OWNERSHIP OF FISHING AREAS AND USE OF FISHING RESOURCES BY ARTISANAL FISHERMEN IN A POND IN SOUTHERN BRAZIL[1]

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ABSTRACT: The Mangueira Lagoon located in southern Brazil, has its northern portion included in the Taim Ecological Station, a federal conservation unit. The fishing practice is among the activities at this region. It has its own characteristics due to environmental conditions and specific physiography of the area. A field protocol based on geographic information was used to characterize the occupation process and the use of fishing resources. Socio-economic information was collected through interviews of the fishermen and also based on fishing data. After compiling the data a statistical descriptive analyses was completed. The average catch per fisherman in the region is 4,766.5 kg per year. The *Loricariichthys anus* showed the highest catch volume, ensuring the economic viability of the local activity. The constant increase of the activity may be compromising the reproductive cycle of the local ichthyological fauna, thus compromising the fishery sustainability.

Keywords: Mangueira Lagoon, fishing effort, artisanal fishing.

APROPRIAÇÃO DE ÁREAS DE PESCA E UTILIZAÇÃO DOS RECURSOS PESQUEIROS POR PESCADORES ARTESANAIS EM UMA LAGOA NO SUL DO BRASIL

RESUMO: A Lagoa Mangueira localizada no sul do Brasil tem sua porção norte incluída na Estação Ecológica do Taim, unidade de conservação federal. Entre os usos dados a esta região, destaca-se a pesca artesanal, que apresenta caracteristicas próprias devido as condições ambientais e fisiográficas da região. Com objetivo de caracterizar o processo de ocupação e uso dos recursos pesqueiros, foi usado um protocolo de campo e de informação geográfica. Dados de pesca foram coletados e entrevistas foram aplicadas para obter informações sócio-econômicas, que foram tabulados e submetidos à análise estatística descritiva. A captura média por pescador na região é de 4.766,5 kg/ano, sendo a viola *Loricariichthys anus* a espécie com maior volume de captura, garantindo a viabilidade econômica da pesca local. O aumento contínuo do esforço de pesca pode estar comprometendo o ciclo reprodutivo da fauna ictiológica local, comprometendo a sustentabilidade da pesca.

Palavras-chave: Lagoa Mangueira, esforço de pesca, pesca artesanal.

INTRODUCTION

Rio Grande do Sul holds 622 km of coastline and several rivers, lakes, dams, coastal lagoons, and estuaries (Garcez and Sánchez-Botero, 2005). Many of these environments are base for communities that develop economic activities such as fishing. This activity is an important source of food, jobs, and income to more than 970,000 families dedicated to the activity that represents about 45% of the fish production in Brazil (Brasil, 2011a). The rates of fish consumption in Brazil reach 9 kg per capita per year (Brasil, 2011b), lower than the recommended by the World Health Organization (WHO), which is 12 kg per capita (FAO, 2010). The kind of fishing developed in the lagoons of southern Brazil, including the Mangueira Lagoon, is predominantly artisanal and characterized by low predation and also low employment opportunities for family and others around that neighborhood (Cardoso, 2001). Although the activity is artisanal there are signs of overfishing, reduction of stocks, and loss of the cultural identity of fishery communities as a result of mismanagement of the natural resources (Kalikoski *et al*., 2002). Porcher *et al.* (2010) recommend the use of traditional and ecological knowledge of fishery communities to develop management strategies to preserve the natural resources on which these populations depend.

This information is fundamental to understand the behavior of fishery populations. The traditional ecological knowledge is beyond the knowledge of fishing itself. The fishermen know the local clime, ecology, biology, have their own technology and trade techniques. This local knowledge and practices are unknown by the academia or consultants, therefore they are an important resource of information to develop management strategies (Berkes *et al*., 2006).

Given the significant importance of artisanal fishing, the objective of this study was to characterize the process of ownership of fishing areas and the use of fishing resources by artisanal fishermen in Mangueira Lagoon.

MATERIALS AND METHODS

The study was conducted from March 2010 to December 2011. Monthly field trips were part of the project to identify fishery communities located on the banks of Mangueira Lagoon (Figure 1). The lagoon is located in the eastern portion of southern Brazil (33° 4′ 5″S and 52° 44′ 5″ W), and it has area of approximately 950 km^2 of water blade. Mangueira Lagoon is part of a complex lacustrine system of coastal plain of Rio Grande do Sul state, with extensive wetlands, modeled by the process of marine regression in the Holocene period (Saito and Steinke, 2010), belonging to the lagoon system known as Patos-Mirim.

Semi-structured interviews were applied to identify the number of fishermen, number of vessels fishing and characteristics of the fishing equipment used. The technique used to structure the interviews is known as a chain of informants, where a respondent indicates another community member (Pieve *et al*., 2009). In parallel to the interviews, the places where fishing communities are established were identified geographically by the Global Positioning System (GPS). The data tabulated and submitted to descriptive statistics were provided by fishermen, through their daily records, from 2005 to 2011.

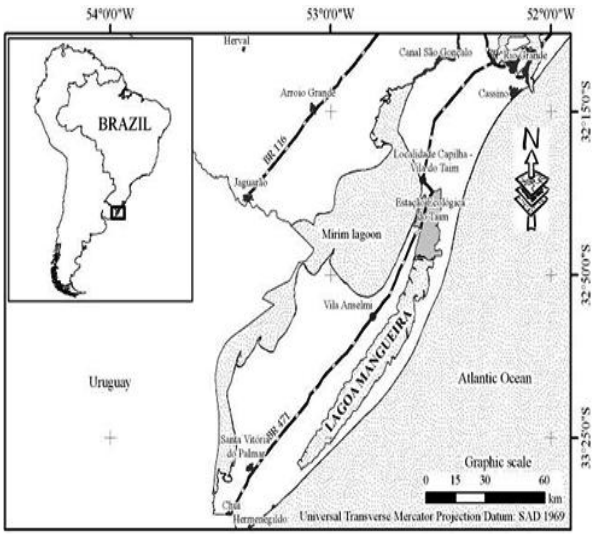

Figure 1. Location map of Mangueira Lagoon, southern Brazil.

The fishing effort, number of hours fished per vessel (FAO, 2000), was calculated based on samples collected in September and October 2010 and in February, March, and April 2011, and 18 day-recorded in three different vessels in the lagoon. A GPS Garmin eTrex Vista® unit was used to record the fishing time (hours), date and speed when the samples were collected. Data were organized in digital spreadsheets for later descriptive statistics. The financial value of each species was calculated

as the average of fish caught a day (kg) multiplied by its market value (US$).

RESULTS AND DISCUSSIONS

Historical Characterization

The process of occupation at the Mangueira Lagoon started in the 1960s, when communities living at the proximities of the Taim Ecological Station, arrived at this new fishing area. The first group came from São Lourenço do Sul to Capilha Place at the proximities of the Lagoon.

They would reach Mangueira Lagoon from the Mirim Lagoon through a connecting channel, where nowadays there is a system of gates to control the level of Taim Marshland along the BR-471. The system built in the 1970s, eliminated the navigable route between the lakes. Then, the transportation of boats to the Mangueira Lagoon was possible with the help of an animal-pulled wagon.

The access to new fishing areas occurred through informal commitments between fishermen and land owners that would authorize the fishermen to cross their lands Thus, the fishermen started to take responsibility for the access of other fishermen and buyers. It is the way it happens nowadays.

Fishermen are spread on the west bunks of the lagoon into 7 cores (Figure 2) commonly known as the access site from the BR-471, or alluding to the surname of the landowners of that place, or even the surname of their own local fishing families.

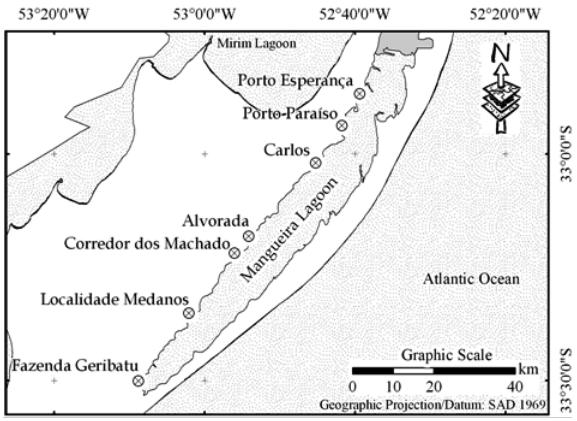

Figure 2. Location map of fishermen cores in Mangueira Lagoon. Fazenda Geribatu; Localidade Medanos; Corredor dos Machado; Alvorada; Carlos, Porto Paraiso; and Porto Esperança.

The number of fishermen cores is the same since the late 1980s, occurring only variation in the number of fishermen in each locality. The first core (Corredor dos Machado) is the largest with a total of 12 villas. After the establishment of this first group children of fishermen when making a family seeks for independence. Creating new cores, such as the nuclei Fazenda Geribatu, Medanos, where currently are established the Machado's family members.

Among the groups of fishermen there is a dynamic of fishing territoriality, which informally is exercised primarily in the southern half of the lagoon, between the nuclei Fazenda Geribatu, Medanos and Corredor dos Machado, due to the high degree of relatedness. Most of the helpers (bowmen), also have some a family relationship.

Eighty-one fishermen were identified operating in 35 vessels. The interviews were conducted with 29 male during the year 2010, representing 35.8% of the fishermen. The average age ranged from 18 to 80 years old, averaging 42 years old. The bowmen are generally younger people working on local fisheries, aged between 18 and 25 years old, being attributed this peculiarity to the fact that they are considered apprentices with the task of helping the more experienced and may or may not become professional fishermen.

The displacement of fishermen from São Lourenço do Sul to Capilha Place and from this to Mangueira Lagoon between 1960 and 1970 is characteristic of artisanal fishermen. It occurs during periods of crop frustration in search of fishing areas with better survival conditions (Allison and Ellis, 2000). Throughout this period the Brazilian fishing had decreased catch, with industrial parks operating at idle (Giulietti and Assumpção, 1995; Kalikoski *et al*., 2002). Thus, the fishermen of the region stimulated by public policies to encourage fishing and traders who sought higher production volumes, start acting in Mangueira Lagoon, especially at a time of hogher occurrence of *H. malabaricus*, between September and February, lives in improvised way at the margins of the lagoon during this period.

The process of occupation and ownership of natural resources found in the Mangueira Lagoon is similar to those regarding the origin of the population and the way of establishment of communities, who are descendants of Portuguese immigrants, indigenous, or slaves, forming groups and settling in the coastal region of Brazil in areas of salt marshes, lagoons, estuaries and areas of Atlantic Forest (Diegues, 2001). In this case, they are descendants of immigrants established in

the neighboring municipality, which become a fisherman as professional alternative.

Substantial volumes captured in Mangueira Lagoon motivated the definitive establishment of the first group of residents with substandard housing, which occurred in the early 1970s, with the Machado's family, locals even today. From the year 1980, the artisanal fishing starts to receive financial resources from National Program for Strengthening Family Agriculture (Programa Nacional de Fortalecimento da Agricultura Familiar - PRONAF, RS) and marketing warranties from the fish industry, resulting in the formation of the first housing project in the location of "Pastoreio" also known as "Corredor dos Machado," alluding to the Machado's family fishermen. A similar process of formation of the fishing nuclei of Mangueira Lagoon (Silva, 2011), where the establishment of a family is followed by the aggregation of other members, motivated by parental order, wedding or related economic activities or even causing separation of the members from nuclei.

This process of appropriation of space and natural resources of common use (Cunha, 2012), where communities are formed in areas on the margins of lagoon, is unsuitable for agricultural use. Consequently, it differs from other processes of occupation is the issue of co-responsibility imposed on fishermen, considering the fishermen in Mangueira Lagoon, as custodians of the area they serve. This process not only as enclosed spaces, but known sites, named, defined and used, where the fishermen have great familiarity, so as to make this territory embedded in their tradition (Cardoso, 2001). These areas are respected by other fishermen and transmitted through generations, where only people with a high degree of relatedness will be allowed to make use of them.

The number of fishermen identified was higher than the indicated existence of 36 fishermen working on the Mangueira Lagoon in 2009 (Ibama, 2010). This difference may be attributed to the fact that not all fishermen have professional registration. Many of them temporarily perform the fishery activity, making it difficult to carry out an accurate statistical for fishing by public agencies and the creation of public policies for the sector. The average age of fishermen in Mangueira Lagoon is similar to the age of fishermen of the Patos Lagoon (Moura and Diegues, 2009).

Art of Fishing

The vessels used are mostly open deck made of wood, with size between 6 and 10 meters long, equipped with engines from 15 to 40 HP, considered small to medium size. They also use boats called "ratoneiros," or even, "caique", small-sized no engine, with a maximum of 4 meters length powered by oars, used for fishing on the lagoon margins, in the areas of swamp, always close of fish landing ports.

The predominant fishing gear used is the gill net with mesh sizes ranging between 30 and 70 mm between opposite knots, with height of up to 3.0 meters, which are the most efficient in the capture of species of interest. To increase the capture of the Viola *(Loricariichthys anus*), which has benthic habit (Albrecht and Silveira, 2001), the floating buoys in the net are almost completely removed, making it remain in the bottom, facilitating the capture of *L. anus*. The adaptation of nets to capture the *L. anus*, due to the knowledge of habits of the species by fisherman, being described in the literature as traditional ecological knowledge, evolving by adaptive processes and passed on through generations by cultural transmission, which concerns the relationship of living beings among themselves with their environment (Berkes, 1999; Berkes *et al*., 2006).

The employment status of the bowman is through informal employment, with payment of 20% of the total catch plus the cost of housing and food. In most cases, the fishermen's families do not reside in the nuclei because living in the nearby municipalities (São Lourenço do Sul, Santa Vitória do Palmar and Rio Grande) provide better study conditions for their children, improved access to health, among other factors. Consequently, even during fishing season, the fishermen move occasionally to visit their family.

The fishermen are still active in the lagoon between February and October when fishing is permitted. While in the closed season (November-January) when fishing is prohibited, they return to the cities where their families reside.

The fish caught each day is packed in ice thermal deposits. The officer or owner of the deposit receive the fish from other fishermen and issue a receipt in the product value. Periodically, once or twice a week, buyers go to the location to pick the fish. In 2010 the fishermen's association of Anselmi Place (Associação dos Pescadores da Vila Alselmi - APEVA), located in the margins of BR 471 in the

town of Anselmi Place, in the municipality of Santa Vitória do Palmar, begins to receive the production of a small number of fishermen. However, most fishermen continue selling their fish to private buyers,and report the difficulty of transporting fish to the cooperative, or even the existence of oral contracts that have signed the partnership between fisherman and the buyer agent.

A total of eight species are captured. The most important commercially species are: *L. anus*, Trahira [*Hoplias malabaricus* (Bloch, 1794)], Pejerrey (*Odontesthes* spp.) and South American Catfish [*Rhamdia* aff. *quelen* (Quoy and Gaimard, 1824)]. The Pearl cichlid [*Geophagus brasiliensis* (Quoy and Gaimard, 1824)], Joana [*Crenicichla punctata* (Hensel, 1870)], Cascudo [*Hypostomus commersoni* (Valenciennes, 1836)] and Tambica [*Oligosarcus robustus* (Menezes, 1969)], accidently captured, are not of fishermen's interest, being mostly discharged due to lack of market or consumed by the fishermen.

Regarding the models of vessels used by fishermen in Mangueira Lagoon, they are similar to those described by Pieve *et al*. (2009).

The minimum mesh size used by fishermen is lower than that determined by the Normative Instruction N°. 2 of 02.09.2004 (Brasil, 2004), which regulates fishing in the region, with a minimum mesh size of 40 mm between opposite knots. Fishing communities front decline in stocks, start to use greater number of nets, improve their fishing equipment and decrease the mesh size, i.e. enhance the fishing effort to maintain the economic viability of the activity (Silvano and Begossi, 2001).

The hiring process is similar to that described by Pieve *et al*. (2009), when referring to the artisanal fishermen of Mirim Lagoon. Fishing performed in Mangueira Lagoon is different from that used by the fishermen of Mirim Lagoon, who mostly stay aboard for a period, camped on the lagoon margins, usually up to five days, or until capturing the amount desired (Garcez and Sánchez-Botero, 2005). The daily period dedicated to fishing is the result of the difference between the lengths of fishing areas, and also the distance of these areas (Pieve *et al*., 2009; Peixer and Petrere Junior, 2009)

Indices of Capture and Income

An increase of rates of capture was verified from 2006 (Figure 3), where records show that each fisherman caught on average of 1,035.7 kilograms of fish per year, reaching a volume of 5,335.8 kilograms of fish captured in 2009, the most recently in 2011, this average decreased to 4,766.5 kg per fisherman per year.

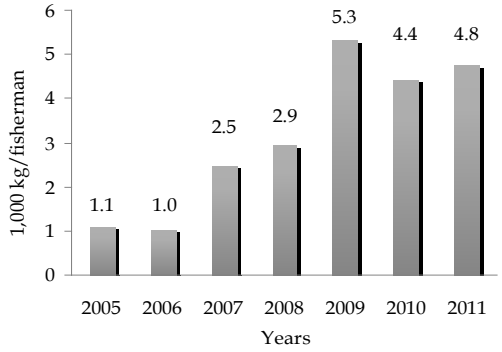

Figure 3. Total average annual cath per fisherman in Mangueira Lagoon.

Although there is an inter-annual variation in total volumes of the main species (Figure 4), currently the *L. anus* is the most representative species for fishing in the Mangueira Lagoon, with 52.2% of the total catch in 2011, and 72.5% of the total catch in 2010.

Fishermen works on average 13 days per month, varying throughout the year mainly due to adverse weather conditions, periods of performing maintenance on their vessels and their fishing equipment, periods of illness. During the winter, the average fishing days reaches only 8 days, while in spring-summer months this average reaches 20 fishing days within a month.

Each vessel catches on average 65.2 kg per day: 42.5 kg of *L. anus*, 11.1 kg of *H. malabaricus*, 8.6 kg of *H. quelen* and 3 kg of *Odontesthes* spp. The value received by fishermen per kilogram of fish was US$ 1.50 for *H. malabaricus*, US$ 1.25 for *L. anus*, US$ 0.60 for *R. quelen*, and US$ 1.00 for *Odontesthes* spp. The amount paid per fish kilogram fluctuates during the year according to the dynamics of the consumer market. The daily gain per vessel is US$ 77.93, and the daily expenditure on fuel is US$ 17.29. Considering the average of thirteen fishing days per month, the vessel's gross monthly income is US$ 1,013.15.

From 2006, *L. anus* becomes the most representative species for fishing in Mangueira Lagoon, overcoming *H. malabaricus*. Since the species was no longer captured in enough amounts to cover operating costs, fishermen sought an alternative that would provide maintenance of their economic gains, intensifying and diversifying the fishing, exploiting an available resource that was not previously used, *L. anus* (Figure 4). This challenge in the importance of the species caught is replacement of fishing for South American Silver

Croaker [*Plagioscion squamosissimus* (HECKEL, 1840)] for Nile Tilapia [*Oreochromis niloticus* (Linnaeus, 1878)] in Barra Bonita reservoir (SP) due to reduced stocks of South American Silver Croaker (NOVAES and CARVALHO, 2011). These data cannot be compared to capture data provided by IBAMA IBAMA, 2010), because it announces the capture of artisanal fishing developed in the entire region of hydrographic basin of Mirim Lagoon, since there are no official data exclusively on fishing in the Mangueira Lagoon.

Fishing in Mangueira Lagoon is performed daily, according to the weather conditions. The number of fishing hours per day varies from 3 to 9 hours with mean of 5.49 hours per day.

Fishermen works on average 13 days per month, varying throughout the year mainly due to climatic adverse condition.

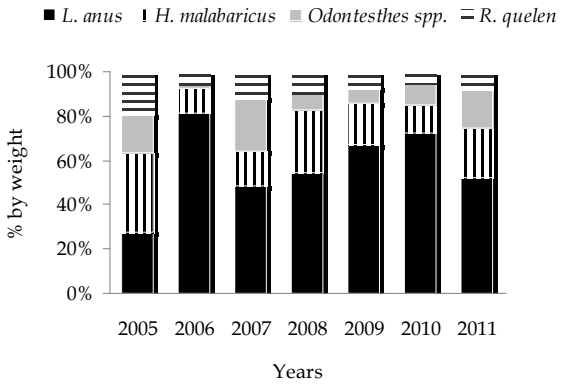

Figure 4. Variation in the total annual catch per species by fishermen in Mangueira Lagoon.

Regarding the captured volume, it is higher compared to the estimated in the Amazon that fisherman catch between 15 and 40 kg per day (MITLEWSKI *et al*., 1999). In Niterói (RJ) was estimated that 34.5 kg per day for artisanal fishermen (TUBINO *et al*., 2007) and 18.9 kg per day in the dam Billings (SP) (Silva *et al*., 2009).

The relationship between fishermen and buyers has several peculiarities referring to the form of fish marketing. Additionally, the buyer is often the supplier of fishing supplies such as: fishing equipment, parts for their boats and vehicles, cooking gas, fuel to the boat and food, but also finances the acquisition of these materials, which are paid with fish, which is deducted gradually (ALVES, 2006). Therefore, the fish buyer has important economic role for the activity of local artisanal fishing, enabling the necessary investments, in addition to market the production. This same relationship is also described for Mirim Lagoon (GARCEZ and SÁNCHEZ-BOTERO, 2005). The fisherman's monthly net income is approximately US$ 600.00. This income is similar to half to four times the minimum national wage, characteristic of artisanal fishing of the Rio Grande do Sul (GARCEZ and SÁNCHEZ-BOTERO, 2005). According to the law, all registered fishermen are entitled to closure-insurance (local minimum wage) received for three months of the year (November-January).

CONCLUSIONS

The occupation of Mangueira Lagoon by fishermen occurred from the beginning of the 1960s, according to the establishment processes of traditional populations, similar to other regions of Brazil, where groups with a high degree of relatedness transmit the traditional ecological knowledge through generations. The fishing is characterized by the use of gill nets with meshes from 30 to 70 mm between opposite knots, and *L. anus* the most important species, representing more than 50% of the total captured. The local fisherman's income is in accordance with what is reported elsewhere in Rio Grande do Sul State and in Brazil. Throughout the present study an increased volume captured was observed due to the continuing increase in fishing effort resulting from the use of greater number of smaller nets.

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