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Conflicts between river dolphins (Cetacea: Odontoceti) and fisheries in the Central Amazon: A path toward tragedy?

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ABSTRACT. Dolphin interactions with fishermen have increased significantly and pose potential risks to the boto, *Inia geoffrensis* (Blainville, 1817), and the tucuxi, *Sotalia fluviatilis* (Gervais & Deville, 1853). The main objective of the present paper was to describe the existing conflicts between river dolphins and fishermen in the municipality of Manacapuru region. Sixteen fishermen were interviewed in Manacapuru, state of Amazonas, Brazil who described a situation of ongoing conflict that may be unsustainable. Two merchants from Manacapuru made unconfirmed reports on a boto carcass trade. Data collection for this study occurred between April 20th and April 25th, 2009, but the first author had been conducting research on river dolphins and fisheries in Manacapuru and nearby cities since the beginning of 2008, in order to gain the trust of the fishermen interviewed. The hunting and deliberate killing of the species is probably more threatening to botos than their incidental capture in fishing gears in the Manacapuru region. This practice may result from the fact that dolphins are prone to damaging fishing equipment, and stealing (and possibly damaging) fish from the nets. They are portrayed negatively in numerous myths and superstitions of traditional Amazonian folklore, making them extremely undesired or even hated, seen as pests, and used in the *piracatinga*, *Calophysus macropterus* (Lichtenstein, 1819) fishery as bait. For tucuxis, incidental capture still represents the major threat to their conservation in the region evaluated here.

KEY WORDS. Amazon river dolphins; fisheries interactions; *piracatinga*.

Conflicts between aquatic mammals and human activities have increased dramatically in recent years. According to Loch *et al*. (2009) the conflicts between these animals and the fisheries can be ecological, when there is predation of commercially important fish stocks, or operational, resulting in physical encounters with fishing gear. The increased pressures from the fisheries in the Central Amazon in recent decades has greatly heightened the potential for river dolphin/fishery interactions; this in turn could adversely affect the status of the dolphins, through higher rates of incidental mortality in fishing gear, through direct competition for certain fish species (da Silva & Best 1996), and more recently through the use of boto carcasses as bait during fishery activities (da Silva *et al*. 2011).

The Amazon basin harbors two endemic species of cetaceans, the tucuxi, *Sotalia fluviatilis* (Gervais & Deville, 1853) (Delphinidae), and the boto, *Inia geoffrensis* (Blainville, 1817) (Iniidae), sympatric in the greater part of their area of distribution (Best & da Silva 1989). Confirmed hostility towards dolphins on the part of the commercial fishermen has been documented (da Silva & Best 1996, Loch *et al*. 2009). This hostility, which could have negative impacts on both dolphin species, has been traditionally countered by numerous protective superstitions about the dolphins (da Silva 1990). However, as the economic pressures of commercial fishery become greater, these superstitions are likely to be less respected, especially by younger fishermen (da Silva & Best 1996, da Silva *et al*. 2011).

Da Silva & Best (1996) stated that all dolphin catches were probably incidental, and that only a very small number of carcasses were used for commercial purposes in the Central Amazon. Apparently, this situation has changed substantially, and the indiscriminate killing of dolphins in the Brazilian Amazon is now frequent, adding up to incidental mortality and direct competition as an important factor that might adversely affect the situation of the dolphins. As an example (V.M.F. da Silva & A.R. Martin, unpubl. data) reported the apparently unsustainable mortality of about 1,650 botos per year due to illegal hunting activities in one area in the Central Brazilian Amazon. Those

animals were probably killed to be used as bait for *Calophysus macropterus* (Lichtenstein, 1819) (Pimelodidae) fishery. *Calophysus macropterus* is known locally as *piracatinga* in Brazil and *mota*, *simi*, or *mapurite* in Colombia, Peru, and Venezuela, respectively. It is a scavenger species that is widely consumed by the local population and has recently gained commercial importance in Colombia, largely replacing the stocks of another catfish known as *capaz*, *Pimelodus grosskopfii* Steindachner, 1879 (Pimelodidae), which have collapsed due to overfishing. The catch and sales of the *piracatinga* have increased over the last decade, and this species has become an important export to Colombia, though the Brazilian market has more recently developed (P.A.C. Flores *et al.*, unpubl. data) in the Central and Northeastern states of Brazil as well (da Silva *et al.* 2011). An intensive market has also developed in the central and upper Amazon River and its tributaries (da Silva *et al.* 2011). Manacapuru has three main companies that commercialize *piracatinga* for both national and international markets, and eight ferries for the state trading (± 50 tons/year). The fish traded is not monitored for quantity.

The "fishing" or any form of molestation and/or intentional capture of cetaceans in Brazilian waters is forbidden (Federal Law 7.643/87). In 1997, conservation issues concerning cetaceans in Brazilian waters were improved, in particular through the institutionalization of the National Aquatic Mammal Research, Conservation, and Management Center (CMA/IBAMA – Administrative Rule IBAMA 143-N/98). In this context, it is important to discuss the negative interactions that involve cetaceans and fishery activities in the country.

This paper reports aspects of interactions between fishermen and river dolphins, including the occurrence of illegal, indiscriminate killings, and also reports the existence of an industry in a town in the Central Brazilian Amazon where boto carcasses are commercialized for fishing bait, which is a cause for concern from a conservation standpoint. Our main objective was to describe the existing conflicts between river dolphins and fishermen in the Manacapuru urban region.

MATERIAL AND METHODS

Manacapuru (Fig. 1) is a city in the Central Amazon, state of Amazonas, Brazil, located approximately 70 km west from Manaus (approximately 80 km by boat or paved road), the State Capital, on the northern bank of the Solimões River. A population census conducted in 2010 registered a total of 85 thousand inhabitants (IBGE 2011), and there are approximately five thousand registered fishermen in the local colony.

Sixteen interviews with fishermen were conducted in the main harbor (03°18'10"S, 60°37'18"W) of Manacapuru between April 20th and April 25th, 2009, but the first author (who was also the interviewer in the present work) had been conducting research focusing on river dolphins and fisheries in municipality of Manacapuru and nearby cities since the beginning of

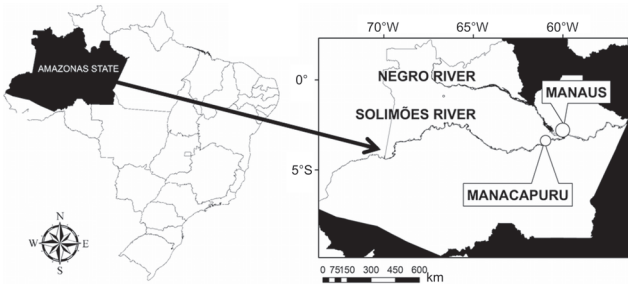

Figure 1. Location of Manacapuru on the map of Amazonas, Brazil.

2008, in order to gain the trust of the fishermen he was going to interview. All interviewed fishermen were chosen according to the following criteria: 1) engaging in artisanal fishery; 2) having fishery as the main economic activity; and 3) conducting artisanal fishery within the occurrence area of *I. geoffrensis* and *S. fluviatilis*.

During the interviews, the interviewer was always accompanied by a local fisherman. This technique, previously employed by Alves & Andriolo (2010), was designed to make the local fishermen more comfortable to interact and to respond to questions. The interviewers (researcher plus local fisherman) conducted interviews at the harbor area. Each fisherman was interviewed individually, to avoid possible interference from other fishermen. The researcher dressed like a local fisherman (flip-flops, shorts and t-shirts). The interviewers introduced themselves and, after a short informal conversation initiated by the contracted fisherman, they asked if the fisherman would participate in a "small research project for the university" which would investigate aspects of the fishery conducted in Manacapuru. Generally no questions were asked by interviewees, who almost always agreed to participate.

The interviews were guided by a standard semi-structured questionnaire (Schensul *et al.* 1999) containing 21 open and 14 closed questions that functioned as a roadmap for the interview. The interview was conducted in an informal manner following this questionnaire (Kendall 2008). However, some questions were not answered and the questionnaire could not be used as a roadmap on those two occasions. While some answers were noted on paper, other reports were digitally registered using a small MP3 recorder with the permission of those interviewed, and were later transcribed and analyzed (Silva 2000). All interviews were conducted through dialogs that facilitated interaction and established trust between the interviewers and the fishermen. The terms used in the questionnaire were in accordance with the usual vocabulary of the local fishermen, and were based on studies carried out by Alves & Andriolo (2010).

The questionnaire itself was divided into categories with questions focusing on: 1) identification of the fisherman (socioeconomic information such as age, address, and city of origin); 2) descriptions of the fishing activity (boats and gear used); 3)

target species (Begossi 2001); 4) ethnoidentification (identification of botos and tucuxis by fishermen); 5) behavior of the Amazon river dolphins during fishing activities (some questions focused only on botos); 6) negative interactions (environmental conflict between fishing activity and the dolphins, such as hunting, entanglement, and deliberate killing; some questions focused only on botos as well); 7) use of dolphin meat for human consumption (the utilization of dead animal carcasses); 8) existence of myths and/or superstitions regarding botos; 9) tourism; and 10) trade of boto carcasses. Some questions focused only on the botos, due to information in the literature cited above.

After transcribing the interviews, a table was created to organize the data by categories related to the initial research questions of the questionnaire (Ryan & Bernard 2000), i.e., socioeconomic aspects, description of the fishing activity, behavior of the animal, conflicts between fishermen and botos, and related myths and/or superstitions. This table allowed the reports to be classified by categories of themes so that the material contained on a particular topic could be easily identified, thus facilitating interpretation of the interviews (Bogdan & Biklen 1994).

The interviewers generally continued conversing with the interviewees after the interviews, and on many occasions important information was thus acquired when the interviewees generally became visibly more comfortable and the interview less formal. The recordings made were analyzed on the same day of the interview, and questionnaires with missing data were completed and subsequently digitized into a database computer file.

Two local merchants (businesspersons) from Manacapuru were also interviewed. A local collaborator (who is well-known in the city due to his participation in local political campaigns) informed the field researcher (interviewer) that these individuals were known in the city as boto-carcass dealers. The local collaborator contacted the merchants and set up a meeting with each one, guaranteeing that the interviewer was not associated with any environmental agency or the police, but was simply a university student conducting a "small research project." Descriptive statistics were conducted and the results present the averages and their respective standard deviation values.

RESULTS

Sample size

The small number of interviews carried out with the local fishermen (N = 16) is justified by the fact that two to four fishermen work in each fishing vessel. These men can work in more than one vessel, and the same pattern of responses became apparent after the 10th interview. In addition, the main objective of the present study was to conduct qualitative research.

Individual fisher identification

Of the 18 fishermen that were approached, only two (11.1%) declined to participate. Of the 16 fishermen interviewed, only one (6.2%) was a woman. Their age varied from 23 to 57 years (average 40.8 ± 10.0 years). Eight interviewees (50%) were born in Manacapuru, but the others came from other regions of the Amazon. Of the eight who were not from Manacapuru, two (12.5%) were just passing through on a fishing trip, whereas all others now live in Manacapuru.

Boats and gear used in fishing activities

Only two interviewees (12.5%) use regional canoes (5.0 and 5.5HP powered), whereas 13 (81.2%) use bigger wooden river boats (from 11 to 22 m in length, average 15.2 ± 3.4 m). Only one fisherman reported that he did not use any kind of watercraft for fishing, he fished from the river's edge.

Of the 16 interviewees, 13 (81.2%) use nets as the main fishing gear (gillnets, *malhadeira*, *arrastão*); three (18.7%) use bottom nets to capture catfish, two (12.5%) use hand lines and one (6.2%) uses harpoons. Although sixteen fishermen were interviewed, some described the use of more than one artifact, explaining the sampling number of 19 reports about gear used.

Target species

The number of fish species that each fisherman identified as targets varied from one to five (average 3.0 ± 1.2 species), totaling 16 species. The species mentioned (in keeping with da Silva & Best (1996), except for *fera*, *pirarara*, *piracatinga*, and *piaba*) were: *jaraqui*, *Semaprochilodus* spp., N = 13; *matrinchã –Brycon* sp., N = 9; *pacu*, *Mylossoma* spp. or *Myleus* spp., N = 4; *cará*, *Geophagus* spp., N = 3; *curimatã*, *Prochilodus nigricans* Agassiz, 1829, N = 3; *tambaqui*, *Colossoma macropomum* (Cuvier, 1818), N = 2; *fera*, many species of catfish, N = 2; *surubim*, *Pseudoplatystoma fasciatum* (Linnaeus, 1766), N = 2; *piranha*, *Serrasalmus* spp., N = 2; *pirarara*, *Phractocephalus hemioliopterus* (Bloch & Schneider, 1801), N = 2; *sardinha*, *Triportheus* spp., N = 1; *piracatinga*, *C. macropterus*, N = 1; *bacu*, *Pterodoras* spp., N = 1; *tucunaré, Cichla* spp., N = 1; *aracú*, *Schizodon* spp., N = 1; and *piaba*, *Astyanax* spp., N = 1.

Ethnoidentification of cetaceans

The interviewees identified more than one species of cetacean (average 2.2 ± 0.4 species), explaining the sampling number of 37 identifications for the seven denominations described in Table I. While 12 fishermen described the two existing species, four described three species.

Dolphin behavior during fishery

When asked if the botos approach fishermen when they are fishing, 13 fishermen (81.2%) said that they do, and only three (18.7%, one of which uses a canoe and two of which use bigger boats) said that botos do not come close to the boat. No one said that botos beg for food. When the 13 interviewees who described dolphin approaches were asked if they actively feed the botos that come close during their activities, they stated that they generally do not feed them intentionally, but eight (69.2%) stated that the botos feed on discarded fish. One fisher (7.7%) said that he throws fish into the water to attract the botos in order to harpoon them, and another (7.7%) reported

Table I. Species ethnoidentified by interviewees.

Ethnospecies	Number of descriptions	Percentage on descriptions (%)	Percentage on interviews (%)
Golfinho pretinho (little black dolphin)	1	2.7	6.3
Roxo (purple)	1	2.7	6.3
Golfinho (dolphin)	1	2.7	6.3
Golfinho do Amazonas (Amazonas dolphin)	1	2.7	6.3
Roxinho (little purple)	4	10.8	25.0
Tucuxi (tucuxi)	13	35.1	81.3
Boto vermelho (red boto)	16	43.2	100.0

throwing fish as far away as he can with the intention of encouraging the botos to leave the surroundings of the boat and stop disturbing the fishing activities.

Negative interactions

When asked if there are conflicts between botos and fishermen, all the interviewees answered yes (Tab. II).

When asked if it is important to protect botos, 11 (68.7%) answered no. The justifications were: 1) "the only thing they like to do is to damage fishing nets"; 2) "there are so many botos" and "nobody likes botos"; 3) "the botos only cause harm"; 4) "it is of no benefit to have so many"; 5) "they have to be exterminated" and "they are river pests"; 6) "it is better to kill them"; 7) "if we let them reproduce, we will not have anything left for humans" and "there are already too many botos"; 8) "they cause harm"; 9) "the fishermen and their families must be protected instead of the botos"; 10) "botos and caimans are bad for people"; 11) "there are too many" and "the IBAMA (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis – Brazilian Environmental Agency) says it is forbidden (to kill them) but they do not pay for the damage the animals cause".

Five respondents (31.2%) responded that they believe that botos need to be protected because: 1) "it is the right thing to do"; 2) "if we exterminate them, there will be no more tourists wanting to observe them by boat"; 3) "they are a part of nature"; 4) "they are not like caimans, which damage our fishing gear and eat people"; 5) "they do not do any harm to humans".

When asked if the illegal hunting of botos occurs in the region, 14 (87.5%) interviewees answered that it does (Tab. III). When asked why this hunting occurs, all mentioned that the carcass is used as bait in the *piracatinga* (also referred to as *fera* or *birosca*) fishery, and only one (7.1%) mentioned human consumption as a motivating factor. Despite reports on boto hunting, only one fisher (7.1%) mentioned the existence a carcass trade, and one other fisher identified himself as a hunter. Two other interviewees (14.3%) identified themselves as users of boto parts as bait in fishery activities.

When asked if the hunting of tucuxis occurs in the region, two (12.5%) answered that it does, and one said that it is used as bait. The other fishermen denied knowledge of this practice. Four interviewees (25%) stated that they do not know if it occurs, whereas the other 10 fishermen (62.5%) answered that the hunting of tucuxis does not occur in the region. Human consumption was not mentioned.

While the entanglement of botos was cited by 15 interviewees (93.7%), 14 (87.5%) mentioned the entanglement of tucuxis (Tab. III). Four fishermen (25%) reported releasing live entangled animals, whereas eight respondents killed them (50%). Of those who killed entangled animals, three stated that they eat or discard the carcasses with no use, and two fishermen (12.5%) said that they kill botos while letting tucuxis go free. Two interviewees (12.5%) did not answer about the destination of entangled animals (Tab. IV). The carcasses of animals found dead in the nets, or killed after entanglement, can be used for human consumption, as fishing bait, or can be discarded without being used (Tab. IV). Despite only one fisher specifically describing the use of entangled animals as bait, we suggest the true number is much higher among the interviewees. This hypothesis is based on the fact that we did not question them about this specifically; respondents only stated that they kill the entangled dolphins and possibly use the carcasses as bait thereafter.

Table III. Illegal activities of fishery on river dolphins.

Activities	*I. geoffrensis*	Percentage	*S. fluviatilis*	Percentage
Hunting	14	87.5	2	12.5
By-catch	15	93.8	14	87.5

Table II. Conflicts between *Inia geoffrensis* and fishery.

Conflicts	Number of descriptions	Percentage of descriptions (%)	Percentage of interviews (%)
Damage to fishing gear	13	56.5	81.3
Steal fish from nets	10	43.5	62.5

Table IV. Destination of entangled botos and tucuxis.

Destination	Number of descriptions	%
Kill both species	8	50.0
Free live animals	4	25.0
Human consumption	4	25.0
Discard dead animals	3	18.8
Let live tucuxis free and kill botos	2	12.5
Use as bait	1	6.3

Use of meat for human consumption

Ten interviewees (62.5%) described the use of dolphin meat for human consumption in the region, and seven of them (43.7% of the total) had previously eaten dolphin meat. When specifically questioned about the human consumption of dolphin meat, 10 interviewees (62.5%) stated that botos are used for that in the region (four of them [25%] reported having eaten the animal). Five of these ten interviewees (31.2% of the total) also mentioned the human consumption of tucuxi meat (three of them [18.7%] reported having previously eaten the meat of both species).

Regional myths

Twelve interviewees (75%) described the existence of local myths and superstitions involving the botos (one of them did not want to describe it), whereas three (18.7%) stated there are no myths or superstitions involving the species and one (6.2%) did not know if such myths exists. The description of the myths were: 1) "botos turn into men and are enchanted" and "they eat people"; 2) "they try to fill the canoes with water in order to sink them" and "they are evil"; 3) "they go up on land, turn into people and jump into the water again"; 4) "they put spells on people" and "they steal the shadows of people"; 5) "they are enchanted" and "they have evil powers"; 6) "in the interior of the State (of Amazonas), I once saw a man flirting with another mens' wives, locals tried to run after him, but he jumped into the water and some meters ahead, a boto emerged"; 7) "menstruating women attract botos and they enchant them and impregnate them"; 8) "we went aboard and the boat shook... we thought a person was causing it (trying to sink the boat), but ahead of us a boto emerged" and "don't mess with him, because he will make you become haunted"; 9) "they enchant us and take us to the bottom of the river"; 10) "they get out of the water in the night as a man all dressed in white to go to the parties" and 11) "they go up on land to dance and get some girls" and "they put spells on people".

Tourism

When asked about the presence of tourists in Manacapuru, six respondents (37.5%) stated that they approve of their presence in the city, four (25%) stated that they do not welcome tourists, four others (25%) did not know the answer, one (6.2%) answered "so-so" without further elaboration, and one other (6.2%) did not answer. Of the six who welcome the presence of tourists, four (25% of the total) stated that tourists represent income for the city. Of the four who unequivocally do not approve of the presence of tourists, two saw no advantage for the city in their presence, and two opined that tourists disturb the local population.

Boto carcasses trading

A woman who owns a small store downtown Manacapuru stated that she actively trades in boto carcasses every year during approximately three months of the dry season of the Solimões River (while she did not specify the months, we believe them to be August, September, and October). Accordingly to the interviewee, some fishermen from Manacapuru know her as a trader and come to her in order to buy or sell carcasses. She sells the carcasses from R$25.00 to R$100.00 (prices from the period of study; approximately US$11.36 to US$45.45 at the time), depending on the size of the animal. The prices she pays for the carcasses were not revealed. Since she does not have a proper storage place, she rents some space in a local fishery exportation company that possesses a cold storage facility. Accordingly to the interviewee, the number of boto carcasses traded per year reaches 75 (approximately 25 per month).

The other businessperson interviewed is a man who works as a manager at a fishery exportation company. He said that the period of highest trading activity is also during the dry season, and that he is responsible for the trading of approximately 225 carcasses per year. He does not allow other people to store boto carcasses in his fishery exportation company's cold storage facility, and stated that other fishery exportation companies are involved in this business, directly or indirectly (i.e., by buying fish that they know was caught using boto carcasses as bait). He did not provide prices or other details. When asked about the monitoring or surveillance of the region by environmental agencies (since this activity is against Brazilian law), he stated that it is a "complicated issue," and changed the subject of the conversation. He is known in Manacapuru as a dealer of *piracatinga* and other fish species.

A total of approximately 300 boto carcasses per year are traded by these two dealers alone. The tucuxi was not mentioned by the interviewees.

DISCUSSION

In this paper we summarize data on a small number of local fishermen and merchants. This collection is by no means a quantitative sampling or an estimate of all the conflicts, but is designed to contribute to a qualitative representation of the existing conflicts between river dolphins and fishermen in the municipal region of Manacapuru. The qualitative approaches based on reports of local members are appropriate for studies related to cultural perception. The objective of these kinds of research is not to quantify, but to reduce the distance between subject and object, because studies of this kind are subjective

and complex, and include elements of the beliefs and symbols of a community (Begossi 1992). According to Crouch & McKenzie (2006), data obtained through local knowledge are useful to understand the subjective processes of a culture, and frequencies are secondary in this line of research. In qualitative studies such as ours, a large sample does not introduce new information related to the objectives of the research, which can become repetitive (Mason 2010).

Da Silva & Best (1996) concluded that the information provided by fishermen is not precise; that most of the time they are afraid to answer, refuse to talk, or lie in an attempt to avoid future problems arising from fishery legislation or tax increases. In their research on dolphin-fishery conflict, Zappes *et al*. (2009) stated that some interviewees did not report accidental dolphin capture, probably due to the controversy surrounding the issue of entanglement. The present study includes subject matter even more controversial than accidental capture: intentional killings and the trading of carcasses. Nevertheless, we believe that the fact that the fishermen's familiarity with the researcher/interviewer and the focus of the research was essential for gaining the trust of those fishermen interviewed. We also believe that the inclusion of a local fisherman in the interviews, and the care taken in selecting the appropriate attire and manner of approach for the interviewer have contributed to successfully overcome the potential suspicions of the fishermen with regards to the nature of the research, increasing their willingness to collaborate with us. Adding a local mediator for the interviews with the businesspersons probably guaranteed the acquisition of more reliable data. Despite interviewing only 16 fishermen and two businesspersons, the results presented add extremely important, unreported information to the boto-fishery conflict issue in the Brazilian Amazon.

Three fishermen specifically mentioned the use of bottom nets for the capture of catfishes (such as the *piracatinga*), but the use of cages, which is widespread in the region and mostly used to catch *piracatinga*, was not mentioned. The relation between different fishing gears and the accidental mortality of dolphins in such equipment needs to be further evaluated through additional research.

Although only sixteen species of fish were mentioned by the fishermen, it is possible that the number of target species is much higher, and that the fishermen generally mentioned the most commonly caught species. Even so, it is interesting that only one fisherman specifically identified the *piracatinga* as a primary target. The boto is known to feed on over 43 species of 19 families of fish of which sciaenids are the preferred prey, followed by cichlids and then by characins (Curimatidae, Best & da Silva 1989). Given this information, we believe that the boto feeds on species regularly caught by the local fishermen, a subject that also requires further investigation.

Most fishermen mentioned the two existing dolphin species correctly, but some interviewees included one more species. It seems that they perceive the tucuxi correctly as one single species, but some interviewees apparently are confused about the boto. Since botos vary greatly in size and coloration, some interviewees may perceive botos as two different species. Other ethnobiological studies on ethnoidentification have reported the attribution by artisan fishermen of more than one name to each small cetacean species in Brazil (Souza & Begossi 2007, Zappes *et al*. 2011). The present study, however, describes fishermen's perceptions of one single species as two different species due to morphological variations.

For the most part, fishermen do not actively feed the botos that approach during fishing activities, though one fisherman related the use of fish thrown into the water as a means of attracting the botos in order to harpoon them, suggesting that botos can be conditioned to come closer to humans and beg for food. According to Alves *et al*. (2011), there are four sites in the state of Amazonas where botos have been incorporated as tourist attractions, putting those individual botos at additional risk.

The results presented here are worthy of concern, as they demonstrate that for all respondents botos contribute negatively with fishery. Although no specific query was made as to any possible positive interaction, the fact that no interaction of this kind was mentioned by any of the interviewees suggests the presence of a highly conflictive situation. Depredation, i.e., the removal or damage of fish caught in fishing gear, causing a reduction in market value, was identified by Read (2008) as a source of conflict with fishermen, a finding corroborated by our results. In addition, fishermen may take retaliatory attitudes towards the animals due to real or perceived monetary losses (Loch *et al*. 2009), which was also corroborated in the present study.

The negative interactions involving the intentional capture of *I. geoffrensis* and *S. fluviatilis* by local fishermen is both illegal and rare in Brazil, but reports of such activity do exist in the northern region of the country (e.g., da Silva & Best 1996, Gravena *et al*. 2008). In the present study, interviewees described mortality as related to the fact that the animals cause damage to fishing gear. Corroborating this, Loch *et al*. (2009) stated that these dolphin species are captured in order to prevent their acquisition of commercially valuable fish species and/or the damage of fishing gear, indicating that there is competition between the local fishermen and these dolphins for fishery resources.

The majority of the respondents stated that it is not important to protect botos. Their justifications for this attitude illustrates the degree to which botos are extremely disliked, unwanted, or even hated by most fishermen, similar to what happens in Sierra Leone, where manatees, *Trichechus senegalensis* Link, 1795 (Trichechidae) are considered "pests" because they damage fishing gear (Reeves *et al*. 1988). This conclusion urges new management strategies: focusing educational efforts on the interaction between cetaceans and fishing activities, in conjunction with the active participation of the local players

(Secchi *et al*. 2004, Zappes *et al*. 2009). In order to preserve local traditional fishing practices while protecting the botos in the Manacapuru region, it is important to develop fishing methods that are less harmful to the cetaceans, in cooperation with local fishermen (Iníguez *et al*. 2003).

The direct hunting of botos seems to be widespread and quite common in the Manacapuru region, and all respondents who recognized its existence said that carcasses are used as bait to catch *piracatinga*. When asked about the direct hunting of tucuxis, the majority responded that it does not occur in the area, though a few stated the contrary. It is clear that direct hunting is focused primarily on the boto.

The number of fishermen that killed live animals caught accidentally in their nets is a cause for concern, for it indicates a problem that imports on the conservation of those species. Furthermore, some fishermen stated that while tucuxis are released when caught alive, botos are killed, showing that botos and tucuxis are perceived differently by the fishermen, with a much higher degree of negative conflict occurring between botos and fishermen.

Some fishermen release dead dolphins caught in nets. A similar fact was observed by Mangel *et al*. (2010), who stated that 40 percent of all small cetaceans which died while entangled were discarded at sea, indicating that interactions with small cetaceans are often accidental. Some fishermen kill the entangled dolphins and discard the carcasses, also suggesting the existence of an extremely high conflictive interaction, differing from the case of manatees in Sierra Leone, where the animals killed are completely consumed by humans. Mangel *et al*. (2010) reported that harpooning dolphins for bait is common among the artisanal fisheries conducted on the Peruvian coast, but that all cetaceans harpooned after entanglement, both by gillnet and longline vessels, were used as bait, showing that, in that case, fishermen killed the dolphins with the intention of using their meat as bait. Accordingly to Loch *et al*. (2009), reports of negative attitudes towards cetaceans with no apparent motive are common in the region of their study, the western Brazilian Amazon, especially towards the boto, considered by the local inhabitants as bad-tempered and capable of disrupting fishing activities.

Harpoons are commonly used in the Manacapuru area to kill entangled animals, and machetes were also mentioned. The killing by harpooning is casual in the Brazilian Amazon, and may occur when a dolphin is disturbing a fisher or fishing gear, or may simply be a case of presenting an irresistible target (da Silva & Best 1996). Though it is not common in Brazil, the practice of harpooning has also been reported for coastal dolphins (Simões-Lopes & Ximenez 1990, Freitas-Netto & Di Beneditto 2008). *Sotalia guianensis* (P.-J. van Bénéden, 1864) (Delphinidae) have been found killed by knife cuts and bludgeoning in the Baía de Sepetiba, state of Rio de Janeiro (Zappes *et al*. 2010) and Baía Norte of Santa Catarina Island (Simões-Lopes & Ximenes 1990).

The human consumption of dolphin meat from accidentally caught dolphins can be confirmed, but the degree to which this practice is widely practiced remains uncertain. According to da Silva & Best (1996), there is a small market value for the dried eyes and sexual organs of dolphins, which are used as love charms, but the meat has no market value, because it is not eaten. In the region of Manacapuru, both boto and tucuxi meat are consumed, but it is important to evaluate how widespread this practice is, and if there is now a market for dolphin meat. Mangel *et al*. (2010) show that, in at least one port in Northern Peru, consumption of small cetaceans commonly occurs. In Brazil, *S. guianensis* meat is consumed by traditional communities in the states of Bahia (Zappes *et al*. 2009), Espírito Santo (Freitas Netto & Di Beneditto 2008, Zappes *et al*. 2009), and Paraná (Przbylski & Monteiro-Filho 2001), and probably others. Siciliano (1994) also describes the human consumption of dolphin meat in the northern region of Brazil.

While the present study showed that most fishermen described the existence of local myths and superstitions, it also showed that they do not prevent botos from being deliberately killed. Furthermore, the fact that most of the myths portray dolphins negatively, could help to explain (together with the statements that they disturb fishery activities) why the botos are extremely unwanted or even hated. The boto is traditionally viewed as a mischievous and tempestuous being, both feared and respected, and the most sensational example of folklore concerning botos is the one in which they manage to transform themselves into Caucasian men who are skilled at dancing and seducing young women (Gravena *et al*. 2008). Similar myths presenting botos as harmful supernatural beings were registered during the present study, showing that fishermen are aware of traditional Amazonian folklore.

Despite some fishermen mentioning that tourism represents income for the city, it is not clear if implementing dolphin-watching activities could result in a positive change in their perceptions, correlating botos with positive income for the city. In some areas of Brazil, tourism involving small cetaceans is not perceived by the local community as a positive activity (Filla & Monteiro-Filho 2009, Zappes *et al*. 2011), because since there are no regulations, those activities end up infringing on the existing environmental laws as well as on cultural mores.

The existence of an illegal network of boto carcass trade suggests that a large number of carcass-providing hunters, dealers, and buyers are involved in this seasonal activity. Mangel *et al*. (2010) reported that entangled dolphins met varied destinies, including live release, use as bait, offshore consumption by humans, sale in local markets or to other gillnet or longline vessels for use as bait, corroborating the findings presented here that a trade market for carcasses does exist.

The numbers provided by only two local traders are cause for concern. If the true number of dealers is much higher (as we suggest it is), and this activity occurs in other parts of the

Amazon, such activity could have a significant negative impact to the populations of botos. There is urgent need for the suppression of such activities and the enforcement of Brazilian law, which does not allow any kind of disturbance or capture of cetaceans. Projects involving the education of locals must be given priority by research groups. Strategies must be developed to encourage a dialogue amongst local communities, researchers, and government officials aiming to mitigate the deliberate killing of botos in the Central Amazon.

Concluding Remarks and Management Implications

In the Central Amazon, the accidental capture of *I. geoffrensis* for the carcass commercialization has become a social, cultural, and economical problem that could very likely reduce the populations of these animals. The monitoring of fishing activities is necessary both in order to evaluate the negative impacts of these activities on the two species of dolphins that occur in the region, and to include the fishing communities in the development of management proposals related to the conservation of the river. Thus, with the help of researchers in their region, it is necessary to provide fishermen with training related to fishery management (on recent innovations in fishing gear, the rotation of fishing areas in order to decrease the incidental capture of cetaceans, and education on current legislation), as well as environmental education (on the conservation of aquatic mammals, aquatic pollution, and fluvial ecosystems). Furthermore, it is of upmost importance to decrease the distance between researchers and local educators, with the aim of providing information to teachers and school managers, and also to promote public meetings in which local leaders and players, government, educators, and researchers can discuss and evaluate the situation regarding to the interaction between human fishery activities and the river dolphin species, and also to discuss, propose, and implement solutions. Local players must be transformed into fishery managers in a way that reduces the conflicts between fishing and cetaceans.

Although fishermen reported conflicts between their activities and both botos and tucuxis, the actions taken towards botos are evidently more drastic, a fact which indicates a higher degree of conflict between the fishermen and this species. Generally, the incidental capture of cetaceans in passive fishing equipment such as gillnets represents the biggest threat to their conservation. Our findings suggest that hunting and deliberate killings are probably more threatening to botos than incidental capture in fishing gear in the Manacapuru region. Such aggression can best be understood as the result of a complex interaction of factors, such as the fact that the botos damage fishing gear, steal (and also probably damage) fish from the nets, are involved in numerous traditional Amazonian folk tales, myths, and superstitions that often portray them negatively, making them extremely unwanted or even hated and considered as pests, and have more recently become a source of bait in *piracatinga* fishery. For tucuxis, the incidental capture still represents the major threat to their conservation in the Manacapuru region.

The present paper was presented during the 64th Annual Meeting of the International Whaling Commission (IWC), held in Panama City, Panama, from 11 June to 6 July 2012, being discussed by the IWC Scientific Subcommittee on Small Cetaceans (L.C.P.S. Alves *et al.*, unpubl. data). In view of the concerns previously presented and information gaps presented ahead, the subcommittee recommended the organization of an international scientific workshop that would involve scientists and managers from the countries where botos and tucuxis occur, and also concluded that the status of the Neotropical river dolphins (boto and tucuxi) should be added as a recurrent item on its agenda for future meetings.

Management actions are needed to guarantee protection of the botos in the Manacapuru region from negative interactions with local fishermen with regard to:

Incidental captures

We suggest that fishing techniques and/or fishing gear be altered or modified to mitigate the impact on river dolphins. Fishermen themselves need to be involved in the development of these changes so that traditional knowledge and practices are taken into account and practical solutions can be found to reduce the incidental capture of dolphins. Regular monitoring of critical habitat for river dolphins (including breeding and calving areas, feeding areas and socialization areas) must be conducted. These areas should be compared with areas used for fishery. Fishing activities should be limited through seasonal and area restrictions. A database on the systematic incidental capture of river dolphins must be developed and this information should be compared with the population estimates available in order to identify the impact on river dolphin populations.

Intentional killing

Methods to assess mortality caused by intentional killing (rapid assessment as well as longer term-approaches). To address the problem of competition between fishermen and dolphins for fish resources, we suggest that an environmental education and outreach program be established for fishermen and their families and local leaders in the community. This would increase peoples' understanding of the botos, their importance in the ecosystem, and dispel harmful misconceptions about the species. In terms of negative cultural attitudes towards botos, we suggest that an environmental education program is needed to create understanding and awareness about myths that create negative feelings or even fear of the dolphins. Many myths are not based on truth. To reduce the use of boto carcasses as fish bait, we suggest the improved government monitoring of fisheries to detect this illegal practice. Effective law enforcement is urgently required to mitigate this illegal practice. The educational programs mentioned above will also help address this serious problem.

Alternative economic activities

Conduct market, environmental, and socioeconomic diagnostic studies in order to identify areas with the potential

for the implementation of dolphin-watching tourism activities. Implementation of sustainable/community based dolphin-watching tourism. Creating a tourism activity that offers two renowned tourism attractions: the Amazon and wild dolphins. This alternative could provide a viable substitute for the artisanal fisheries at least in some periods of the year. Promote the qualification of the fishery community members of the Manacapuru region through training, using government funding in order to guarantee that the local players can manage this profitable tourism activity themselves. Commercial sustainable use, by the whole fishery community, of natural resources in order to produce handmade artisanal art and other products in order to allow the community to add another profitable activity that is compatible with touristic dolphin-watching activities.

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