

Fishpen and Fishcage Culture in Laguna de Bay: Status, Economic Importance, and the Relative Severity of Problems Affecting its Practice

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ABSTRACT

This paper reviews the status of fishpen and fishcage culture in Laguna de Bay, with emphasis on its economic importance and the relative severity of the problems affecting its continued practice. The paper aims to provide an economic analysis that will help decisionmakers, stakeholders, and other interested parties make informed decisions and opinions on the conduct of the activity. Sources of data are the survey of fishpen and fishcage operators and their operations and key informant interviews conducted in 2007, records of government institutions involved in aquaculture in Laguna de Bay, and relevant published literature.

The analysis shows that fishpen and fishcage culture in Laguna de Bay has important economic and social contributions to the lake municipalities and to the country. In particular, it significantly contributes to fish production, income, employment, and generation of public revenues. Furthermore, it helps supply cheaper fish to Metro Manila where a large segment of urban poor population resides. Because of these, caution must be exercised before any decision related to its reduction or termination can be made.

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The analysis further shows that while fishpen and fishcage culture is economically and socially important, such practice is also facing numerous problems foremost of which are environmental. These problems have to be prioritized and addressed if the practice of fishpen and fishcage culture is to continue. This paper strongly supports specific courses of action leading to a more rational management of fishpen and fishcage culture in Laguna de Bay.

INTRODUCTION

Aquaculture or the raising of fish in controlled environments such as fishpens and fishcages has been practiced in Laguna de Bay over the years. Since the early 1970s when it was first shown to be commercially viable, fishpen and fishcage culture in the lake has proliferated, providing income, employment and livelihood to the surrounding communities, public revenues to the government, and fish to the consuming public.

While fishpen and fishcage culture increased in Laguna de Bay, it also faced numerous problems that prevented it from attaining its full potential as an economic activity. Some of these problems were created by the practice itself and had negative impact not only on aquaculture but on other sectors as well. As a result, there were suggestions and efforts of late to reduce, if not totally eliminate, fishpen and fishcage culture in the lake (Adraneda 2008; Adraneda and Macairan 2008; The Daily Tribune 2008).

Based on these concerns, this paper reviews the status of fishpen and fishcage culture in Laguna de Bay, with emphasis on its economic importance and the relative severity of the problems it faces. The paper intends to provide an economic analysis that will help decisionmakers, stakeholders, and other interested parties make informed decisions and opinions about the wisdom of continuing, reducing, or terminating the conduct of fishpen and fishcage culture in Laguna de Bay.

This paper is based on some of the results and findings of a study jointly conducted in 2007–2008 by the Southeast Asian Fisheries Development Center-Aquaculture Department (SEAFDEC-AQD) and the Philippine Institute for Development Studies (PIDS) which assessed aquaculture development in Laguna de Bay. The second, third and, fourth sections discuss the methodology and relevant literature related to the study and provide a brief profile of Laguna de Bay. A selective review of the status of fishcage and fishpen culture in the lake is presented in the fifth section while the sixth and seventh sections measure the economic importance and relative severity of problems in fishpen and fishcage culture. The last section presents the conclusion and recommendations. The figures and tables are presented as they are discussed in the text.

METHODOLOGY

To measure the economic importance of fishpen and fishcage culture in Laguna de Bay, the paper quantifies its economic contributions particularly in terms of output, income, employment, public revenues, and foreign exchange generation which are the standard parameters of a sector's economic contribution. To measure the relative severity of the problems faced by the activity, perceptions of fishpen and fishcage operators in the lake about these problems were gathered through a survey. The perceptions of fishpen and fishcage operators were considered important because they are the most knowledgeable about the problems related to fishpen and fishcage culture, they are directly affected by the problems, and are therefore the most interested in seeing to it that the problems are addressed. Aside from the perceptions of the operators, the survey also generated background data and information on fishpen and fishcage operators and their operations, some of which are presented in this paper as part of the selective review of the status of the practice of the activity in the lake.

The survey of fishpen and fishcage operators and their operations was conducted in 2007 covering two municipalities and one city around Laguna de Bay which have fishpen and fishcage operations. These are Binangonan in Rizal, Biñan in Laguna, and Muntinlupa City in Metro Manila. These areas were selected so that the two provinces and Metro Manila were represented in the survey. Furthermore, they were chosen because they had the largest number of registered fishpen and fishcage operations, specifically in terms of the number of operators and area covered (Table 1). These two municipalities and one city accounted for 18.75 percent of the total number of 16 municipalities with fishpen and fishcage operations in the lake.

Through random sampling, 20 fishpen operators and 40 fishcage operators each from Binangonan, Biñan, and Muntinlupa City were selected for survey coverage. Thus, a total of 60 fishpen operators and 120 fishcage operators were surveyed. The sample of 60 fishpen operators comprised 30 percent of the total number of registered fishpen operators in the covered areas (Table 2). Meanwhile, the 120 fishcage operators represented 25 percent of the total number of registered fishcage operators in the covered areas. The total area covered by the fishpen sample formed 20 percent of the total area of the registered fishpen operations while the total area covered by the fishcage sample comprised 18 percent of the total area of the registered fishcage operations.

Aside from the survey, interviews with key informants from both the private and public sectors involved in fishpen and fishcage culture in Laguna de Bay were conducted to gather additional primary data and information. Data and

Table 1. Registered fishpen and fishcage operators and area of fishpens and fishcages in Laguna de Bay, by zone and municipality, 2006

Zone/Municipality	Fishpens		Fishcages		Total	
	Operator (No.)	Area (Ha)	Operators (No.)	Area (Ha)	Operators (No.)	Area (Ha)
Zone A	176	3,951	506	429	682	4,380
Muntinlupa City	107	2,179	218	168	325	2,347
Taguig City	43	994	223	203	266	1,197
San Pedro	26	778	65	58	91	836
Zone B	36	901	204	80	240	981
Biñan	26	650	76	35	102	686
Sta. Rosa	2	100	8	3	10	103
Calamba City	8	150	43	25	51	174
Los Baños	0	0	58	14	58	14
Pila	0	0	19	4	19	4
Zone C	0	0	126	22	126	22
Sta. Cruz	0	0	28	7	28	7
Pakil	0	0	92	15	92	15
Kalayaan	0	0	6	0	6	0
Zone D	95	3,018	247	142	342	3,160
Cardona Main	41	1,099	70	46	111	1,145
Tanay	6	210	17	12	23	222
Pililla	26	664	80	30	106	695
Jala-jala	22	1,045	80	53	102	1,098
Zone E	68	1,734	188	134	256	1,868
Binangonan Main	68	1,734	188	134	256	1,868
Zone F	80	2,513	328	190	408	2,703
Binangonan Talim	58	1,746	130	87	188	1,833
Cardona Talim	22	767	198	103	220	870
Total	455	12, 117	1,599	998	2,054	13, 115

Sources of data: Laguna Lake Development Authority (2006a, 2006b). Note: The figures for area were rounded off.

information from records of major government and publicly-funded institutions involved in aquaculture in Laguna de Bay and from published relevant literature were also gathered.

Table 2. Number and area of survey respondents and all fishpen and fishcage operators in the three municipalities of Laguna de Bay, by area, 2007

Municipality	Fishpen			Fishcage		
	Number/ Area Respondents	Number/ Area of All Operators	%	Number/ Area Respondents	Number/ Area of All Operators	%
Number						
Binangonan	20	68	29	40	188	21
Biñan	20	26	77	40	76	53
Muntinlupa City	20	107	19	40	218	18
Total	60	201	30	120	482	25
Area (Hectares)						
Binangonan	412	1,734	24	36	134	27
Biñan	205	650	32	14	76	18
Muntinlupa City	295	2,179	14	19	168	11
Total	912	4,563	20	69	379	18

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

BRIEF REVIEW OF RELATED LITERATURE

Several studies have been conducted on the economic aspects of fishpen and fishcage culture in Laguna de Bay. Some of these looked into the financial and economic viability of the activity (e.g., Basiao 1989; Garcia and Medina 1987; Delmendo 1987; Gonzales 1984; Delmendo 1982; Librero and Nicolas 1981; Nicolas and Librero 1977; Delmendo and Gedney 1976). In general, these studies indicated that fishpen and fishcage culture was a profitable business venture and economically important to the surrounding lake communities.

The following studies also touched on the problems facing fishpen and fishcage culture in Laguna de Bay: Palma et al. (2005), Lasco et al. (2005), Mane (1987), Delmendo (1982), De La Cruz (1981), Librero and Nicolas (1981), and Nicolas and Librero (1977). These works identified numerous problems that include technical, production, economic, social, environmental, institutional, and other issues. The most often mentioned problems were: the high prices of production inputs and poor durability of construction materials; occurrence of algal blooms, fish kills, water hyacinths and water pollution; incidence of poaching and displacement of municipal fishermen; overcrowding of fishpens and existence of illegal fishpens; insufficient technical support from the government; and fortuitous events particularly floods and typhoons.

A study which looked into the numerous problems affecting Laguna de Bay in general and on fisheries and aquaculture in particular is Lasco et al. (2005). This study, together with its component study by Palma et al. (2005),

emphasized that although fishpen and fishcage culture in the lake has helped increase fish production, it has also significantly reduced the area for capture fisheries. As a result, social conflicts between aquaculture operators and sustenance fishermen in the lake have occurred. This study also mentioned that overall fisheries in the lake have declined over the years in terms of productivity and species composition as a result of human, industrial, and environmental factors.

This brief review of relevant literature shows that although the economic importance of fishpen and fishcage culture in Laguna de Bay has been partly addressed in previous works at the micro level, the economic contributions of the activity at the macro level have yet to be quantified. Such an effort would contribute to a better understanding of the true importance of fishpen and fishcage culture to the surrounding communities of the lake and to the country. Also, although the different problems affecting fishpen and fishcage culture are already known, their relative severity has yet to be assessed. Such an investigation would be useful in identifying those problems that should be prioritized and given immediate attention.

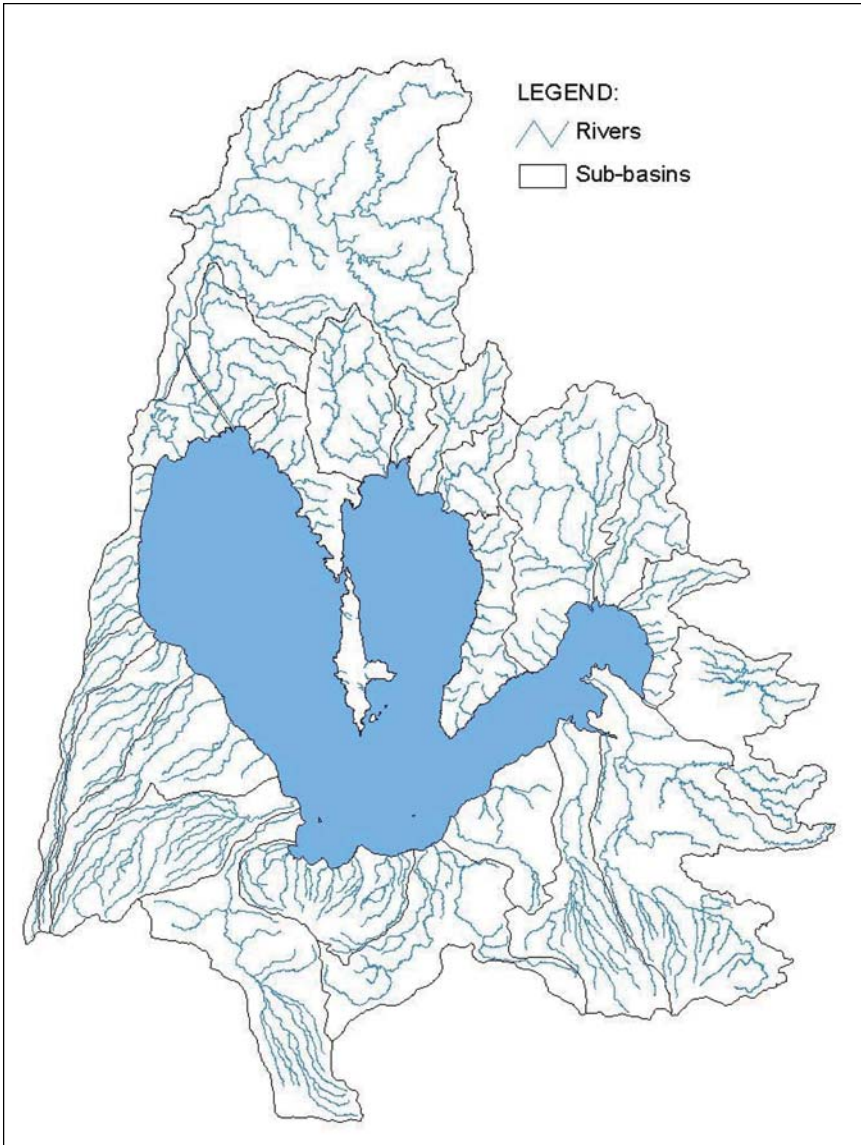
BRIEF PROFILE OF LAGUNADE BAY

Laguna de Bay is located in the middle part of Luzon and borders the capital region of Metro Manila and the provinces of Rizal and Laguna. It is comprised of three corporate bays: the west bay, central bay, and east bay. These three corporate bays converge toward the south carving out what resembles a large bird or dinosaur (LLDA n.d.). The lake flows and discharges its water into the Manila Bay through the Pasig River.

The total watershed area of Laguna de Bay is called the Laguna de Bay Region (Figure 1). This region has a total area of 292,000 hectares (ha) and spans 14 cities and 47 municipalities in the provinces of Rizal, Laguna, Cavite, Batangas, Quezon, and Metro Manila. It had an estimated total population of 13.2 million people in 2005. The coastal municipalities of Laguna de Bay are Muntinlupa City and Taguig City in Metro Manila; Taytay, Angono, Binangonan, Cardona, Morong, Baras, Tanay, Pililla, and Jala-Jala in Rizal; and Mabitac, Siniloan, Pangil, Pakil, Paete, Kalayaan, Lumbar, Sta. Cruz, Pila, Victoria, Calauan, Bay, Los Baños, Calamba, Cabuyao, Sta. Rosa, Biñan, and San Pedro in Laguna, for a total of 29 municipalities.

Laguna de Bay has a total water surface area of about 90,000 ha, an average depth of 2.5 meters, a maximum depth of 20 meters located in Diablo Pass, an average water volume of 2.25 billion cubic meters, and a coastline length of 285 kilometers (km) (LLDA 2006). The lake has various economic uses to the population and sectors of the surrounding areas including busi-

Figure 1. Map of the Laguna de Bay watershed and its sub-basins



Source: LLDA

ness, transportation, electricity, industrial cooling, agriculture, recreation, and as floodwater reservoir.

Pre-historic Filipinos called Laguna de Bay “Lawa ng Bai” or Mother Lake (LLDA n.d.). With the coming of the Spaniards, the name became Laguna de Bay

or Lake of Bay. There are a number of versions about how Laguna de Bay originally started. Among the earlier suggestions was that the lake was formerly a volcanic crater or that it originated through a subsidence volcano. The most accepted theory, however, is that Laguna de Bay was once part of Manila Bay as remnants of almost identical species of marine shells were found in some parts of both water bodies.

STATUS OF FISHPEN AND FISHCAGE CULTURE IN LAGUNA DE BAY

Background of fishpen and fishcage culture

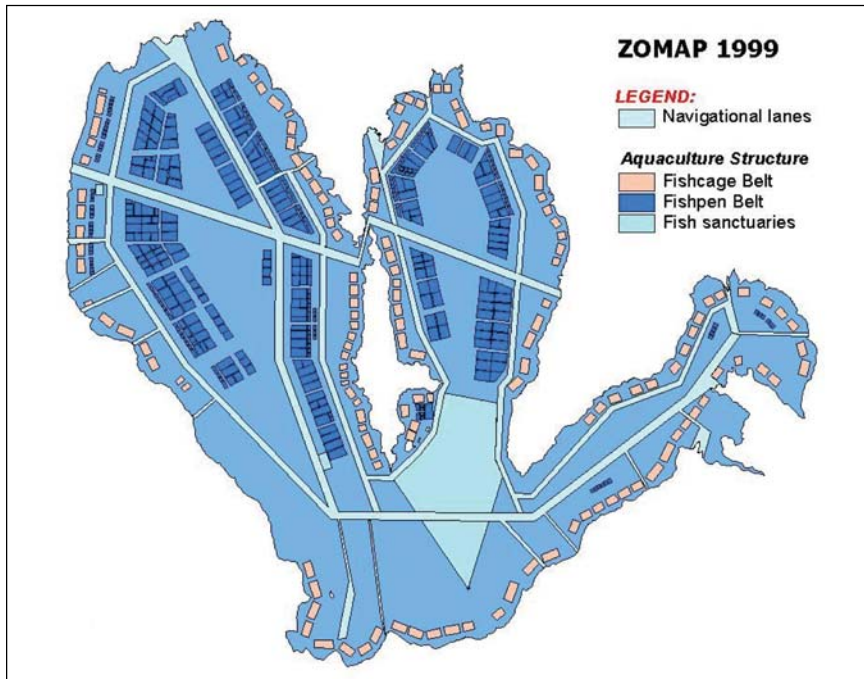
By definition, a fishpen is an artificial and stationary water enclosure for the culture of fish and other aquatic animal species. It is made up of bamboo poles, wood, screen, and other construction materials intentionally arranged to prevent the escape of fish. A fishcage is an artificial and stationary or floating water enclosure smaller than a fishpen but made up of similar construction materials. In Laguna de Bay, a fishpen is further defined as having a water surface area of more than one hectare while a fishcage has a water surface area of one hectare or less. A fishcage in the lake generally has a net bottom while a fishpen has none.

Fishpen culture in Laguna de Bay was first experimented in 1965 by the Philippine Fisheries Commission but the project did not make much headway and was later abandoned (Mane 1987, 1982). Then in 1970, the Laguna Lake Development Authority (LLDA) successfully demonstrated the commercial culture of milkfish in fishpens in its pilot project in Cardona, Rizal. The LLDA's project showed that milkfish production in fishpens generated more than four times than those in brackishwater fishponds. As a result of this high productivity, fishpen milkfish production grew by leaps and bounds in the following years and proliferated in many municipalities bordering the lake. From only 38 ha in the 1970s, fishpens in Laguna de Bay increased to more than 30,000 ha in 1983, reducing the water areas available for open fishing and navigation (Nepomuceno 2004; Santos-Borja and Nepomuceno 2003).

Fishcage culture in Laguna de Bay was first attempted in the early 1970s, also in the LLDA fishpen pilot project in Cardona, Rizal (Garcia and Medina 1987). In 1977, the cage culture of Nile tilapia started to develop as a commercial enterprise in the lake. The tilapia fishcage industry noticeably grew in 1981 particularly along the Binangonan and Cardona side of Talim Island in Rizal and greatly expanded elsewhere in the lake in the succeeding years.

Fishpen and fishcage culture in Laguna de Bay is generally practiced within the fishpen and fishcage belts specified by the Laguna de Bay Fishery Zoning and Management Plan (ZOMAP). The fishpen belt is located in the west and central bays while the fishcage belt is situated in the coastal areas all over the lake (Figure

Figure 2. Laguna de Bay fishery zoning and management plan, 1999



Source: LLDA

2). The ZOMAP allocates a maximum of 10,000 ha for the practice of fishpen culture and 5,000 ha for fishcage culture. According to LLDA informants, the area of 15,000 ha allotted for fishpens and fishcages, which comprised about 17 percent of the total area of Laguna de Bay, is based on the carrying capacity of the lake.

Participation and coverage of fishpen and fishcage culture

In recent years, both the participation and coverage of fishpen culture in Laguna de Bay have increased. From 2000 to 2006, the number of registered fishpen operators and total area of fishpens in the lake in particular have risen at an average annual growth rate of 9.91 percent and 8.40 percent, respectively (Table 3). Furthermore, although the total area of registered fishcages had decreased at an annual average of 12.46 percent, the number of registered fishcage operators had increased at an average annual growth rate of 11.55 percent.

The figures in Table 3 indicate that the limit of 10,000 hectares for fishpens in Laguna de Bay has been exceeded since 2003. Key informants mentioned that in that year, the LLDA started registering fishpens that were operating outside the fishpen belt designated by the ZOMAP. Furthermore, although a moratorium

Table 3. Number of registered fishpen and fishcage operators and area of fishpens and fishcages in Laguna de Bay, 2000 – 2006

Year	Fishpen		Fishcage		Total	
	Number of Operators	Area (Ha)	Number of Operators	Area (Ha)	Number of Operators	Area (Ha)
2000	299	8,180	871	4,556	1,170	12,736
2001	230	7,051	1,018	1,050	1,248	8,101
2002	232	6,870	1,370	770	1,602	7,640
2003	363	10,064	1,546	854	1,909	10,918
2004	362	10,393	1,758	986	2,120	11,379
2005	365	10,174	1,808	1,111	2,173	11,285
2006	455	12,117	1,599	998	2,054	13,115
Average Annual Growth Rate (%)	9.91	8.40	11.55	-12.46	10.38	3.41

Source of data: LLDA

on the registration of new fishpens was imposed since 2005, the figures show that the number of fishpen operators and the area of fishpens continued to increase in 2006.

In 2006, there were 455 registered fishpen operators in Laguna de Bay covering an area of 12,117 ha and 1,599 registered fishcage operators covering an area of 998 ha for a total 2,054 registered fishpen and fishcage operators covering an area of 13,115 ha (Table 3). In 2006, therefore, the maximum limit of 10,000 ha for fishpens was exceeded by 2,117 ha while the area coverage of fishcages was below the maximum limit of 5,000 ha.

Corporations, sole proprietorships, and cooperatives are allowed to put up fishpens in Laguna de Bay while sole proprietorships and cooperatives, particularly those representing the poor sector of the population are allowed to put up fishcages. Of the 455 registered fishpen operators in 2006, 57 percent were corporations, 36 percent were sole proprietorships and 7 percent were cooperatives (Table 4). Of the total fishpen area, 89 percent was owned by corporations, 7 percent was by sole proprietorships and 4 percent was under the operation of cooperatives. On the other hand, of the 1,599 registered fishcage operators in 2006, key informants mentioned that almost all were operated by sole proprietorships and only a minimal number were run by cooperatives. These data and information indicate that corporations dominated fishpen culture, sole proprietorships dominated fishcage culture, and cooperatives formed only a small percentage of fishpen and fishcage culture in Laguna de Bay.

Table 4. Registered fishpen operators and area of fishpens in Laguna de Bay, by type of ownership, 2006

Type of Ownership	Fishpen Operators and Fishpen Areas			
	No. of Operators	% to Total	Area (Ha)	% to Total
Corporation	258	57	10,795	89
Sole Proprietorship	164	36	823	7
Cooperative	33	7	499	4
Total	455	100	12, 117	100

Source of data: LLDA

Key informants explained that an important reason the maximum limit of 5,000 hectares for fishcages in Laguna de Bay has not been surpassed is that the LLDA has been strict in providing permits only to sole proprietorships and cooperatives that represent the poor. This strict implementation and the lack of access to capital among the less privileged sector of the population have been identified as the main reasons for the limited practice of fishcage culture.

Culture practices in fishpens and fishcages

Traditionally, the fish species cultured in fishpens and fishcages in Laguna de Bay were mostly milkfish and tilapia. In recent years, however, carp (particularly bighead carp), were also grown. In addition, although not intentionally stocked in fishpens and fishcages, catfish were also caught as an incidental crop.

Based on survey results, the majority of fishpen operations in Laguna de Bay raised only milkfish but some also raised tilapia and/or carp in polyculture with milkfish (Table 5). Fishcage operations, on the other hand, usually raised carp and/or tilapia in either monoculture or polyculture but occasionally milkfish is also raised with either or both species (Table 6). The choice by fishpen and fishcage operators of which species to grow depends on many factors including demand and supply, financial profitability, technical knowhow, availability of production inputs particularly fry and fingerlings, availability of capital, and other factors.

The majority of fishpen and fishcage operations in Laguna de Bay use the extensive method of culture which depends mainly on the natural food in the lake for feeding the fish. However, there are also operations that utilize either the semi-intensive or intensive method which uses supplemental feed in addition to natural food. The high and rising cost of feeds was mentioned as a major reason for the prevalent use of the extensive method in fishpens and fishcages operations. In addition to the cost of feeds, other determinants of the choice among the extensive, semi-intensive and extensive systems are financial profitability, technical knowhow, availability of capital, and other related factors.

Table 5. Fish species grown in fishpen operations in Laguna de Bay, by municipality, 2007

Species	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish only	4	20	16	80	18	90	38	63
Tilapia only	0	0	0	0	0	0	0	0
Carp only	6	30	2	10	0	0	8	13
Milkfish and Tilapia	1	5	0	0	1	5	2	3
Milkfish and Carp	5	25	1	5	1	5	7	12
Tilapia and Carp	2	10	1	5	0	0	3	5
Milkfish, Tilapia and Carp	2	10	0	0	0	0	2	3
Total	20	100	20	100	20	100	60	100

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

Table 6. Fish species grown by fishcage respondents in Laguna de Bay, by municipality, 2007

Species	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish only	0	0	1	3	0	0	1	1
Tilapia only	3	8	0	0	15	38	18	15
Carp only	16	40	39	98	9	23	64	53
Catfish only	1	3	0	0	0	0	1	1
Milkfish and Tilapia	0	0	0	0	3	8	3	3
Milkfish and Carp	2	5	0	0	0	0	2	2
Tilapia and Carp	13	33	0	0	12	30	25	21
Milkfish, Tilapia and Carp	5	13	0	0	1	3	6	5
Total	40	100	40	100	40	100	120	100

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

The majority of fishpen operators that grow milkfish practice the monoculture system; those that grow tilapia use the polyculture system, while those that grow carp employ both monoculture and polyculture systems (Table 7). In contrast, the majority of fishcage operators that grow milkfish and tilapia practice the polyculture system while most of those that raise carp use the monoculture system (Table 8).

The majority of fishpen operators who grow milkfish practice the extensive system, more of those who grow tilapia use the extensive and semi-intensive

Table 7. Culture system of fishpen respondents in Laguna de Bay, by species, by municipality, 2007

Culture System/ Stocking System	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish								
Monoculture	4	33	16	94	18	90	38	78
Polyculture	8	67	1	6	2	10	11	22
Total	12	100	17	100	20	100	49	100
Tilapia								
Monoculture	0	0	0	0	0	0	0	0
Polyculture	5	100	1	100	1	100	7	100
Total	5	100	1	100	1	100	7	100
Carp								
Monoculture	6	47	2	50	0	0	9	45
Polyculture	9	53	2	50	1	100	11	55
Total	15	100	4	100	1	100	20	100

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

Table 8. Culture system of fishcage respondents in Laguna de Bay, by species, by municipality, 2007

Culture System/ Stocking System	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish								
Monoculture	0	0	1	100	0	0	1	8
Polyculture	7	100	0	0	4	100	11	92
Total	7	100	1	100	4	100	12	100
Tilapia								
Monoculture	3	14	0	0	15	48	18	35
Polyculture	18	86	0	0	16	52	34	65
Total	21	100	0	0	31	100	52	100
Carp								
Monoculture	16	44	39	100	9	39	64	65
Polyculture	20	56	0	0	14	61	34	35
Total	36	100	39	100	23	100	98	100

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

systems, while most of those who grow carp employ the extensive system (Table 9). On the other hand, half of fishcage operators who grow milkfish and tilapia use the extensive system while most of those who grow carp use the extensive system (Table 10).

Table 9. Stocking system of fishpen respondents in Laguna de Bay, by species, by municipality, 2007

Stocking System	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish								
Extensive	8	67	17	100	17	85	42	86
Intensive	2	17	0	0	1	5	3	6
Semi-intensive	2	17	0	0	2	10	4	8
Total	12	100	17	100	20	100	49	100
Tilapia								
Extensive	1	20	1	100	1	100	3	43
Intensive	1	20	0	0	0	0	1	14
Semi-intensive	3	60	0	0	0	0	3	43
Total	5	100	1	100	1	100	7	100
Carp								
Extensive	9	60	4	100	0	0	13	65
Intensive	3	20	0	0	0	0	3	15
Semi-intensive	3	20	0	0	1	100	4	20
Total	15	100	4	100	1	100	20	100

Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

Sources of fish stocks and supplemental feeds

The milkfish stocked in fishpens and fishcages in Laguna de Bay originates from fry sourced from local fry gatherers, local hatcheries, and foreign fry producers (Figure 3). From these sources, the fry pass through various traders including concessionaires, importers, and other middlemen and eventually brought to a milkfish nursery. In the nursery, the fry are raised into fingerlings and then again, passing through middlemen, are sold to fishpen and fishcage operators. In general, therefore, the fishpens and fishcages in Laguna de Bay that grow milkfish are stocked with fingerlings and not fry. The fingerlings come from Bulacan, where many milkfish nurseries are located, as well as from other provinces that are producing fingerlings.

The fishpens and fishcages in Laguna de Bay that grow tilapia get their fry and fingerling from tilapia hatcheries and nurseries around the lake and other

Table 10. Stocking system of fishcage respondents in Laguna de Bay, by species, by municipality, 2007

Stocking System	Binangonan		Biñan		Muntinlupa City		All	
	Number	%	Number	%	Number	%	Number	%
Milkfish								
Extensive	4	57	0	0	2	50	6	50
Intensive	1	14	0	0	1	25	2	17
Semi-intensive	2	29	1	100	1	25	4	33
Total	7	100	1	100	4	100	12	100
Tilapia								
Extensive	8	38	0	0	18	58	26	50
Intensive	5	24	0	0	6	19	11	21
Semi-intensive	8	38	0	0	7	23	15	29
Total	21	100	0	0	31	100	52	100
Carp								
Extensive	24	67	32	82	17	74	73	74
Intensive	6	17	1	3	5	22	12	12
Semi-intensive	6	17	6	15	1	4	13	13
Total	36	100	39	100	23	100	98	100

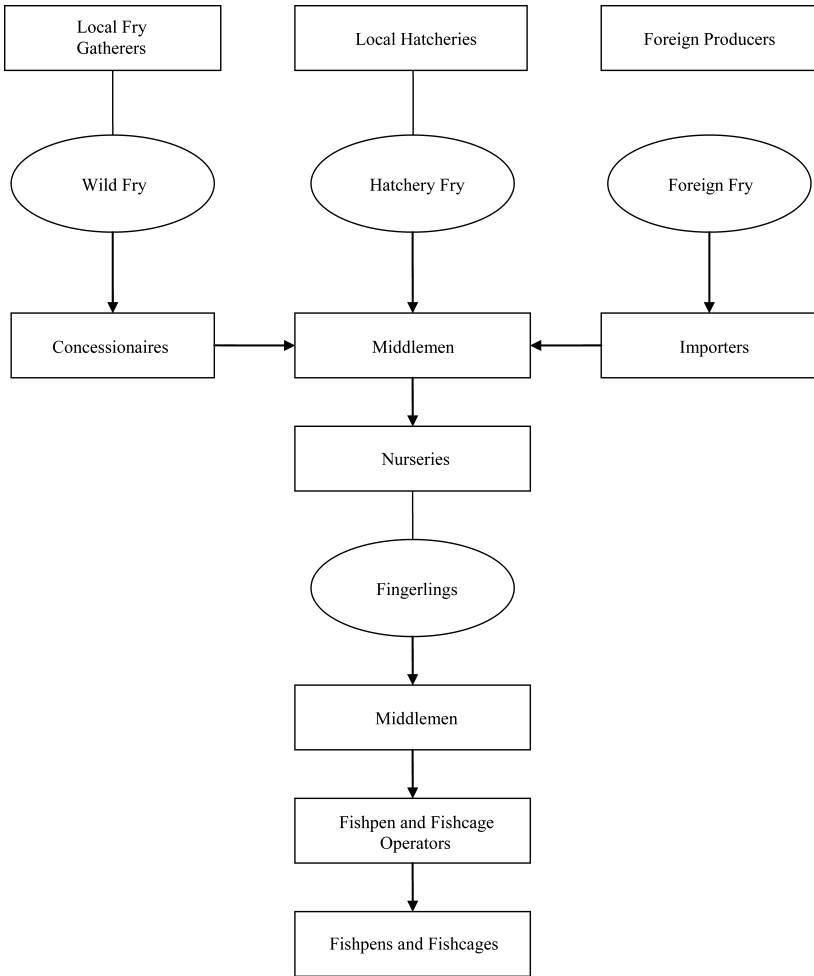
Source: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007.

areas. In 2007, there were 269 land-based tilapia hatcheries around Laguna de Bay covering a total area of 179 ha. Most of these hatcheries are located in Laguna while a few are in Rizal.

The fishpens and fishcages that raise carp get their fry and fingerling from the few hatcheries operating around the lake. The municipality of Binangonan, Rizal, where nine bighead carp hatcheries operate, was the main producer of bighead carp fry and fingerling in 2007. Although few in number, key informants stated that these carp hatcheries can supply the current fry and fingerling needs of fishpen and fishcage operators except when there are typhoons and other weather-related problems which disrupt hatchery operations.

Supplemental fish feeds are used by fishpen and fishcage operators to augment the food supply for fish when the supply of natural food is not enough. Supplemental feeds include trash fish, which are sourced from the municipal fishermen around the lake, and trash food such as stale bread which are sourced from bakeries, groceries and other bread sources. Other supplemental feeds are rice bran and formulated feeds which are sourced from the dealers of agricultural products in municipalities also around the lake.

Figure 3. Marketing channels for milkfish fry and fingerlings in Laguna de Bay



Source of data: Interviews with key informants, 2007.

Natural food is generally abundant in Laguna de Bay during dry season when there is more inflow of saltwater into the lake which stimulates the growth of planktons. In contrast, natural food is less available during wet season when the inflow of saltwater is low or minimal. The use of supplemental feeds is therefore more important during wet season especially during the cold months of December to January when fish grow the slowest.

Harvesting period and fish prices

Depending on the fish species and physical features (e.g., size and age at stocking), the culture period in Laguna de Bay usually takes at least three months while the number of croppings is once or twice a year. The timing of fish harvest depends on several factors but price is an important consideration. In general, barring fortuitous events like typhoons and floods, harvesting is done at the end of the culture period and when the prevailing market price of fish is considered relatively high and favorable to the fishpen and fishcage operators.

Key informants said that in 2006, prices of milkfish and tilapia were considered high at above P60 per kilo, average at P40–60 per kilo, and low at below P40 per kilo. On the other hand, the price of carp was considered high at above P30 per kilo, average at P30 per kilo, and low at below P30 per kilo. Key informants further noted that, in general, the prices of milkfish, tilapia, and carp produced in Laguna de Bay were relatively lower compared to the prices of those produced in other areas. This is due to various reasons including the low quality of fish from Laguna de Bay as perceived by fish buyers and consumers.

Labor requirements and compensations

Labor used in fishpen and fishcage operations in Laguna de Bay includes regular workers like caretakers and security guards. Hired laborers are employed during fish stocking and harvesting and in fishpen and fishcage construction. Caretakers and security guards are generally permanent employees who earn fixed salaries, sometimes allowances and other benefits. They are generally skilled and highly knowledgeable of their work. In particular, caretakers are required to be skilled in the technology of fish culture as well as in diving, human relations, and overall management. Security guards are expected to be well trained in the proper use of guns, proper apprehension of security violators, and overall security management. On the other hand, hired laborers provide either skilled or unskilled labor and are hired for only a limited period. Hired laborers are expected to know how to install and fix pens, cages, and nets and stock and harvest fish in the pens and cages. The caretakers, security guards and hired laborers employed in fishpen and fishcage operations come from the areas around Laguna de Bay and even from distant areas.

In 2006, caretakers in fishpens and fishcages in Laguna de Bay earned an average of P3,000 per month and some with additional benefits in the form of bonuses computed as a percentage of production income. Security guards and hired workers in general earned less, at about P2,000 per month. Key informants mentioned that pay rates of these permanent and temporary workers are considered lower compared to other employment options in the Laguna de Bay area.

However, given the high rate of unemployment around the lake and the country in general, people accept these salary rates instead of going jobless.

Other inputs to fishpen and fishcage operations

Gasoline is used in fishpen and fishcage operations in Laguna de Bay to operate the motorized boats used in hauling people, inputs, fish, and other materials to and from fishpens and fishcages. Gasoline is also used by the motorized boats during stocking and harvesting and in guarding and monitoring the fishpen and fishcage surroundings. This input is generally available from the numerous gasoline stations and dealers in municipalities around the lake.

Aside from seeds, feeds, gasoline, and labor used in fishpen and fishcage operations, other inputs are also used. Ice and salt are utilized during harvesting to preserve the freshness of the fish. Fertilizers are generally not used as the lake bottom is too deep for sunlight to penetrate for fertilizer to be effective. Other inputs like pesticides and chemicals are also not used because the free flow of water in and out of fishpens and fishcages make them ineffective and even dangerous to both fish and the water environment.

In the construction of fishpens and fishcages, caretaker's huts, guard posts, and other fixed structures, operators use several construction materials. These include lumber, bamboo poles, anahaw poles, nets, ropes, and miscellaneous materials like nails. Lumber is sourced from lumber yards and other suppliers located in municipalities around the lake. These establishments get the timber, from which lumber is produced, from logging companies operating in neighboring and distant provinces.

The bamboo poles used for fishpen and fishcage construction are usually sourced from the municipalities around Laguna de Bay where bamboos are plenty, such as Binangonan and Cardona in Rizal and in nearby provinces particularly Batangas and Quezon. The operators order directly from the seller or indirectly through middlemen who deliver the bamboos at an agreed place and price. Poles from palm tree, popularly called anahaw, are also used in fishpen construction to enclose a large area and durably protect it from strong typhoon and big waves. These poles are ordered from contract dealers in Quezon and the Bicol region where anahaw trees are in abundance.

The brand new nets used in fishpen and fishcage construction are sourced either directly from the net manufacturers or through the net distributors. Second-hand nets are sometimes used and can be availed from fellow fishpen and fishcage operators. Or these can be bought from sellers who buy damaged nets and fix them for resale. Construction materials like nails and other hardware items are bought by the operators from the numerous hardware stores in the municipalities around the lake.

Profitability of fishpen and fishcage culture

The financial profitability of fishpen culture in Laguna de Bay was determined. In the evaluation, the monoculture of milkfish in fishpen sizes of 50 ha and 5 ha was analyzed (Table 11). Results showed that a 50-ha fishpen doing milkfish monoculture in 2006 generated an annual total revenue of P14 million, an annual total cost of P7.5 million, an annual net income of P6.5 million, and an annual net income per ha of P130,749. On the other hand, a 5-ha fishpen conducting milkfish monoculture derived an annual total revenue of P1.5 million, an annual total cost of P1.1 million, an annual net revenue of P0.43 million, and an annual net income per ha of P86,423.

The financial profitability of fishcage culture in Laguna de Bay was likewise determined. In the analysis, the polyculture of bighead carp and tilapia in a one-hectare fishcage and the monoculture of tilapia in a one-hectare fishcage were analyzed (Table 11). Results showed that a one-hectare fishcage doing polyculture of bighead carp and tilapia generated an annual total revenue of P403,750, an annual total cost of P118,529, and an annual net income of P285,222 in 2006. On the other hand, a one-hectare fishcage conducting tilapia monoculture derived an annual total revenue of P400,000, an annual total cost of P150,589, and an annual net revenue of P249,411.

The results of these analysis indicated that these operations were profitable business ventures generating positive net incomes for the fishpen and fishcage operators at different sizes of fishpens and fishcages. While this was established, key informants, however, also noted that in 2006, there were reports of some fishpens and fishcages that were damaged by typhoons resulting in financial losses for some operators.

Table 11. Estimated annual costs and returns of fishpen and fishcage culture in Laguna de Bay, 2006

Culture System/Hectare	Total Revenues	Total Costs (Pesos)	Net Income (Pesos)	Net Income Per Hectare (Pesos)
Milkfish Monoculture in a 50-ha Fishpen	14,000,000	7,462,595	6,537,405	130,749
Milkfish Monoculture in a 5-ha Fishpen	1,527,273	1,095,154	432,119	86,423
Carp and Tilapia Polyculture in a 1-ha Fishcage	403,750	118,529	285,221	285,221
Tilapia Monoculture in a 1-ha Fishcage	400,000	150,589	249,411	249,411

Source of data: Interviews with key informants, 2007.

Fish marketing

Fishpen and fishcage operators in Laguna de Bay differ, to some degree, when marketing the fish they produce. Most fishpen operators sell through *consignacions* located in fish landings and markets in some municipalities around the lake. *Consignacions* are fish brokers who assist fishpen and fishcage operators for a fee in selling the fish they produce to wholesalers, retailers and other buyers. In 2007, there were 13 fish landing areas located in nine municipalities in Laguna de Bay and operating in some of these areas were 19 *consignacions* (Table 12).

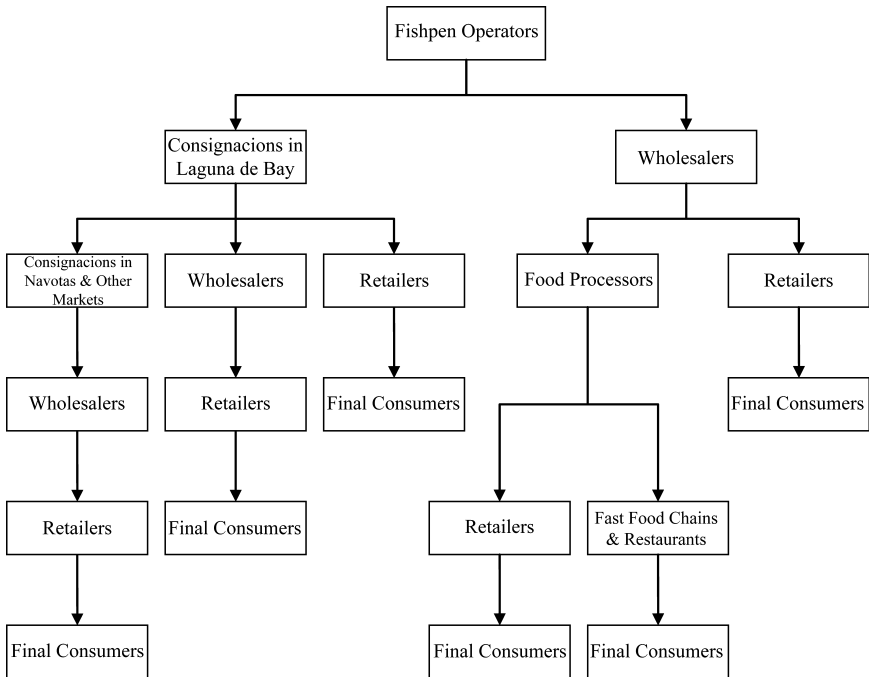
Most of the fish passing through *consignacions* in Laguna de Bay are bought by wholesalers and retailers in the lake while a small portion is brought to *consignacions* in Navotas and other areas (Figure 4). The fish brought to *consignacions* in Navotas and other areas are sold to wholesalers, retailers, and final consumers in these areas. Wholesalers who buy from *consignacions* in Laguna de Bay resell them to retailers and final consumers mainly around the lake. Retailers who purchase from *consignacions* in Laguna de Bay also resell to final consumers around the lake.

Table 12. Number of fish landings and consignacions in Laguna de Bay, 2007

Area/Municipality	Number of Fish Landings	Number of Consignacions
Zone A		
Muntinlupa City	2	3
Taguig City	4	4
Zone B		
Biñan	1	0
Calamba	1	1
Los Baños	1	0
Pila	1	0
Zone C		
Sta. Cruz	1	0
Zone D		
Cardona	1	8
Zone E		
Binangonan	1	3
TOTAL	13	19

Source of data: Interviews with key informants, 2007.

Figure 4. Flow chart for fish marketing by fishpen operators in Laguna de Bay



Source of data: Interviews with key informants.

The small portion of fish harvested by fishpen operators which does not pass through *consignacions* are directly sold, by the operators themselves, to wholesalers who in turn resell the fish to food processors and retailers. Food processors sell their processed fish products to retailers such as supermarkets and to fastfood chains and restaurants. In turn, these establishments, as well as those retailers who buy fish directly from the wholesalers, sell their products to the final consumer.

Fishcage operators differ from their fishpen counterparts when it comes to marketing their harvested fish because most of them bypass the *consignacions*. Because of their much smaller volume of harvest, fishcage operators usually sell directly to wholesalers, retailers, and final consumers; only a few sell through *consignacions*. Those who pass through *consignacions* usually do it when their volume of harvest is one ton or more. When harvest is below one ton, they sell directly to the wholesalers, retailers, and final consumers.

IMPORTANCE OF FISHPEN AND FISHCAGE CULTURE**Fish production**

The main economic contribution of fishpen and fishcage culture in Laguna de Bay is the marketable fish that it produces. In terms of quantity, from 1996 to 2006, total fish production in fishpens and fishcages grew at an annual average rate of 10.65 percent (Table 13). Carp was the fastest growing species cultured, followed by milkfish and tilapia. Data reflect that catfish harvest has been recorded only in the last few years and only in small quantities. In 2006, total production was 48,187 metric tons with milkfish contributing more, followed closely by tilapia and carp. In terms of value, carp again posted the fastest growth, followed by milkfish and tilapia (Table 14). In 2006, total production amounted to P1.8 billion with tilapia contributing more, followed closely by milkfish, with carp a distant third.

By province, Rizal was the dominant producer of fish in fishpens and fishcages, followed by Laguna and Metro Manila (Tables 15 and 16). However, for the period 1996–2006, production in both volume and value terms had been growing faster annually on average in Metro Manila, followed by Laguna and Rizal. In 2006, volume of production was 37,274 metric tons in Rizal, followed by 8,729 metric tons in Laguna, then 2,184 metric tons in Metro Manila. On the other hand, total value of production was P1.2 billion in Rizal, P488 million in Laguna, and P101 million in Metro Manila.

Table 13. Production in fishpens and fishcages of Laguna de Bay, by Species 1996–2006 (in metric tons)

Year	Milkfish	Tilapia	Carp	Catfish	All
1996	10,779	6,990	1,295	0	19,064
1997	14,151	8,061	1,570	0	23,782
1998	13,729	7,480	4,440	0	25,649
1999	15,973	7,979	10,136	0	34,088
2000	13,515	10,632	10,284	0	34,431
2001	2,835	8,121	19,271	0	30,227
2002	8,274	8,733	17,933	0	34,940
2003	16,015	12,019	8,629	0	36,663
2004	20,766	13,543	13,337	0	47,646
2005	18,971	15,915	16,757	2	51,645
2006	16,997	15,716	15,470	4	48,187
Average Annual Growth Rate (%)	24.63	9.85	43.49	-	10.65

Source of raw data: Bureau of Agricultural Statistics (BAS).

Table 14. Value of aquaculture Production in fishpens and fishcages of Laguna de Bay, by species, 1996–2006 (in P'000)

Year	Milkfish	Tilapia	Carp	Catfish	All
1996	618,745	305,683	33,308	0	957,736
1997	696,389	342,968	24,490	0	1,063,847
1998	676,000	340,825	92,356	0	1,109,181
1999	814,269	377,916	212,450	0	1,404,635
2000	732,608	573,396	260,840	0	1,566,844
2001	123,607	416,582	389,366	0	929,555
2002	305,752	437,538	232,246	0	975,536
2003	674,235	535,983	179,885	0	1,390,103
2004	953,007	654,359	323,061	0	1,930,427
2005	905,638	737,104	334,486	41	1,977,269
2006	729,764	739,472	329,304	221	1,798,761
Average Annual Growth Rate (%)	22.17	10.94	47.14	439	9.26

Source of raw data: BAS.

Table 15. Volume of aquaculture production in fishpens and fishcages of Laguna de Bay, by province, 1996–2006 (in metric tons)

Year	Metro Manila	Laguna	Rizal	All
1996	205	2,720	16,139	19,064
1997	339	3,035	20,408	23,782
1998	400	3,103	22,146	25,649
1999	754	3,158	30,176	34,088
2000	678	6,520	27,233	34,431
2001	753	6,015	23,459	30,227
2002	4,228	6,528	24,184	34,940
2003	2,955	7,613	26,095	36,663
2004	3,343	8,312	35,992	47,647
2005	3,118	9,483	39,043	51,644
2006	2,184	8,729	37,274	48,187
Average Annual Growth Rate (%)	58.07	15.48	10.05	10.65

Source of raw data: BAS

There were no available time-series data on total fisheries production in Laguna de Bay in recent years covering both aquaculture and capture fisheries.

Table 16. Value of aquaculture production in fishpens and fishcages, in Laguna de Bay, by province, 1996–2006 (in P'000)

Year	Metro Manila	Laguna	Rizal	All
1996	10,888	148,888	797,960	957,736
1997	13,220	158,115	892,512	1,063,847
1998	18,780	162,287	928,114	1,109,181
1999	36,520	181,899	1,186,216	1,404,635
2000	32,023	393,531	1,140,750	1,566,304
2001	37,578	335,071	556,906	929,555
2002	133,507	363,856	478,173	975,536
2003	123,520	385,396	881,187	1,390,103
2004	153,263	432,730	1,344,434	1,930,427
2005	149,124	476,107	1,352,038	1,977,269
2006	101,068	487,612	1,210,081	1,798,761
Average Annual Growth Rate (%)	39.99	16.16	10.14	9.25

Source of raw data: BAS

This would have been useful in measuring the relative contributions of aquaculture and capture fisheries to total fish production in the lake. However, LLDA (2005) reported that catch from capture fisheries in the lake had been falling over time and was 38,000 metric tons in 1996. Thus, even assuming that this level of production remained the same in 2006, the total fisheries output in the lake that year was 86,187 metric tons with the production of 48,187 metric tons from fishpens and fishcages. Fishpens and fishcages, therefore, contributed approximately 56 percent to total fisheries output in Laguna de Bay which was more than that from capture fisheries. This percentage contribution was a conservative estimate given that output from capture fisheries was already falling over time and thus must have actually decreased onwards from its 1996 level.

It should be further noted that the percentage contribution of fishpen and fishcage culture of more than half of total fish production in Laguna de Bay was attained despite the relatively small area in the lake that was allotted for the activity. In 2006, the registered area of 13,115 hectares used for fishpen and fishcage culture was only 14.6 percent of the total water surface area of the lake.

As noted by Laseo et al. (2005) and Borja (2003), the total fisheries production of Laguna de Bay, from both capture fisheries and aquaculture used to supply more than two-thirds of the freshwater fish requirement of Metro Manila and adjoining provinces. At present, however, this contribu-

tion has been reduced to just 18 percent presumably due to the reduced catch from capture fisheries.

At the national level, fishpen and fishcage production in Laguna de Bay significantly contributes to fish production as well. From 1996 to 2006, fish production from fishpens and fishcages contributed from 1.94 percent to 3.25 percent (at its highest) to national aquaculture production and from 0.69 percent to 1.24 percent (at its highest) to total national fisheries production (Table 17). In 2006, the aquaculture production of 48,187 metric tons in the lake accounted for 2.30 percent of the total national aquaculture production. In the same year, aquaculture production in the lake contributed 1.09 percent to the total fisheries production.

Again, it should be noted here that these percentage contributions were attained even with the very small area allotted for fishpens and fishcages in Laguna de Bay as compared to the entire area used for aquaculture and fisheries at the national level. The 13,115 hectares used for fishpen and fishcage culture in Laguna de Bay in 2006 formed only an insignificant percentage of the inland and marine resources of the country that can be utilized for aquaculture and fisheries production (Table 18).

Table 17. Volume of aquaculture and total fisheries production in Laguna de Bay and Philippines, 1996–2006 (in metric tons)

Year	Production in Fishpens and Fishcages in Laguna de Bay (A)	Aquaculture Production in the Philippines (B)	Total Fisheries Production in the Philippines (C)	A/B (%)	A/C (%)
1996	19,064	980,929	2,769,150	1.94	0.69
1997	23,782	984,439	2,793,556	2.42	0.85
1998	25,649	997,841	2,829,520	2.57	0.91
1999	34,088	1,048,679	2,923,772	3.25	1.17
2000	34,431	1,100,902	2,993,332	3.13	1.15
2001	30,227	1,220,456	3,166,530	2.48	0.95
2002	34,940	1,338,393	3,369,524	2.61	1.04
2003	36,663	1,454,503	3,619,282	2.52	1.01
2004	47,646	1,717,027	3,926,173	2.77	1.21
2005	51,645	1,895,847	4,161,870	2.72	1.24
2006	48,187	2,093,371	4,409,567	2.30	1.09
Average Annual Growth Rate (%)	10.64	7.99	4.79	2.72	5.68

Source of data: BAS, various years.

Table 18. Fishery resources of the Philippines, 2005

Type of Resources	Area
A. Marine Resources	
1. Total Territorial Water Area (including the EEZ)	2,200,000 sq km
a. Coastal	266,000 sq km
b. Oceanic	1,934,000 sq km
2. Shelf Area (Depth 200m)	184,600 sq km
3. Coral Reef Area (Within the 10–20 fathoms where fisheries occur)	27,000 sq km
4. Coastline (length)	17,460 km
B. Inland Resources	
1. Swamplands	246,063 ha
a. Freshwater	106,328 ha
b. Brackishwater	139,735 ha
2. Existing Fishpond	253,854 ha
a. Freshwater	14,531 ha
b. Brackishwater	239,323 ha
3. Other Inland Resources	250,000 ha
a. Lakes	200,000 ha
b. Rivers	31,000 ha
c. Reservoirs	19,000 ha

Source: Bureau of Fisheries and Aquatic Resources (BFAR), 2006.

Other economic contributions

In addition to fish production, fishpen and fishcage culture in Laguna de Bay contributes to income generation. In 2006, the value of production in fishpens and fishcages of about P1.8 billion (Table 14) can be taken as an estimate of the direct gross incomes of fishpen and fishcage operators from their operations. Indirectly, the operations also resulted in the generation of income for the other participants in the lake's aquaculture industry. These included the numerous sellers of fry and fingerlings, feeds, nets, bamboos, and other participants in the inputs market; the *consignacions*, wholesalers, retailers, and other participants in the marketing of fish and fish products.

There are no available data that can be used to directly measure employment in fishpens and fishcages in Laguna de Bay. However, using extrapolation, it was estimated that fishpen and fishcage culture in the lake employed 5,152 people in 2006. The various activities also indirectly contributed to the employment of many more people who were, in one way or another, dependent on aquaculture in the lake for their livelihood through their involvement in the inputs and product markets.

Fishpen and fishcage culture likewise contributes to public revenue generation. Public revenues include bid price, annual registration fees, and other fees that operators pay for the right to operate their fishpens and fishcages in the lake. The annual registration fees alone were substantial. In 2006, annual registration fees for fishpens were P6,600 per hectare while those for fishcages were P4,400 per hectare. With the 12,117 hectares of registered fishpens and 998 hectares of fishcages in 2006, the total registration fees generated that year were P80 million from fishpens and P4.4 million from fishcages for a total of P84.4 million. In addition to the various fees cited above, it also contributes to the generation of income taxes and other forms of taxes from the numerous economic activities of the operators, sellers of production inputs, sellers of fish and fish products, and other industry participants. For instance, corporations involved in fishpens pay the national government 35 percent of their net taxable incomes from their operations.

Finally, since most of the fish harvests are consumed domestically, the foreign exchange generation contribution of the activity is considered only small, if not minimal. This lack of a foreign market has been mentioned by key informants as one of the important problems faced by fishpen and fishcage operators.

Social contributions

Aside from its economic contributions, fishpen and fishcage culture in Laguna de Bay has significant social implications. *First*, the milkfish, tilapia, and carp produced in fishpens and fishcages in the lake are not cash crops but relatively low-value species. These are mainly consumed by the lower economic brackets of society which comprise the majority of the national population.

Second, depending on individual species, results of the survey indicate that 70–95 percent of the fish produced in fishpens in Laguna de Bay are sold in Rizal, Laguna, and Metro Manila. Between 60 and 80 percent of the fish produced in fishcages are sold in the same area as well. The bigger percentage of the fish produced in the lake, therefore, is sold in the metropolitan area where a highly significant segment of the urban and relatively politically-sensitive population of the country resides.

RELATIVE SEVERITY OF THE PROBLEMS IN THE PRACTICE OF FISHPEN AND FISHCAGE CULTURE

Problems in fishpen and fishcage culture

As mentioned in the literature, fishpen and fishcage culture in Laguna de Bay has been facing various problems that hinder its development. For this paper, these problems may be classified as technical, production, economic, social, environmental, and institutional problems. However, it should be noted that while the

problems are grouped as such, they are not mutually exclusive but are actually interrelated. The individual problems are as follows:

Technical problems

- ◆ Poorly-sited fishpens and fishcages - some fishpens and fishcages in Laguna de Bay, although located in the designated aquaculture belts, are actually poorly sited and not conducive for the practice of fish culture.
- ◆ Inappropriate culture practices - some fishpen and fishcage culture practices used are inappropriate. For instance, the practice of monoculture does not utilize all the available natural food in the water for fish.

Production problems

- ◆ Occasional low supply of seeds - fry and fingerling for stocking are not always available resulting to the occasional late stocking, low stocking, or non-stocking of some fishpens and fishcages.
- ◆ Poor quality of production inputs - some of the production inputs used in fishpen and fishcage culture are of low quality resulting to poor harvest performance and high production costs.
- ◆ High prices of production inputs - over the years, the prices of production inputs have been increasing because of the generally inflationary trend in the economy and the rising cost of fuel, among others.

Economic problems

- ◆ Poor quality and low price of fish - the fish cultured in Laguna de Bay is perceived to be of low quality. As a result, market prices are relatively low compared to fish from other areas.
- ◆ Low level of fish processing - most of the fish cultured in Laguna de Bay are sold in fresh or frozen form. Fishpen and fishcage operators do not benefit from value addition that can be attained through fish processing.
- ◆ Lack of foreign markets for fish - fish from Laguna de Bay are generally sold only in the domestic market. Fishpen and fishcage operators do not benefit from international trade.
- ◆ Lack of access to cheap capital - limited financial capital is a perennial constraint in fishpen and fishcage culture as traditional institutional sources like banks lend at high interest rates and stiff collateral requirements and raised the price of fish to final consumers.
- ◆ Too many middlemen - the presence of several *consignations*, wholesalers, retailers, and other fish traders have diluted the income that fishpen and fishcage operators derive from their operations.

Social problems

- ◆ Poaching – the stealing of fish in fishpen and fishcages by poachers reduces the profits of operators and increases the chance of social conflict; it also forces operators to spend on security measures to prevent it.
- ◆ Reduction in fishing areas - because of the construction of fishpens and fishcages, municipal fishermen have to fish in smaller areas causing enmity between them and the fishpen and fishcage operators.
- ◆ Obstruction of navigational lanes - some fishpens and fishcages obstruct navigational lanes used by other sectors and this has caused problems between fishpen and fishcage operators and other lake users.
- ◆ Overcrowding of fishpens and fishcages - fishpens and fishcages are highly overcrowded in some areas within designated belts and this causes conflicts between fishpen and fishcage operators.
- ◆ Existence of illegal fishpens and fishcages - unregistered and inappropriately constructed fishpens and fishcages exist in Laguna de Bay both located within and outside the aquaculture belts.
- ◆ Presence of squatters - the presence of illegal settlers in the coastal areas has caused problems particularly to fishcage operators near these areas as some were found stealing the property of operators.
- ◆ Shoreline conversion - some coastal areas are already converted into residential, commercial, and industrial uses which hinder the movement of people and materials involved in fishpen and fishcage operations.

Environmental problems

- ◆ Occurrence of algal bloom - algal bloom causes fish mortality or fish kill as stocks die of asphyxiation due to oxygen depletion. Furthermore, the fishes that survive have a tainted flesh and mud-like taste.
- ◆ Proliferation of water hyacinth - water hyacinths crowd fishpen and fishcages and cause various problems including fish mortality, destruction of pen and cage structures, and obstruction of navigation.
- ◆ Invasion of alien species - the proliferation of alien fish species, particularly janitor fish of late, has caused problems. This fish destroys nets and competes for natural food and living space with cultured species.
- ◆ Occurrence of fish diseases - cultured fish in Laguna de Bay is affected by various diseases that cause fish mortality or fish kill which in turn reduce the financial viability of aquaculture operations.

- ◆ Deterioration of water quality - the worsening water quality in Laguna de Bay, which is caused mainly by water pollution, results to fish diseases, fish mortality, and reduced fish quality.
- ◆ Siltation and sedimentation - siltation and sedimentation have made Laguna de Bay shallow and reduced the living space for the fish and other aquatic animals as well as navigational space for man.

Institutional problems

- ◆ Obstructed saltwater inflow – fishpen and fishcage operators argue that the backflow of saltwater from Manila Bay into Laguna de Bay through the Pasig River is obstructed. Among others, this reduces the growth of natural food and contributes to the proliferation of water hyacinth.
- ◆ Poor access to training and extension – fishpen and fishcage operators have limited access to training and extension and operate mainly based on practical experience. This has contributed to the general practice of traditional and less innovative aquaculture practices in the lake.
- ◆ Difficult registration process - the registration process for fishpen and fishcage operations is considered by operators to be difficult and long, increasing the time and financial costs of registration.
- ◆ Overall lack of government support - overall technical, financial, economic, market support, and law enforcement by the government are considered inadequate by fishpen and fishcage operators. Government agencies are perceived as not doing enough to develop aquaculture in Laguna de Bay.

Other problems

- ◆ Occurrence of typhoons and floods - events like typhoons and floods destroy fishpens and fishcages causing the escape of cultured fish, destruction of property, and economic losses to fishpen and fishcage operators.

Of the various problems cited above, the social problems of poaching, reduction in fishing areas, obstruction of navigational lanes, overcrowding of fishpens and fishcages, and existence of illegal fishpens and fishcages are specific problems that fishpen and fishcage culture has either fully or partially caused. These problems negatively affect not only fishpen and fishcage culture but other sectors in the lake as well.

Under environmental problems, the occurrence of algal blooms and the deterioration of water quality have been partly attributed to fishpen and fishcage

culture in Laguna de Bay as well. This is because some fishpen and fishcage operations tended to or may have excessively used feeds, a practice that can cause eutropication or the increase of phosphate and nitrogen in the water that leads to algal bloom and the deterioration of water quality. However, although overfeeding may be occurring to some degree in the lake, there is also reason to believe that it is not as widely practiced as feared. Survey results indicate that about 80 percent of fishpen operators and 50 percent of the fishcage operators practice the extensive method of culture that depends only on the natural food for feeding fish.

Siltation and sedimentation may also be partly attributable to fishpen and fishcage culture. This is because the overcrowding of fishpens and fishcages in some areas can cause poor water circulation that leads to the accumulation of silt and sediments in these areas. Siltation and sedimentation is further aggravated by the accumulation of decaying bamboos, anahaw poles, and other construction materials left behind rotting in the lake water by fishpen and fishcage operations.

Nevertheless, although fishpens and fishcages may have contributed to algal bloom, reduced water quality and caused siltation and sedimentation, it may not be a major cause of water pollution in Laguna de Bay. Bacallan (1997) explained that of the water pollution in the lake, 40 percent came from agricultural sources, 30 percent was caused by industrial sources, and 30 percent came from domestic sources. Centeno (1987) further identified the various sources of water pollution in the lake including industrial effluents, sanitary wastes, effluents from agribusiness activities, run-off from agriculture, and inflows from the Pasig River.

Relative severity of the problems

The perceptions of fishpen and fishcage operators in Laguna de Bay on the relative severity of the various problems facing fishpen and fishcage culture were gathered (Table 19). Problems were ranked in terms of their relative severity and tested for significant differences (Table 20). Ranked as the most severe as a group were environmental problems that include the deterioration of water quality, siltation and sedimentation, invasion of alien species, proliferation of water hyacinth, occurrence of algal bloom, and occurrence of fish diseases. Of these problems, the deterioration of water quality, siltation and sedimentation, and invasion of alien species were found significantly different from the other problems in terms of relative severity.

Aside from environmental problems, other problems under the other classifications were also ranked highly in terms of their relative severity. These include the social problem of poaching, the institutional problem of limited overall government support, and the economic problem of lack of access to cheap capital.

Table 19. Relative severity of problems facing fishpen and fishcage operators in Laguna de Bay, 2007

Problems	Very Serious	Moderately Serious	Lightly Serious	Not a problem	No opinion	Total
Technical Problems						
Poorly sited fishpens	23	101	31	3	22	180
Inappropriate culture practices	13	103	31	4	29	180
Production Problems						
Occasional low supply of seeds	8	38	89	6	39	180
Poor quality of production inputs	8	31	98	4	39	180
High prices of production inputs	8	37	92	4	39	180
Economic Problems						
Poor quality and low price of fish	28	91	27	5	29	180
Low level of fish processing	11	90	36	8	35	180
Lack of foreign markets for fish	10	96	30	8	36	180
Lack of access to cheap capital	63	65	14	4	34	180
Too many middlemen	28	91	27	5	29	180
Social Problems						
Poaching	100	43	16	6	15	180
Reduction in fishing areas	23	95	37	3	22	180
Obstruction of navigational lanes	38	80	28	5	29	180
Overcrowding of fishpens	23	101	31	3	22	180
Existence of illegal fishpens	38	86	22	5	29	180
Presence of squatters	12	90	27	9	42	180
Shoreline conversion	23	95	37	3	22	180
Environmental Problems						
Occurrence of algal bloom	89	32	18	2	39	180
Proliferation of water hyacinth	89	38	12	2	39	180
Invasion of alien species	136	17	3	2	22	180
Occurrence of fish diseases	74	50	20	6	30	180
Deterioration of water quality	140	22	6	1	11	180
Siltation and sedimentation	138	24	6	2	10	180
Institutional Problems						
Obstructed saltwater inflow	15	96	35	4	30	180
Poor access to training & extension	15	102	29	4	30	180
Difficult registration process	24	63	52	1	40	180
Overall limited government support	85	58	9	3	25	180
Other problems						
Occurrence of typhoons & floods	15	96	35	4	30	180

Source of Data: Survey of Fishpen and Fishcage Operators and Operations in Laguna de Bay, 2007

Table 20. Ranking of the relative severity of the problems facing fishpen and fishcage Operators in Laguna de Bay, 2007

Problem	Non-Missing Observations	Rank Sum	Relative Rank
Deterioration of water quality	169	548771.5	1 – 3
Siltation and sedimentation	170	545622.0	1 – 3
Invasion of alien species	158	522897.5	1 – 3
Poaching	165	452939.0	4 – 9
Overall limited government support	155	424745.0	4 – 9
Proliferation of water hyacinth	141	401119.0	4 – 9
Occurrence of algal bloom	141	392632.0	4 – 9
Occurrence of fish diseases	150	375877.0	4 – 11
Lack of access to cheap capital	146	362643.0	4 – 11
Existence of illegal fishpens and fishcages	151	319205.5	8 – 25
Obstruction of navigational lanes	151	310718.5	8 – 25
Poorly sited fishpens	158	300118.0	10 – 25
Overcrowding of fishpens and fishcages	158	300118.0	10 – 25
Poor quality and low price of fish	151	296093.0	10 – 25
Too many middlemen	151	296093.0	10 – 25
Reduction in fishing areas	158	291631.0	10 – 25
Shoreline Conversion	158	291631.0	10 – 25
Poor access to training and extension	150	272353.5	10 – 25
Inappropriate culture practices	151	268296.5	10 – 25
Obstructed Saltwater Flow	150	263866.5	10 – 25
Occurrence of typhoons and floods	150	263866.5	10 – 25
Lack of foreign markets for fish	144	243353.0	10 – 25
Difficult registration process	140	240220.5	10 – 25
Low level of fish processing	145	238450.0	10 – 25
Presence of squatters	138	237003.0	10 – 25
Occasional low supply of seeds	141	154592.5	26 – 28
High prices of production inputs	141	154192.0	26 – 28
Poor quality of production inputs	141	145705.0	26 – 28

Note: A Kruskal-Wallis one-way analysis of variance by ranks was used to test the equality of severity among problems experienced by the fishpen and fishcage operators. The results were significant (Chi-squared with ties=1263.342, Df=27, P=0.0001) indicating that there is a significant difference in the severity of problems. A post-hoc treatment Wilcoxon-Mann-Whitney test using Bonferroni-corrected alpha level was further performed to specify which problems differ in severity at the 0.05 (Bonferroni-adjusted=0.0001) significance level. The results of the tests are summarized in this table.

Based on the data in Table 19, results further indicate that all the rest of the problems under the various classifications were considered by most operators in Laguna de Bay as at least lightly serious. Many of the problems, particularly those classified as technical, economic, social, institutional, and other problems were

considered by most respondents as moderately serious. Moreover, it is noted that few respondents considered any of the problems as not a problem while a substantial number of respondents had no opinion.

In summary, the analysis show that environment-related problems in Laguna de Bay are the ones considered by fishpen and fishcage operators as the most severe among those they are facing in terms of their aquaculture operations. Other issues they consider as most severe are poaching, lack of overall government support, and lack of access to low-interest capital. It is important to remember that some of these problems considered as very serious are also activities that are partly or fully caused by fishpen and fishcage culture.

CONCLUSION AND RECOMMENDATIONS

The analysis in this paper shows that, indeed, fishpen and fishcage culture in Laguna de Bay has important economic and social contributions to the neighboring lake municipalities and to the country. Because of these, great caution must be exercised before any decision related to its reduction or termination can be made.

The analysis further indicates that while fishpen and fishcage culture is economically and socially important, it is facing numerous problems foremost of which are environmental problems, the social problem of poaching, the institutional problem of lack of overall government support, and the economic problem of lack of access to cheap capital. These problems, therefore, have to be prioritized and addressed if the practice of fishpen and fishcage culture in the lake is to continue. Along this line, the following courses of action, most of which have already been put forward by some sectors involved in fishpen and fishcage culture in Laguna de Bay, are strongly supported for a more rational management of the activity:

Illegal structures in Laguna de Bay should be immediately dismantled. The total area of 10,000 ha allotted for fishpens, in particular, has already been exceeded even counting registered fishpens alone. Dismantling will help reduce overcrowding and improve the social and environmental conditions in the lake. To reduce the potential short-term social conflicts arising from the dismantling, all affected sectors must be made party to the decision. Those to be dismantled must be well-informed in advance of the specific actions related to the demolition as well as financially fairly compensated.

The optimal area for fishpen and fishcage culture in Laguna de Bay should be determined once and for all as some sectors argue that the present allotment of 15,000 ha is too large. There are also concerns that the allotment is beyond the specified 10 percent of the suitable water surface area of all lakes and rivers mentioned in the Philippine Fisheries Code of 1998. This effort, which will determine a more environmentally sustainable level of aquaculture in the lake, should

involve all stakeholders for a scientifically, socially, and politically valid and acceptable result.

Both national and local governments should develop alternative livelihood programs for the municipal fishermen in Laguna de Bay. Among others, uplifting their economic status will lessen the conflict between them and the fishpen and fishcage operators on such issues as poaching.

Since lack of access to low-interest capital has been found to be a major problem in aquaculture in Laguna de Bay, it must be addressed in some way. A credit program to promote increased participation of qualified poor households in fishcage culture, either individually or as a cooperative, must be contemplated. This program will help disperse the benefits of aquaculture development and make it an effective vehicle for poverty alleviation.

Research agencies should fund and conduct more research on environmental problems in Laguna de Bay. As environmental problems may be considered relatively more severe than other problems in the lake, emphasis on them will serve the interests of the numerous stakeholders who depend on an environmentally sustainable lake for their livelihood and needs.

A clean-up of Laguna de Bay of decaying bamboos, anahaw, poles, and other materials should be done. This may be conducted by the operators within and around their fishpens and fishcages while the government can undertake clean-up in the open areas.

The government can also achieve much by simply strengthening the monitoring and enforcement functions of its relevant institutions in Laguna de Bay. Failure in this respect has been blamed as a major cause of the proliferation of various social, environmental, and other related problems.

Despite financial and other constraints, the government can attain a lot by streamlining the operations of its pertinent agencies involved in Laguna de Bay. Streamlining will help decrease waste, promote efficiency, and increase the overall level of support that it can provide to the various economic sectors and stakeholders in the lake including the fishpen and fishcage operators.

Finally, a comprehensive study must be conducted to determine the full costs and benefits of fishpen and fishcage culture in Laguna de Bay, including financial, economic, social, political, environmental, institutional, and other relevant costs and benefits, relative to its other uses and development or conservation options. This study should be a multisectoral effort participated in by scientists, various other sectors and stakeholders of the lake. Once completed, this study will be a scientifically and politically acceptable basis for deciding once and for all whether or not fishpen and fishcage culture in the lake will be continued, reduced, or dismantled.

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