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Natural resource appropriation in cooperative artisanal fishing between fishermen and dolphins (*Tursiops truncatus*) in Laguna, Brazil

Débora Peterson [a,*], Natalia Hanazaki [a], Paulo César Simões-Lopes [b]

[a] Laboratório de Etnobotânica e Ecologia Humana, Universidade Federal de Santa Catarina, CCB/ECZ, Florianópolis, SC 88010-970, Brazil
[b] Laboratório de Mamíferos Aquáticos, Universidade Federal de Santa Catarina, CCB/ECZ, Florianópolis, SC 88010-970, Brazil

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ABSTRACT

Access control and exploitation restrictions are problems related to common property resources. In Laguna, Brazil, there is a communal property system where fishermen and dolphins (*Tursiops truncatus*) participate in cooperative fishing, taking advantage of the same prey, the mullet (*Mugil* spp.). Cooperative fishing is dependent upon institutions (rules, norms and regulations) adopted and obeyed by the fishermen themselves. This study aims to analyze the existence of implemented institutions in cooperative fishing, its implications on the management of local resources and possible consequences of external interferences. Through these institutions enforced by local fishermen, they can regulate, supervise and also exclude outsiders in almost all fishing areas.

1. Introduction

According to the Brazilian Constitution of 1988 (Chapter IV, article 225, paragraph 4), coastal zones and their natural resources are considered state property. However, in practice, different property rights regimes are found in such areas – open access, communal property, state property and private property [1]. Regardless of the regimes they are under, coastal resources such as fisheries are liable to severe depletion. This depends on location and degree of exploitation [1]. This risk is also due to the simultaneous occurrence of several manners these coastal areas are utilized, due to the concentration of economic practices such as (over)fishing, mariculture, agriculture, industrialization, leisure activities, as well as urban and tourism expansion.

The attributes of the resources, the characteristics of its users and the relationship between both community and resources affect the degree of difficulty in establishing access and exploitation restrictions [2]. These problems are closely related to property rights regimes. In communal property regimes, natural resources are managed by an identifiable community of interdependent members that regulate their own use of resources, while excluding the action of outsiders [3,4].

The durability of property rights regimes is associated with principles such as: (1) clear-cut boundaries between property rights regimes and the users entitled to exploit their resource units; (2) the congruence between appropriation and resource use norms, that is to say, the rules defining time, place and resource utilization, as well as the technology applied; and (3) the minimal recognition by users of such regimes of the right to organize themselves [5].

The ability of resource users to organize themselves without the external interference of governmental or private authorities is frequently found in communal property regimes. This is what typically occurs when users implement institutions to carry out their own local management practices [5,6]. The term "institutions" refers here to the set of rules, regulations and processes that are utilized by the members of a community for the management of its local resources [5]. According to Jentoft [7], institutions are as essential to fishing as the fish and the fishermen. Local fishermen often devise institutions to regulate access to fisheries and to define the fishing gear type that can be employed. Thus, they are more likely to comply with and enforce the rules made by themselves [5].

The access and control of fishing areas by local appropriators can be done either through formal or informal institutions. Formal institutions are more recent and originated from social mobilizations aiming at protecting resources and the local livelihood; they are supported by the legal system. Informal institutions, however, are older and consuetudinary in nature, that is, are governed by traditional informal rules that are enforced and complied by local users. They are based on *respeito* (respect) [8]. Examples of communal property regimes governed by the highly regarded *respeito* code of ethics, assuring sea tenure and regulation of access to fisheries and applying informal sanctions to whomever infringe these local institutions, can be found in the literature [9,10].

In Laguna, Santa Catarina state, southern Brazil, there is an artisanal fishermen community that carries out small-scale fishing. Post-Columbian settlement in Laguna region was intensified during the 16th century with the arrival of Azorian migrants. Fishing

* Corresponding author. Tel.: +55 48 37219460.
E-mail address: deborapeterson@yahoo.com.br (D. Peterson).

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activities increased during the 19th century with the decay of farming. Nowadays fishermen catch is for self-consumption, but part of it is sold at the local markets. Mullet is fished all year round, but more intensively from April to June [11], when schools migrate to their spawning grounds in the southern and southeastern Brazil [12]. Artisanal mullet fishing is a very important cultural event both in southern and southeastern Brazil, not only for its economic importance, but also for the social role it plays as it requires organized practices among local community members, thus strengthening their sense of belonging [8].

In Laguna, the mullet season is also eagerly awaited because of a particular event: the cooperative fishing that involves humans and dolphins (*Tursiops truncatus*). The artisanal fishermen and the dolphins are the principal actors of this fishing practice in which both species take advantage of the same prey [11,13,14]. According to Simões-Lopes [13], the behavior of dolphins and fishermen in cooperative fishing are distinctly ritualized. The fishermen can differentiate the movements of dolphins, recognizing the right moment to throw their nets. Dolphins, in turn, drive mullet schools towards the fishermen, who act as a dynamic barrier, unraveling the schools and spreading the fish, as the fishermen cast their nets [11]. Disoriented and isolated fishes are more easily captured by the dolphins [11]. This cooperation between humans and cetaceans was described in some regions in Brazil, Africa and Australia [11,13–19]. This unique interaction draws the curiosity of people external to the Laguna fishermen community, such as tourists and occasional fishermen.

This study was based on the assumption that cooperative fishing in Laguna is related to institutions that regulate the utilization of resources (fish and dolphins) by the local artisanal fishermen. These institutions shape the ways community members gain access to the fisheries and fishing quotas, sometimes involving informal sanctions. The implementation of institutions for fishing with dolphins – probably based on history and tradition – can contribute to the regulation and conservation of local natural resources.

The objective of this study is to analyze the existence of institutions implemented by the artisanal fishermen of Laguna that are involved in cooperative fishing with dolphins. In addition to studying the institutions governing cooperative fishing, the impact of this activity on the management of local resources and the possible consequences of external interference are also studied. Local users, the natural resources involved and the fishing gear utilized are characterized here. Then, we describe in detail the institutions, showing how the use of space and resources in cooperative fishing is regulated in Laguna. We also make comments on conflicts involving local and occasional fishermen. In the end, we discuss the factors that jeopardize the stability of institutions, comparing the cases in question to the ones found in the literature, and the possibility of failure of the current resource management system adopted in cooperative fishing.

2. Characterization of the study area

The study area is located in Laguna, Santa Catarina state, in southern Brazil. The municipality of Laguna has approximately 49,000 inhabitants [20], distributed in urban and rural areas. The region's most important economic activity is fishing, which employs several techniques. Cattle rearing, tourism and commerce are also important. Approximately 4000 members comprise the local fishermen organization, but not all of them fish with dolphins.

The region's complex system of lagoons and estuaries covers approximately 225 km^2. It is basically comprised by the Mirim, Imaruí and Santo Antônio Lagoons. The Tubarão River and a channel constitute the mouth of this system that flows into the Atlantic Ocean. The Santo Antônio Lagoon, the Tubarão River delta and the channel comprise the southern area. This is where cooperative fishing takes place [11]. Eight fishing spots are located alongside the 1.6-km long and 200-m wide channel, where small slanting beaches can be found [11] (Fig. 1).

The majority of cooperative fishing spots are located in urban areas. Many fishermen live near the channel and carry out this activity close to their homes. Due to their proximity to tourism areas, some spots are greatly disrupted by outsiders, mainly during the mullet season and in summer.

3. Methodology

The data collection took place from January to May, 2005, in three stages: (1) identification of potential informants (interviewees) in the fishing spots; (2) initial contact with the fishermen; and (3) the interviews. The main fishing spots where interactions between men and dolphins occur, as described by Simões-Lopes et al. [11], were

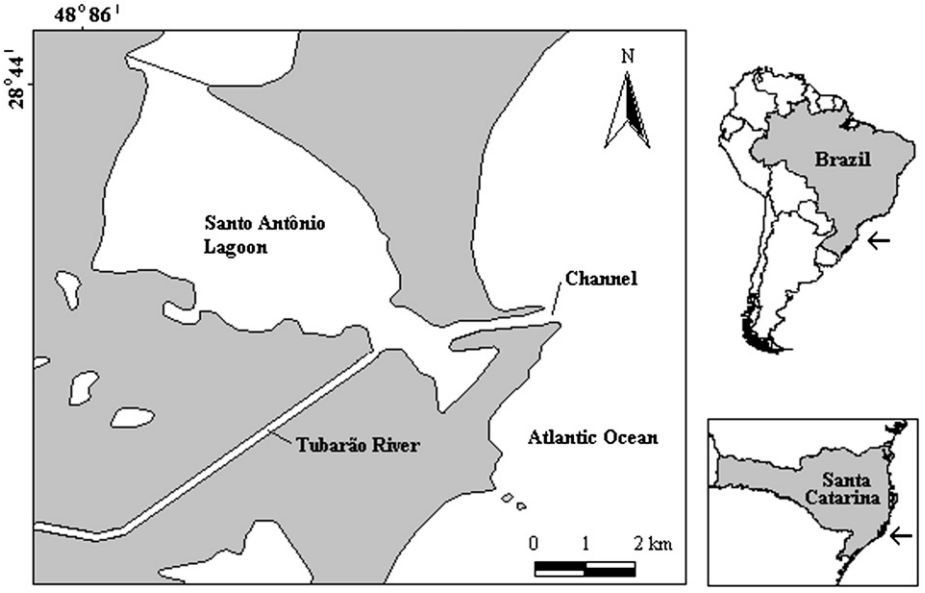

Fig. 1. The study region, Laguna, Santa Catarina, Brazil. Black dots indicate the 14 fishing spots cited in the text.

used for identifying the informants. For obtaining the fishermen sample the snowball methodology was utilized [21]. This methodology assumes that the researcher identifies one or more individuals that could be interviewed according to previously set criteria for the study. At the end of each interview, the interviewees are asked to recommend other potential fishermen with similar background.

All informants met the previously established criteria, namely: (1) to be an artisanal fisherman; (2) to be professionally active, that is, not retired; (3) to have fishing as his primary economic activity; and (4) to perform cooperative fishing with dolphins. In an initial contact, the objectives of this work were clarified to the informants who were then asked if they agreed to be interviewed. The advantage of this prior contact is trust-building. Thus, the fishermen usually feel more comfortable during the interview, allowing casual conversation to take place in parallel. This conversation provides a rich pool of qualitative information. All potential interviewees – all of them men, since it is an exclusively male activity – agreed to participate. The interview was then scheduled according to the preference and availability of each fisherman. Interviews were conducted after work, at the informant's home, or in local bars, squares, streets and, when possible, at the fishing spots. In order to avoid possible interference from other informants, all fishermen were individually interviewed.

The interviews were conducted based on a questionnaire of 34 semi-structured and unstructured questions previously tested and adjusted through pilot interviews at the same community. The questions were broken down into four categories: (1) *social economic aspects*, with questions about age, address (neighborhood), source of income and fishing background; (2) *cooperative fishing dynamics*, inquiring about the time the individual practices cooperative fishing, importance of the dolphin in artisanal fishing, adequate climatic conditions for fishermen–dolphins interaction and local institutions in cooperative fishing; (3) *ecology of dolphins*, with questions focusing on trophic interactions, resident population size and reproductive behavior; and (4) *environmental conflicts*, with questions concerning possible interference of other types of fishing practices, tourism and pollution.

In this paper we focus on cooperative fishing dynamics, particularly on the local institutions involved in this practice, and on the conflicts that could interfere with it. For complementing the data collection, three retired fishermen who used to participate in cooperative fishing in previous decades were also interviewed. These fishermen were identified with the aid of the snowball methodology and interviewed through unstructured questions, where historical aspects about cooperative fishing were approached. In addition to these interviews, we used the participation observation technique, which anticipates that the researcher should pay attention to the important events that occur in the field [21].

The analyses of the information provided by the interviewees resulted in a detailed description of the current resource management system used in cooperative fishing governed by local institutions.

4. Characteristics of cooperative fishing

4.1. The fishermen

The interviewees ($n = 51$) were between 13 and 75 years old. Among those, 86% were from Laguna and 14% were born in other localities, but have been living in that municipality for 8–48 years. These fishermen earn their living primarily from artisanal fishing, but, in order to complement their income, most of them work or have worked in other jobs, such as painting, construction work, industrial fishing, among others. Only two of the interviewees stated that cooperative fishing was their only source of income.

The fishermen informed that they learned how to fish when they were between 6 and 47 years old. The profession was usually taught by close relatives, such as fathers, brothers, uncles, cousins, or in-laws. They were also trained by older and more experienced fishermen (not necessarily relatives). Some interviewees reported that they learned how to fish by themselves, just by observing other professionals. Most interviewees, however, answered that their fishing skills were handed down from their fathers.

4.2. The dolphins

The dolphins (*T. truncatus*) in question are part of a resident population of approximately 51 individuals. About 20 of them are involved in cooperative fishing [11]. The fishermen of Laguna classify these animals according to their interaction in cooperative fishing. Those that participate are called *botos bons* (''good dolphins''), whereas the animals that do not participate are called *botos ruins* (''bad dolphins'') [14]. ''Good dolphins'' are further classified according to their fishing movements. Some dolphins perform circular movements around the schools, rounding up the fish; they play an active role in Tubarão River interactions, although they can also be seen interacting in other fishing spots. Other ''good dolphins'', on the other hand, drive the schools towards the fishermen barrier by performing oblique, parallel and perpendicular movements. Cooperative fishing has been kept in that particular dolphin population through cultural transmission from female to calf. Females that interact with the fishermen teach the typical cooperative fishing movements to the calves that follow them during the event [11].

4.3. The fish

In Laguna, mullet (*Mugil* spp.) is the main prey species found in cooperative fishing [11]. During autumn and winter (April–August) in southern Brazil, mullets migrate northwards from Patos Lagoon [12]. That is when some schools enter the Laguna channel, attracting many fishermen to this place. Mullet season has become an extremely important cultural event there [13]. It is a unique opportunity for the artisanal fishermen to get some extra cash; it also encourages them to socialize by sharing several tasks [8].

The high intensity of interactions during mullet season is directly associated with the importance of this fish to the diet of the dolphin [11]. The mullet is the fish of choice of fishermen communities [22].

4.4. The fishing gear

In cooperative fishing, the gear employed by artisanal fishermen is called *tarrafa de argola* in Portuguese, a cast net of the falling type. This appliance is a circular nylon net with lead weights attached to its perimeter. It is circular when totally deployed and cone-shaped when closed. The principle underlying this fishing technique consists of casting the net upon the water surface and in catching the fish as it falls and closes upon them [23]. The casting operation requires considerable knowledge and skill. It can be performed either from the shore or from a boat, both inland and shallow marine waters [23]. As the *tarrafa de argola* is pulled by the fisherman, a ring slides on the thick nylon cord that structures the net, which then takes the shaped of a large ''bag'', holding the fish inside, but not necessarily gillnetted. This type of cast net is found in Laguna with the following perimeter dimensions: 17 and 27 fathoms (one fathom officially measures 1.83 m, however, the fishermen's traditional fathom is the span of their outstretched arms). The mesh size ranges from 5.5 to 7.0 cm.

Fishermen started using the *tarrafa de argola* in Laguna back in the 1960s and 1970s. Today, all those involved in cooperative fishing have this type of falling gear. Older fishermen used a different type of cast net named *tarrafa de rufo*. Those nets were made out of natural fibers, much less resistant than nylon, such as the *tucum* plant (*Bactris* sp.) or animal fibers [24]. In addition to being smaller, its structure was simpler than that of the present cast net type. In the old days, the fish were gillnetted, entangled or enmeshed in those nets.

According to the fishermen, the advent of the *tarrafa de argola* has greatly enhanced the efficiency of cooperative fishing, because it catches more fish per cast. An additional benefit is that nets do not require frequent mending, as they are now made of a much more durable material.

5. Informal institutions in cooperative fishing

An important aspect of institutions that regulate the cooperative fishing practised in Laguna is associated with the notion of *vaga*. The word *vaga* means "slot" or "vacancy" and, in this particular case, can be defined as the time and place assigned to a given fisherman for him to use the resource (fish and dolphins) in cooperative fishing. In other words, *vaga* is spatially and, in some cases, chronologically limited. Each fishing spot has several – but a limited – number of *vagas*.

The informal rules for *vaga* assignment basically differ according to the location of the fishing spot and the use of boats. These norms regulate variables such as the time an individual stays at the *vaga*, fish quotas, fish shares, period during which each fisherman has the right to fish and, in some cases, the right moment for the nets to be cast, as well as the maximum number of *vagas* according to the area of the fishing spots.

Local rules define the cooperative fishing spots where boats are allowed (Table 1). Group 1 shows fishing spots where fishermen can use boats freely. Most boats employed in cooperative fishing are dugout canoes and punts that use no motor. Boats of other materials can also be found. In interactions that occur along the Tubarão River, motorboats are also common. An area is delimited and a maximum number of anchored boats are permitted at these fishing spots. The objective of this norm is to prevent fishermen on board crafts from disrupting the success of those on foot, since the former have the advantage of gaining access to bigger portions of the schools, of storing the fish caught inside the boats, and of making less effort to catch the fish, because they can cast their nets from above the water surface level.

Group 2 shows fishing spots where all fishermen use boats. Boats are needed in this case due to greater water depths and no institutions apply here. However, there is a norm that defines the way boats are organized. They are typically moored in a bow-stern alignment. In Tubarão River, however, there is a different and more dynamic organization, where the fishermen utilize a shift rotation system.

Group 3 shows fishing spots exclusive for fishermen on foot. Fishermen can cast their nets from inside the water, at knee- or waist-high depths, aligned side by side. These men are not allowed to stand in the way of their colleagues. In some cases they stand outside the water, on specific rocks.

Four different institutions for fishing with dolphins were found in Laguna: (1) fishermen on board (except for Tubarão River); (2) fishermen on foot (except for North Jetties); (3) fishing in Tubarão River; and (4) fishing at the North Jetties.

5.1. Fishermen on board

When established in a *vaga*, a fisherman who is on board is entitled to staying in that very same slot for as long as he wants, regardless of his catch. This is due to the fact that boats operating in these spots are not subject to fishing quotas. To access a slot, especially during mullet season, some fishermen arrive first thing in the morning, often times before daybreak. Some hold their position during several days by sleeping on the moored boats. Fig. 2 shows the alignment of moored boats. Fishermen are only allowed to leave their slots for short periods of time, otherwise they will be taken by someone else. However, in some spots, a variation of these local rules may occur. Closer to their homes, "*Ponta de Pedras*" for example, taken slots are signaled by the moored boats, even if the fishermen are not on board, but out, having their meals or sleeping.

In Tubarão River, in addition to the above rules, the shift rotation system is the institution of choice.

5.2. Fishermen on foot

Fishermen on foot align themselves parallel to the beach or, depending on the characteristics of the fishing spot, upon the rocks (see Fig. 3). Slots are taken in order of arrival.

When a fisherman catches two mullets (of any size) he has to leave the slot, which is then taken by the next person waiting in line. The candidate to a given slot waits for his turn immediately behind the one at work, or, often times, leaves his gear on the beach or rock to signal that he is the next person in line.

At *Ponta do Aterro*, however, the rules are slightly different: here, what counts is the size of the fish caught. The person who gets a fish big enough to feed his family that day has to yield the slot to the next one. Even if two small fish are caught, he can keep on fishing in the same slot.

5.3. Tubarão River

Cooperative fishing in Tubarão River – carried out by a small group of people on board – is characterized by a stricter access

Table 1
Boat use in cooperative fishing spots, Laguna, Brazil

Groups	Fishing spots	Situation
1	*Areia*, *Balsa*, *Ponta do Aterro*, *Ponta do Guia*, *Toca-da-bruxa*	Fishermen on board, fishermen on foot
2	*Areal*, *Arrebentão*, *Cabeçuda*, *Iate Clube*, *Ponta das Pedras*, Tubarão River	Fishermen on board
3	North Jetties, *Quarto Espigão*, *Praia da Tesoura*	Fishermen on foot

Fig. 2. Fishermen at work waiting for dolphins on board. Photo by D. Peterson.

Fig. 3. Fishermen at work on foot. Photo by D. Peterson.

control. This activity takes place upstream, further from the river mouth, a difficult area to access. There, fishermen organize themselves in groups of three or, sometimes, five boats, and establish a very neat shift rotation system (see Fig. 4). The fishermen ride their boats upstream very early in the morning and take their slots in order of arrival. The first three fishermen to do so adopt the bow-stern alignment scheme and wait for the dolphins. Latecomers wait in line.

When the dolphin comes, the boat in the middle has the right of way to cast the net. The second one, which is downstream, is next, followed by the one upstream. Sometimes all three boats follow the dolphins as they chase the schools usually performing circular movements. Once all boats cast their nets, the one upstream leaves the formation and the slot is taken by the next boat in line. Through this rotation system, each fisherman has the opportunity to cast his net three times. Sometimes, two such formations are found fishing simultaneously, interacting with a different dolphin.

We were told that these norms have changed throughout time. In the past, just married men were entitled to fish in Tubarão River, a privilege granted to those who had to support their families.

5.4. Fishing on the jetties

Cooperative fishing also occurs in the North Jetties of the Laguna channel, but it is not the fishermen's place of choice because dolphins hardly ever stay there. Despite the rare presence of these cetaceans in this spot, fishermen cast their nets in the hope of catching some fish. The strategy used here involves a tight group of fishermen. In addition to other benefits, this way of organizing themselves also prevents the disruption caused by outsiders. Something similar is found in Tubarão River, as seen before. In the jetties, when dolphins are not around, four fishermen stand on four different rocks known by specific names. The first fisherman to cast his net will be the one positioned most favorably on a prominent rock. His net is cast as soon as a fifth fisherman announces the approach of mullets from a vantage point. Then, all other men cast their nets as the school spreads (see Fig. 5).

However, when dolphins appear, the fishermen who were standing on those specific rocks are free to choose the right time and place to cast their nets, following the animal's ritualized movements.

5.5. Partnership and conflict

Local fishermen sometimes establish partnerships among themselves. Partnership, in this specific case is defined as the association with other(s) to fish, and in which results of this activity are shared. In *Praia da Tesoura*, such partnerships usually involve two fishermen. While one is interacting with the dolphins in a slot, his partner is selling the catch nearby. After some time, they may switch positions. At the end of the day, they share results (fish and/or cash). This partnership may result from a prior arrangement or made at the spot, shortly before fishing. One fisherman reported having had the same fishing partner for about 20 years. Such partnerships are also found in other cooperative fishing spots. At the jetties (in the case of the five men of the first example) fishermen often share their catch.

Conflicts are also a part of life among these men. Most of the time, however, are caused by outsiders. One such case of conflict often occurs with other fishermen from Laguna whose target is catfish (Ariidae). Catfish is caught in trammel nets, called *feiticeira* or *tresmalho*, which consists of three layers of netting with a slack small mesh inner netting between two layers of large mesh netting within which fish will entangle [23]. Trammel nets are occasionally set in strings, kept vertically by floats on the upper line and by weights on the ground-line, and are especially used to fish in inland and marine waters [23]. Dolphins are often accidentally entangled, injured, or killed in them. For 66% of interviewees ($n = 50$), trammel nets are detrimental to cooperative fishing when they block the

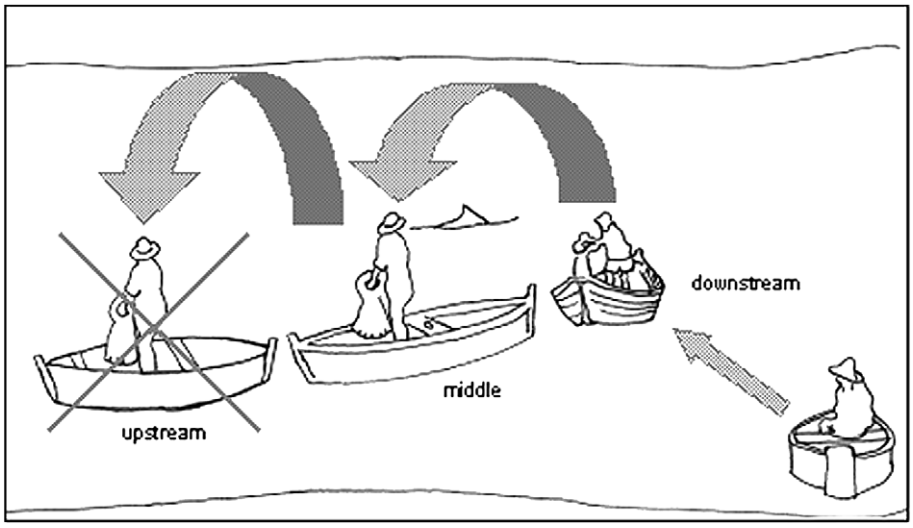

Fig. 4. Shift rotation system in Tubarão River.

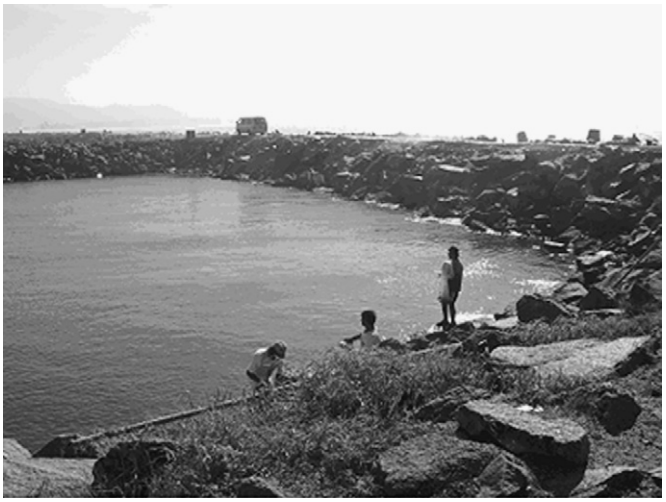

Fig. 5. The North Jetties. Photo by N. Peroni.

channel at night. That is when dolphins are entangled. This problem was first described and published by Simões-Lopes [13]. Elder fisherman reported other conflict between fishermen and some dolphins that used to steal the fish from the nets; in such occasions the fishermen used to throw sand or stones to frighten these dolphins [11].

A second conflict between fishermen refers to the participation of foreigners who do not belong to that cooperative fishing community. The simple fishing technology, the relative low cost of cast nets and the easy access to some fishing spots make this interference possible. The fishing spots that are more vulnerable to this "invasion" are those closer to the beach, an area that is particularly vulnerable to real estate developments and tourism. Occasional fishermen usually show up in summer (December–February), but more frequently during the mullet season (April–June). Among the problems that annoy the local fishermen is the fact that these outsiders ignore the behavior of dolphins during interactions and, thus, disrupt cooperative fishing and the socio-economic implications it entails.

Other problems associated to occasional fishermen are related to the competition for resources and the lack of knowledge or blatant disregard for local institutions. In addition, overcrowding in fishing spots caused by this sudden influx of outsiders decreases the chance of locals and puts more pressure on the resources.

6. Discussion

Communal resource management effectively occurs when local residents regulate, comply with and enforce their property rights [2]. The use of resources by the fishermen community of Laguna is maintained through an informal system based on respect – *respeito* – adopted by its members. Cordell [10] refers to a similar case in *calão* (surrounding net type) fishing in Bahia, northeastern Brazil. There, fishermen respect a colleague's fishing ground even when he is absent. Following this code of ethics, these men mitigate conflicts and regulate access to the best places to cast their nets. *Respeito* shapes interpersonal relations, helps organize space, and the use of natural resources [10]. The Brazilian legislation also affects men–dolphin cooperative fishing in Laguna. By law, any citizen who holds a valid professional fishing license can perform this activity in the country. This law privileges occasional/foreign fishermen and is detrimental to locals. The involvement of government fishing regulators in the cooperative fishery is incipient: there are no governmental rules or regulations built in the specific context of cooperative fishing involving dolphins and fishers. When this study was conducted, there was a beginning governmental initiative directed to artisanal fisheries, however, small-scale fisheries are still under valuated in both state and union levels. A specific governmental action with short comes to local small-scale fishery is the creation of an environmental protection area aiming to the conservation of *Eubalaena australis*, however, the most of the estuary of the Santo Antônio Lagoon is excluded of this protection area due to the Laguna harbor.

The institutions regulating and enforcing resource use in Laguna are well established. The local fishermen, including the youths, comply with them. These institutions were defined and established by the artisanal fishermen community with the objective of ensuring their equal access to natural resources. The recognition of the right to organize themselves is one of the requirements proposed by Ostrom [5] and is strongly present in the cooperative fishing in Laguna.

These communities can mitigate conflicts and decrease pressures on resources when they organize themselves with the goal of managing their common space. Through institutions, they control overfishing by limiting the number of people and the technologies (fishing gear, boats) that can be employed in sound fishing [6,10]. For this reason, institutions play a crucial role in resource regulation [4,25], which can be managed successfully during long periods of time. The success of these collective actions to prevent and control overexploitation is recognized in many studies [6,8].

Laguna's cooperative fishing institutions are well-organized, detailed and diversified, corroborating with the principle of congruence between appropriation and resource use norms [5]. According to this principle, rules restricting time, place, technology and quantity of resources exploited should be proportional to the conditions found at the property rights regimes.

Depending on the fishing spot, cooperative fishing rules are based on several systems, such as shift rotation, partnerships, and first-come rights. Similar institutions defined by local communities were described in Brazil and elsewhere [10,26]. In Bahia, Brazil, the use of common property resources, such as fishing spots, is an organized practice in which the master of each boat waits for his turn to deploy their nets [10]. Likewise, in *Praia da Tesoura* and in the Patos Lagoon [1], the next in line must wait for his slot. In Alanya, Turkey, fishermen on board boats rotate shifts in the fishing spots, thus assuring to everyone the same chance of fishing successfully in the best spots [26]. Similarly, in Tubarão River, where cooperative fishing is more dynamic, fishermen carry out a shift rotation system which allows every participant the opportunity to interact with dolphins and catch fish.

Despite being well established, local institutions in Laguna have undergone changes due to technology improvements and the increase in the number of fishermen involved in cooperative fishing. These rules are, however, subject to change depending on the rearrangement of the agents or factors involved in the process. One such change was caused by the replacement of the old cast net model by the nylon types which cover more water surface and, therefore, catch more fish. Another meaningful change was the boats in fishing spots that were exclusively exploited by fishermen on foot. Today, there are so many boats that the fishermen have to arrive very early to ensure a slot. Another example is the old restriction imposed to single men in Tubarão River, the resources of which were reserved to married men only. In short, changes were driven by the need to enhance the catch per unit effort.

According to Jentoft [7], the consolidation of institutions is a difficult process and normally takes a long time. The Norwegian quota system, for example, took around 10 years to reach its present model [7]. In addition to these difficulties, property rights regimes are subject to instabilities [27,28]. They are susceptible to failure if their basic principles are affected or absent [5]. An example is Santa Lucia Lake, in eastern South Africa, where property rights regimes were collapsing. The major causes were poor resource management, inefficiency in controlling and monitoring outsiders. Another

weakness was the lack of a sound policy on who could gain access to the strategic fisheries [28].

For the management of common property resources to succeed, some important actions must be taken, such as the delimitation of the area(s) in which resources are found; the definition of who are entitled to exploit them; and the efficient exclusion or control of outsiders [5]. Cooperative fishing in Laguna is limited to the fishing spots previously described. These spots are apparently stable throughout time, since most of places described by Simões-Lopes et al. [11] were the same found in our study conducted 7 years later.

However, at the fishing spots that are more exposed to urban expansion and tourism, local fishermen have had difficulties to exclude the large number of outsiders intruding upon their activities. This fact may jeopardize the local management system [5]. The problem of exclusion was described in lagoons and coastal zones in Turkey and in Patos Lagoon, Brazil, resulting in the loss of resource control by those communities. Many fishermen quit fishing. Others, in turn, geared their efforts towards more distant fishing spots. Another consequence of this problem was the increase in number of fishing spots within the fishermen's original communities, due to an ever-growing number of people who put more pressure on the resources [1,26].

If access is not exclusive to local users, many outsiders will compete for the resources and crowd fishing spots [26]. The presence of large numbers of occasional fishermen in Laguna may threaten the resource management model implemented by its community. Other factors also trigger conflicts: outsiders' disregard for local institutions and their lack of knowledge about the behavior of dolphins. In short: disrespect.

Fishermen in Laguna do not count on strong public policies that are able to protect their interests. They are not organized in cooperatives or association acting on their behalf. Their current organization takes no action to control the undesirable presence of outsiders. The loss of resource control by the community may disrupt their local management system. This may, in turn, change a communal property into an open access one [26], causing the so-called "tragedy of the commons" [29].

The literature shows plenty of cases of unsettlement of consolidated management systems by external interference [3,30]. In many of them, resource depletion occurred after open access conditions were created in consequence of the destruction of communal property systems [1,3,4,30].

In order to prevent the failure of the informal institutions governing cooperative fishing and to help promote the success of communal property, we suggest (a) to create a record of local professional fishermen in Laguna; (b) to grant annual fishing permits, similar to the ones issued to the Patos Lagoon fishermen. There, permits are granted only to the residents that have fishing as their primary source of income [1]; (c) to adopt legal measures that recognize informal institutions and conserve cooperative fishing spots; and (d) to urge the official environmental agencies to permanently supervise the critical fishing spots, and help enforce both the legal and the informal institutions that protect natural resources; (e) to encourage the environmental protection initiatives of those whose livelihood depend on cooperative fishing.

The conservation of resources vital to cooperative fishing in Laguna is the result of the joint collaboration of organized local fishermen and of the official environmental agencies. Both public policies and the fishermen's informal institutions play a fundamental role in conserving not only natural resources but also the cultural identity and livelihood of the members of the cooperative fishing community.

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