period of 10 years, limited to the following reduction percentages. This benefit is also available for companies wishing to expand or modernize their operating facilities or to diversify their production line.

- From 1998 to 2003: 75%
- From 2004 to 2008: 50%
- From 2009 to 2013: 25%

Existing companies: benefits industrial or agricultural companies operating in SUDENE´s jurisdiction, with an income tax due value reduction until 2013, with the following reduction percentages.

- From 1998 to 2003: 37.5%
- From 2004 to 2008: 25.0%
- From 2009 to 2013: 12.5%

Reinvestment
Existing companies: benefits industrial, agricultural, and construction companies, operating within SUDENE´s jurisdiction. This provision allows the reinvestment of portions of income tax owed, as long as the funds come from the company's own earnings (50% of the tax reduction may be reinvested), in order to modernize or add equipment. This provision also applies until 2013, with the following percentages allowed

- From 1998 to 2003: 30%
- From 2004 to 2008: 20%
- From 2009 to 2013: 10%

Sources: Banco do Nordeste (Northeast Bank), BNDES (National Development Bank), and STEN (Economic and Technical Services Ltd.).

Desirable Management Practices

Shrimp farming is a highly technical activity that requires careful management practices both to increase productivity and to avoid contamination. Recommended control and management practices are primarily intended to provide adequate nutrients for the cultured animals and to reduce contamination of effluent water. Measures include mechanical aeration, water exchange, chemical and biological treatments, and the application of food to supplement the cultured animal's diet.

In general, on-farm management practices are made more difficult by the dynamic nature of the aquaculture system. Although many interactions that occur daily in confined systems have been described, they have not yet been completely quantified. As a result, for example, the exact amount of feed to administer to a shrimp pond or a fish cage when water quality conditions are below the optimal, or when the biomass of naturally occurring food organisms is depleted, is unknown. Ideal stocking densities (i.e., the biomass of animal per volume unit of culture area) may also vary in a culture site, depending on biotic or abiotic factors (e.g., phytoplankton productivity and water exchange rates). Increased feed inputs or excessive stocking densities can potentially exceed the maximum carrying capacity of the culture environment, leading to the generation of excessive aquaculture waste and other environmental damage (Nunes 2000).

Pond Construction

Brazil has along its coast from Bahia up to Pará state huge land reserves that are suitable for marine shrimp farming. There are perhaps 50,000 ha of old salt flats available, and even more hectares of

intertidal land, which is subject to some flooding during high tides yet unsuitable for growing mangroves, and too saline for agriculture or other vegetation.

Discussion has continued for years about the use of mangrove areas for pond construction, in some places creating controversy. Because Brazil has immense land reserves outside of the mangrove regions, it does not make sense to allow any cutting of mangroves. In addition, it does not seem to be a good business practice to use mangrove land, since the cost of preparing the land is in many cases higher than in alternative non-mangrove areas. Mangrove areas are also affected by tidal flow, which makes it difficult to harvest the shrimp and dry out the ponds for the next crop. The biggest threat to mangroves comes from small farmers who do not have the mobility to go elsewhere for farm expansion and are difficult for the environmental agencies to control because of their large numbers and their local support (they, too, provide needed employment).

Finally, we should note that as land becomes more scarce in certain regions, some shrimp farmers will be tempted to build ponds on agricultural land, since shrimp farming is currently more profitable than agriculture. However, if the shrimp industry suffers a decline, the land will turn into a desert. The authorities should therefore not allow the use of agricultural land for shrimp farming.

Stocking Density

Density has increased over the last year and is now at an industry average in Brazil of 25 PL/m^2. Many farmers, however, lack the infrastructure and technological skill to manage such a high biomass of shrimp in their ponds. The result is low survival rates and the appearance of diseases. Unfortunately, farmers in general do not voluntarily adopt limits on density but rather try to push the envelope toward higher and higher stocking rates. This approach is not ecologically sustainable in the long run and opens the door for industry wide disease outbreaks.

Inputs

Less intensive production systems are characterized by a complex food web and network of interactions. Under these conditions, naturally occurring organisms provide a major food source, contributing to as much as 75% of penaeid shrimp growth. In these systems, improved yields can be achieved with somewhat higher stocking densities and supplemental feeding. Fertilization promotes natural productivity and water quality can be enhanced by increased water exchange rates.

The Brazilian shrimp industry is following the trend for lower water exchange, greater aeration, and encouraging higher natural productivity in the pond water, which would allow using low-protein feeds. Today aquaculture is criticized for using large quantities of fishmeal. It is expected that in the future fishmeal consumption will decrease while electrical energy use will rise. Despite energy being mostly generated with hydro sources, the tendency is to rely more on fossil-fuel power plants, which are not environmentally sound.

According to Nunes (2000) feeding expenses in commercial shrimp farming operations may surpass 50% of the total operating costs. However, only a portion of the organic matter and nutrients in pelleted feeds that enter the system are converted to shrimp biomass and removed from ponds at harvest. The remainder may be consumed and/or recycled by the pond's biotic community; flushed from the system with water exchange; or deposited in the pond sediment, acting as a source of organic pollution. It is estimated that 15–20% of the total feed ration added to these systems may not be consumed directly by shrimp, and about 33% of all consumed feed may be indigestible.

Effluents

Brazil should avoid high concentrations of farms on a single estuary. The maximum carrying capacity of the water bodies is unknown, since the Brazilian authorities lack the infrastructure and specialized personnel needed to determine the limits of concentration. Thus it is wise to avoid operating great numbers of farms in a limited area. The shrimp industry is growing quickly and in some regions, in the absence of any government planning, the situation is getting critical. People and companies continue to buy land for aquaculture without thinking about the long-term consequences of creating insufficient access to clean water for all in the area.

Summary: Incentives and Disincentives

The state environmental agencies need to consider and define their policies for the use of land by the shrimp industry, to provide clear criteria for authorizing the construction of new shrimp farms. It would be ideal to first survey and map the coastal areas, marking suitable areas with regard to soil conditions, carrying capacity of local water bodies, protection of mangrove areas, the use of agricultural land, and other factors. Executing such a surveying project requires a lot of money and highly skilled professionals, but accurate maps would make the decision process more transparent and rational.

At the moment, there is an absolute absence of any scientific research from Brazilian governmental bodies concerning PL production in hatcheries or raising shrimp in ponds. All the progress made to date has come from producers' own on-site research or the expertise of international consultants. The members of the producers' association (ABCC) agreed to pay a "research tax" levied on the feed sold to farmers. These private funds support research projects proposed by ABCC's members that have industry wide relevance. It is odd that on the one hand the public sector in Brazil is highly effective in taxing all kinds of economic activities, and on the other hand has not built a public research infrastructure that would strengthen the industry.

As mentioned above, enforcement of labor laws consumes a good part of the administrative capacity of shrimp farms' management staff. Especially for a foreign company, a long learning period and large sums of money are necessary to become familiar with the system. Government entities (Ministry of Labor, Ministry of Agriculture, Environmental Protection Agency) work poorly in Brazil. They are normally understaffed; lack funding to execute the most basic services, and their employees are poorly motivated because of low wages and political interference. That does not stop them from creating a jungle of laws and regulations, which companies and citizens then try to obey.

The legal system is extremely slow-moving, and the outcome of a court battle is not always based on a clear application of the law in Brazil. Many companies are turning to arbitration when disputes arise, to avoid the Brazilian courts. The Supreme Court has to decide yet whether arbitration decisions can be appealed in a Brazilian court.

One issue to be resolved is the use of marine land as collateral for credit, since most farms are situated on marine land. Normally the actual land where a shrimp farm is built represents the highest-value component of the farm. Banks or other lenders will demand additional collateral if the owners lack the land's title, since they consider "occupancy of marine land" not equivalent to having a definitive title to the real estate. It would greatly enhance the borrowing capacity of shrimp farmers if the federal government can resolve this issue.

Investment Screens

The following criteria should be considered by any entity weighing investment in the Brazilian shrimp farming business.

- Is the land suitable for pond construction (based on soil consistency, impermeability, location, and so on)?
- Are adequate inputs available—electrical energy, labor availability in surrounding areas, a processing facility, distance to a hatchery, road access, shipping ports, airports, and others?
- Will the site have access to long-term sources of clean water, and are other industry participants likely to vie for and perhaps pollute those waters?
- How will the farm obtain its supply of PL, by constructing its own hatchery or making an agreement with an existing hatchery? This is an important issue because the supply of PL is still tight and imports are prohibited.
- What is the legal status of the land where the farm is to be built, and who owns it?
- What are the positions and attitudes of the state environmental agency and the local branch of IBAMA (National Agency for the Environment) in the state?

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Annex 1: Legislation Related to Fishing in Brazil

Introduction

Legal analysis of fishing activities—including shrimp exploitation—must include two perspectives: (1) wild shrimp exploitation and (2) raising shrimp with aquaculture.

Starting with matters related to wild shrimp exploitation, it is necessary to consider certain aspects such as international limits for the application of the Brazilian legislation; fishing rights and restrictions on the high seas; public waters and international rivers. Most of these issues are governed at least in part by the United Nations Convention on the Law of the Seas (UNCLOS/82) among others.

For pond-raised shrimp, it is relevant to scrutinize domestic Brazilian laws and regulations settling rules directly or indirectly affecting shrimp activities.

Brazil's Jurisdiction Over Bodies of Water – General Overview

Brazil's jurisdiction over water bodies is mapped out by the Brazilian Fisheries Code (Law Decree 221/67), Article 4. It provides that the country's jurisdiction over water bodies applies to interior waters, the sea within the country's territory, the contiguous zones, the continental shelf, the high seas, and the exclusive economic zone. These concepts are all established by international agreements, primarily the UN Convention on the Law of the Seas, signed in Montego Bay, Jamaica, on the 10th of December 1992. UNCLOS was internalized in Brazil with the enactment of Law 8.617/93.

Interior waters, also known as national waters, are located within the boundaries established by UNCLOS in its Article 8. Such boundaries are usually defined by low-tide limits along the shoreline. Coastal states have jurisdiction over their interior waters and have complete legal rights over them, all of their natural resources (fisheries included), and the resources of the soil (e.g., riverbeds) and subsoil beneath.

The territorial sea is also established by the UN Convention, providing that every state has the right to establish this area up to a limit of 12 nautical miles from the shore. In Brazil, Law 8617/93 confirmed the 12 nautical-mile limit, measured from low-tide marks along the shore. Coastal states also have unlimited sovereignty over such waters, their natural resources, and the resources of their soil and subsoil.

The contiguous zone encompasses the outer limit of a country's territorial seas. Within the contiguous zone, a coastal state has the right to take inspection measures to prevent infringement of its territory and its internal laws and regulations.

The Exclusive Economic Zone (EEZ) is an area beyond and adjacent to the territorial sea. The breadth of the Exclusive Economic Zone cannot extend beyond 200 nautical miles from the boundaries of the territorial sea. Within the EEZ, the coastal state has sovereign rights to explore, exploit, conserve, and manage the natural resources, whether living or mineral, of the waters, the seabed, and its underlying subsoil.

The continental shelf of a coastal state comprises the seabed and underlying soil of the territory between 12 and 200 nautical miles from the coastline. The coastal state possesses sovereign rights over its continental shelf for the purposes of exploration and exploitation of natural resources. If the coastal state does not explore the continental shelf and/or exploit its natural resources, no other country or entity may undertake these activities without the express consent of the coastal state.

Within the high seas are included all waters that are not included in the EEZ, in the territorial sea, in the internal waters of a state, or in the archipelagic waters of a state. The high seas are open to all states, whether coastal or land-locked, for fishing freely, subject to certain conditions. One such condition is

respecting the interests of other coastal states. The coastal state must provide due notice of conservation and management laws and regulations, including changes to same, to any other state.

Articles 61 and 62 of UNCLOS are relevant because they provide that a state shall determine the allowable catch of the living resources in the EEZ, as well as promote the optimal utilization of the living resources in the EEZ.

Specifically, from Article 61.3, this provision governs fishing activities:

> "Such measures shall also be designed to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors, including the economic needs of coastal fishing communities and the special requirements of developing states and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether sub-regional, regional or global."

Article 62.4 further provides that nationals of other states fishing in a coastal state's EEZ must comply with the conservation measures and other conditions established in the laws and regulations of the coastal state. Such laws and regulations govern the following:

- Licensing of fishermen, fishing vessels, and equipment, including payment of fees and other forms of payment, which in the case of developing coastal states may consist of adequate compensation in financing, equipment, and technology.
- Determining the species that may be caught and setting maximum catch limits (for specific species or groups of species, for catch per vessel over a period of time, or for total catch by nationals of any state during a specific period).
- Regulating seasons and areas of fishing; the types, sizes, and amount of equipment; and the types, sizes, and number of fishing vessels that may be used.
- Limiting the age and size of fish and other species that may be caught.
- Specifying information required of fishing vessels, including catch and effort statistics and vessel position reports.
- Requiring specified fisheries research programs and regulating the conduct of such research, including the sampling of catches, disposition of samples, and reporting of associated scientific data.
- The placing of observers or trainees on board such vessels by the coastal state.
- The landing of all or any part of the catch by such vessels in the ports of the coastal state.
- Terms and conditions relating to joint ventures or other cooperative arrangements.
- Requirements for training personnel and the transfer of fisheries technology, including enhancement of the coastal state's capability to undertake fisheries research.

Organization of Fishing Activities in Brazil

The concepts established in fisheries-related international agreements and regulations are mirrored by Brazil's legislative structure, primarily the 1967 Brazilian Fisheries Code (Law Decree 221/67). After the entrance in force of the 1982 UNCLOS, basic concepts already established in Law Decree 221/67 were restated in Law 8.617/93, which internalized UNCLOS in the country. Ultimately, the Brazilian Fisheries Code is the main governance structure controlling fishing activities in the country.

Definition of Fishing under Brazilian Law

Fishing is defined under Brazilian law in Article 1 of Law Decree 221/67 (the Brazilian Fisheries Code) as "all acts intended to capture or extract living animal or vegetable matter whose natural habitat is water bodies." More recently, the Brazilian Environmental Criminal Law (Law 9605/98, Article 36) defines fishing as "all activities that result in capture, extraction, collecting, or obtaining groups of fish, crustaceans, molluscs, and water plants, whether or not they have market value."

In general, further Brazilian legislation on fishing will establish rules for fishing activities carried out in Brazil's territorial seas or its internal waters. Several basic legal instruments used in Brazil for the regularization of fishing activities, defined in Law 9605/98, Article 33, cover:

- Prohibiting fishing activities during certain times of the year in the country.
- Establishing restrictions on equipment used for fishing.
- Establishing a list of fisheries and their maximum allowed catch during allowed fishing periods.

Fisheries in Public and Private Waters in Brazil

Fishing in Public Waters

Access to fish species is also established by the Fisheries Code. Article 3 provides that "all animal and vegetable matter found in waters within Brazilian jurisdiction are in the public domain." That is, they are *res nullius*, meaning that all fisheries resources existing in public waters can be caught by anyone who observes the laws and rules for administration of water bodies and limits of allowable catch. The rule that fisheries are *res nullius* is further discussed in Articles 599–602 of the Brazilian Civil Code.

Fishing in Privately Owned Waters

The concept of *private waters* is established by Federal Decree 24.643/34, also known as the Brazilian Water Code. The Water Code provides in its Article 8 that *private waters* are "watersheds and all other waters located on privately owned lands, so long as such waters may not be classified among waters regarded as common to all, or public waters." It follows that fishing activities carried out in wells, **acudes**, small dikes, or other water bodies located on privately owned lands are under the owner's control and require permission from the owner. Both the Brazilian Civil Code and the Brazilian Fisheries Code clearly provide that fish found on private lands belong to the owner (Article 601, and Article 33, paragraph 3, respectively).

With the recent passage of the Brazilian National Law on the Use of Water Resources (Law 9433/97), it is likely that administration of water resources itself will be restructured. Article 1 of this law establishes, for example, that water bodies are public goods. However, the classification of water bodies is to be regulated by specific environmental laws and regulations that were not yet enacted by 2000. Hence, and in accordance with Article 10 of this law, the classification of private waters defined by the Brazilian Water Code currently remains valid.

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