UNIVERSIDADE ESTADUAL DE CAMPINAS

INSTITUTO DE BIOLOGIA

Shirley Pacheco de Souza

"ETNOBIOLOGIA DE CETÁCEOS POR PESCADORES ARTESANAIS DA COSTA BRASILEIRA"

Tese apresentada ao Instituto de Biologia para obtenção do Título de Doutor em Ecologia.

Orientadora: Profa. Dra. Alpina Begossi

Campinas, 2011.

FICHA CATALOGRÁFICA ELABORADA PELA
BIBLIOTECA DO INSTITUTO DE BIOLOGIA – UNICAMP

So89e

Souza, Shirley Pacheco de
Etnobiologia de cetáceos por pescadores artesanais da costa brasileira / Shirley Pacheco de Souza. – Campinas, SP: [s.n.], 2011.

Orientador: Alpina Begossi.
Tese (doutorado) – Universidade Estadual de Campinas, Instituto de Biologia.

1. Etnobiologia. 2. Cetáceo. 3. Pescadores artesanais. 4. Conhecimento ecológico local. I. Begossi, Alpina. II. Universidade Estadual de Campinas. Instituto de Biologia. III. Título.

Título em inglês: Ethnobiology of cetaceans by artisanal Brazilian fishers.
Palavras-chave em inglês: Ethnobiology; Cetaceans; Artisanal fishers; Local ecological knowledge.
Área de concentração: Ecologia.
Titulação: Doutor em Ecologia.
Banca examinadora: Alpina Begossi, Priscila Fabiana Macedo Lopes, Salvatore Siciliano, Renato Azevedo Matias Silvano, Eleonore Zulnara Freire Setz.
Data da defesa: 22/06/2011.
Programa de Pós-Graduação: Ecologia.

Campinas, 22 de junho de 2011.

BANCA EXAMINADORA

Profa. Dra . Alpina Begossi (Orientadora)	Assinatura
Prof. Dr. Mohamed Ezz El-Din Mostafa Habib	Assinatura
Prof. Dr. Salvatore Siciliano	Assinatura
Prof. Dr. Renato Azevedo Matias Silvano	Assinatura
Profa. Dra. Eleonore Zulnara Freire Setz	Assinatura
Prof. Dra. Priscila Fabiana Macedo Lopes	Assinatura
Prof. Dr. Ivan Sazima	Assinatura
Prof. Dr. Marcos César de Oliveira Santos	Assinatura

iii

Dedico este trabalho aos meus pais Therezinha e Silmar,

pelo apoio, amor e incentivo constantes.

À Luna, Stella e Marcio pela paciência, companheirismo e amor.

Se as coisas são inatingíveis... ora!
Não é motivo para não querê-las...
Que tristes os caminhos, se não fora
A presença distante das estrelas!

Mario Quintana

Agradecimentos

Aos pescadores agradeço pela paciência durante as entrevistas, pelas estórias gostosas e por gentilmente compartilhar seu conhecimento sobre as baleias e os botos, especialmente: Trajano, Chico, Xalopa e Ademar em Soure; em Ponta Negra: 'Uão', 'Dedé', 'Chico Pequeno' e Cássio; em São Sebastião: Jandira, 'Servinho' (em memória), 'Toninho', Flávio, 'Bahia', João Carlos, Olinto, Crisântemo e Carlão; em Pântano do Sul: Valmiro, 'Barrinha', Abelardo e Célio.

À minha família, meus pais, minhas filhas, Marcio, Dona Dita, Sidney, Fabi, Raul e Laura, tias Silma e Silmira, Edson, Danilo e Danielle, Dulce, e tantos outros, pela paciência, apoio incondicional, acolhida, incentivos e carinho.

À minha orientadora, Alpina Begossi, que me ensinou tanta coisa da Ecologia Humana, agradeço pela oportunidade que me deu, pelos horizontes que me abriu, pela ajuda sempre pronta e necessária e pela amizade sincera.

Ao CNPq pela bolsa concedida durante a realização deste doutorado.

Ao João, guia turístico, e Angélica, bióloga do GEMAM, pela companhia e auxílio diário em Soure. À Claudia Martinelli, pela amizade e companhia em Natal. Ao Valmiro e 'Mazinha' pela simpatia e apoio que me deram em Pântano do Sul. À Silene, Maria Idalina, Márcia, Giba, Vivian, Nina, Monique, Maria José e todos os amigos do Instituto Terra e Mar em São Sebastião, pela amizade, companheirismo e por compartilharmos os mesmos ideais.

Aos Professores da Ecologia da UNICAMP, Eleonore, Benson, Brown e Luiz Duarte pelos ensinamentos, simpatia e incentivo. À Célia e Sílvia, secretárias do Programa de Pós-Graduação em Ecologia, por sua gentileza e dedicação. Ao Prof. José Geraldo, por compartilhar sua paixão pela etnoecologia e nos inspirar a conhecer este mundo tão rico de conhecimentos.

Aos amigos Salvatore Siciliano, Angélica Rodrigues, Sandra Cuenca, Juliana Marigo, Fernando Alvarenga, Luciana Araújo, Álvaro Migotto, Renato Silvano e Mariana Clauzet por estarem sempre disponíveis a conversar, palpitar, trocar idéias e apoiar.

Agradeço de coração a todos e a Deus por viver tudo isso com vocês!

Índice

Índice de Figuras

Introdução

Capítulo 1

Capítulo 2

Capítulo 3

Capítulo 4

Índice de Tabelas e Apêndices

Resumo

Este estudo registra e analisa o conhecimento ecológico dos pescadores artesanais da costa brasileira. O conhecimento dos pescadores é empírico, prático e contém registros em longo prazo sobre espécies e eventos ambientais, incluindo informações biológicas, ecológicas e culturais. Tendo a Ecologia Humana e a Etnobiologia como bases conceituais e metodológicas caracterizamos o conhecimento dos pescadores sobre a classificação, a nomenclatura e a ecologia dos cetáceos. Entrevistamos 171 pescadores artesanais de comunidades localizadas em Soure (Ilha do Marajó) na região norte, em Ponta Negra (Natal) na região nordeste, em São Sebastião (São Paulo) na região sudeste e em Pântano do Sul (Florianópolis) na região sul do Brasil. Os cetáceos fazem parte da megafauna impactada pela captura acidental na pesca. Cerca de metade das espécies existentes no Brasil está classificada pela Lista Vermelha da IUCN como espécies com dados insuficientes, devido à falta de informação sobre elas. Conforme os resultados desta pesquisa, os pescadores reconheceram 17 espécies de cetáceos e as agruparam em quatro etnogêneros e 37 etnoespécies. O conhecimento dos pescadores sobre as áreas de ocorrência, habitats preferenciais, sazonalidade, tamanhos de grupo e reprodução dos cetáceos forneceu informações para 16 espécies. O boto-cinza (*Sotalia guianensis*) e o golfinho-nariz-de-garrafa (*Tursiops truncatus*) foram as espécies mais citadas nas quatro áreas. Os tópicos mais conhecidos foram áreas de ocorrência e tamanhos de grupo, e o menos conhecido foi reprodução. Em relação às interações entre cetáceos e atividades pesqueiras, as informações obtidas indicaram os seguintes tipos de interações: competição (com os peixes e os pescadores), cooperação (com os pescadores) e predação (sobre as espécies-alvo da pesca ou como presa para outros predadores de topo). As espécies mais comuns em cada área (*S. guianensis*, *T. truncatus*, *Inia geoffrensis*, *Stenella clymene*, *Pontoporia blainvillei* e *Eubalaena australis*) são as mais conhecidas e as mais mencionadas como principais competidores ou cooperadores. A captura acidental de cetáceos foi a interação mais citada. Os pescadores conhecem detalhes sobre os hábitos alimentares de alguns cetáceos, descrevendo 28 tipos diferentes de comportamentos alimentares e listando 48 espécies de peixes, moluscos e crustáceos como presas preferenciais. Fatores culturais e ambientais, tais como variações oceanográficas nas áreas de estudo e variações no uso de recursos influenciaram o conhecimento dos pescadores. Comparando as informações dos pescadores sobre as espécies mais comuns de cetáceos com aquelas contidas na literatura científica encontramos grande concordância em relação aos aspectos ecológicos e às interações com a pesca. Apenas para duas espécies (*Stenella clymene* e *Inia geoffrensis*) o conhecimento dos pescadores foi discordante da literatura. Estes casos de inconsistência entre os dois tipos de conhecimento podem refletir alguma falta de conhecimento dos pescadores sobre estas espécies ou, por outro lado, podem sugerir novas linhas de pesquisa. O conhecimento dos pescadores sobre as interações envolvendo cetáceos são úteis ao manejo das capturas acidentais, fornecendo informações sobre áreas críticas de captura e sugerindo locais e designs alternativos para as redes de espera. Sugerimos que este conhecimento seja considerado nas estratégias de manejo pesqueiro, já que pode contribuir para minimizar as interações negativas entre os cetáceos e a pesca.

Abstract

This study records and analyzes fishers' local ecological knowledge (LEK) on cetaceans in the Brazilian coast. Fishers' (LEK) is empirical, practical-oriented, embedded with long-term records on local species or environmental events, and includes important biological, ecological and cultural information. Choosing Human Ecology and Ethnobiology as methodological base and considering cultural and oceanographic variations in the studied areas, we present fishers' knowledge through Folk Taxonomy and Ethnoecology. We interviewed 171 fishers from communities situated in four areas in Brazil: Soure (at Marajó Island, northern coast), Ponta Negra (at Natal, northeastern coast), São Sebastião (at southeastern coast) and Pântano do Sul (at Florianópolis, southern coast). Cetaceans are among the megafauna impacted by bycatch in fisheries. Nearly half of the cetacean species occurring in Brazil are classified by the IUCN Red List as "data deficient" due to lack of information about them. We studied fishers' LEK on cetaceans' classification and nomenclature. Fishers recognized 17 cetacean species and included them in four folk genera and 37 folk species. We recorded fishers' knowledge on cetaceans' ecology. Fishers reported 112 occurrence areas, providing information on preferential habitats, seasonality patterns, group sizes and reproduction for cetacean species. The topics most known by the fishers are occurrence areas and group sizes, and the least known is reproduction. The Guiana dolphin (*Sotalia guianensis*) and the bottlenose dolphin (*Tursiops truncatus*) are the most cited species. Fishers' LEK on cetaceans' interactions with fisheries indicated the following kinds of interactions: competition (with local fish and fishers), cooperation (to the fishers), and predation (on fisheries' target species or as prey for other top predators). The most common species in each place (*Sotalia guianensis, Tursiops truncatus*, *Inia geoffrensis, Stenella clymene, Pontoporia blainvillei and Eubalaena australis*) are the most known by the fishers, and those mentioned as the main cooperators or competitors. As a result of these interactions some cetaceans are accidentally caught by gillnets used near the coast. Fishers know details about the feeding habits of some species, describing

28 different feeding behaviors and listing 48 species of fishes, mollusks and crustaceans as preferential prey. There were variations among fishers' LEK in the study areas, probably influenced by the level of communities' dependence on natural resources and by variations in oceanographic parameters. We compare fishers' knowledge on the most common species with the information in the scientific literature and we found great concordance in relation to cetaceans' occurrence areas, seasonality, group sizes, prey items and their interactions with fisheries except for two species (*Stenella clymene* and *Inia geoffrensis*), to which fishers' information was discordant. These cases of inconsistency between LEK and scientific literature could reflect the fishers' lack of knowledge on these species or, conversely, could suggest new lines of investigation. Fishers' knowledge on the cetaceans' feeding behavior and their interactions to fisheries can be helpful, through the indication of bycatch critical areas and alternative location for setting gillnets, as well as possible alterations in gillnets' designs. We suggest that fishers' knowledge should be considered in fisheries management plans, helping to minimize the negative interactions between cetaceans and fisheries.

INTRODUÇÃO GERAL

Este estudo registrou e analisou o conhecimento ecológico local sobre cetáceos em comunidades de pescadores artesanais, localizadas em quatro áreas geograficamente distintas na costa brasileira: Ilha do Marajó, Natal, São Sebastião e Florianópolis.

Desta forma, tendo a Ecologia Humana e a Etnobiologia como bases conceituais e metodológicas e levando-se em conta as variações oceanográficas e culturais entre as quatro áreas, buscou-se caracterizar o conhecimento dos pescadores sobre a classificação, nomenclatura e a ecologia dos cetáceos.

Um dos objetivos gerais deste trabalho é identificar informações que possam complementar as lacunas de conhecimento relativas à ecologia das espécies de cetáceos pouco conhecidas, bem como contribuir com alternativas para um manejo pesqueiro mais eficiente, minimizando as interações negativas entre a pesca e os cetáceos.

1. Etnobiologia: Conhecimento Ecológico Local

A Ecologia Humana é a ciência que estuda as relações entre os seres humanos e outros seres vivos, bem como entre os fatores ambientais e sobrenaturais, relações estas que ocorrem não apenas no âmbito biológico, mas também nos âmbitos econômico e social (Bruhn 1974; Begossi 1993). Conseqüentemente, é uma ciência interdisciplinar, agregando conceitos da Antropologia, Sociologia, Geografia, Psicologia, Economia, entre outras áreas, e inclui várias linhas de pesquisa, como a Etnobiologia, a Etnoecologia, a Etnobotânica, a Etnozoologia e suas ramificações. Bruhn (1974) destaca o fato de que existe uma interação entre o ambiente social e o ambiente físico que é afetada por valores culturais e percepções, bem como por variações nos fatores físicos, que moldam o comportamento humano. Sendo assim, este autor sugere que as pesquisas em Ecologia Humana sejam realizadas priorizando o enfoque interdisciplinar, a fim de que todas as áreas possam contribuir na solução dos problemas que envolvem as interações humanas com o meio ambiente.

O conhecimento que as populações humanas têm em relação ao ambiente, também conhecido como *conhecimento ecológico tradicional*, *indígena*, *nativo* ou *local* (conforme o grupo estudado), é transmitido oralmente entre gerações e é construído pelo conhecimento empírico*,* através de experiências diárias acumuladas ao longo da vida, pela *prática* resultante das atividades humanas e pelas *crenças* que influenciam a percepção humana e as formas de interação com o meio natural (Toledo 2002; Berkes 2008). Neste estudo, utilizaremos a expressão *conhecimento ecológico local* (ou a sigla LEK, de *local ecological knowledge*), para nomear o conhecimento dos pescadores de cada uma das áreas estudadas.

A Etnobiologia é um ramo da Ecologia Humana que estuda o conhecimento das diversas culturas humanas sobre o meio ambiente (Begossi 1993). De acordo com Berkes (2008), o estudo do *conhecimento ecológico tradicional* (indígena, nativo ou local) se inicia pela análise de como determinados grupos humanos classificam os seres vivos (Etnotaxonomia ou Taxonomia Folk) e avança pesquisando o conhecimento que estes grupos possuem acerca dos processos ecológicos e a forma como interagem com o meio ambiente (Etnoecologia). A Etnoecologia também estuda as estratégias de uso e manejo de recursos naturais e o repertório cultural (crenças e mitos) envolvido nas relações entre os seres humanos e o meio ambiente (Nazarea 1999; Toledo 2002).

Pesquisas sobre o conhecimento ecológico local têm sido conduzidas em diversas culturas, sobre diferentes tópicos. Pesquisadores como H. C. Conklin, R. Bulmer, C. Brown, B. Berlin, S. Atran, W. Baleé, e E. Hunn estudaram a classificação etnobiológica (Etnotaxonomia) dos povos Hanunóo, Navajo, Maya, Aguaruna, Tzeltal, Tupi-Guaraní (Berlin 1992). Na área de Etnobotânica, G. T. Prance, R. E. Schultes, O. L. Phillips, A. Begossi, N. Hanazaki e N. Peroni tem pesquisado o conhecimento de povos da Amazônia e da Mata Atlântica sobre o uso das plantas (Begossi *et al.* 2002, Hanazaki 2004). D. A. Posey estudou por cerca de duas décadas a etnotaxonomia e a etnoentomologia dos índios Kayapó na Amazônia (Posey 1984, 1986). Robert E. Johannes estudou o conhecimento ecológico de pescadores da Oceania sobre peixes e pesca por mais de vinte anos

(Johannes 1977, 2003). Nas últimas três décadas, F. Berkes tem estudado o conhecimento ecológico tradicional sobre a pesca e sistemas de manejo no Canadá, Caribe, América do Sul e Índia, entre outros lugares (Berkes 2008), e K. Ruddle tem abordado a importância, a validação e as limitações do LEK de pescadores artesanais e discutido o manejo pesqueiro na Ásia e no Pacífico (Ruddle and Davis 2011). H. P. Huntington tem estudado o LEK de caçadores do Ártico sobre mamíferos marinhos nas últimas duas décadas (Huntington 1999, 2004). Neste mesmo período, A. Begossi tem estudado o conhecimento de pescadores da Amazônia e da costa brasileira sobre pesca, peixes, plantas, manejo pesqueiro, tabus alimentares e uso de recursos (Begossi 2004; Begossi *et al.* 2010). J. G. W. Marques tem estudado o LEK dos pescadores brasileiros sobre os peixes (Marques 2001) e R. A. M. Silvano tem comparado o conhecimento dos pescadores brasileiros com o conhecimento dos pescadores da Austrália, além de comparar o LEK com estudos biológicos, registrando sua importância em relação ao manejo pesqueiro (Silvano e Begossi 2005; Silvano e Valbo-Jorgensen 2008; Silvano e Begossi 2010).

Embora seja uma área cujas linhas de pesquisas se diversificaram muito e se intensificaram nas últimas cinco décadas, a Etnobiologia ainda enfrenta algum preconceito dentro dos meios acadêmicos. O não-reconhecimento do conhecimento ecológico local pela ciência ocidental é uma realidade que tem sido apontada por muitos autores (Johannes 2000 e 2003b; Gilchrist *et al.* 2005; Ruddle 2007; Berkes 2008). A falta de homogeneidade dos dados produzidos pelo LEK e a dificuldade em quantificar ou "validar" esse conhecimento têm sido alguns dos argumentos apresentados para explicar esta atitude de alguns ecólogos em relação ao conhecimento ecológico local. Berkes (2008) considera que, possivelmente, a relutância por parte destes cientistas em aceitar o conhecimento ecológico das populações estudadas é mais uma questão de disputa pela autoridade e legitimidade do conhecimento do que uma dúvida em relação à sua qualidade.

Apesar da resistência em aceitar o LEK, os resultados de pesquisas sobre este conhecimento demonstram que ele fornece informações valiosas sobre vários tópicos. Estudos sobre Etnoictiologia, por exemplo, mostram que os pescadores detêm informações importantes sobre aspectos biológicos e ecológicos pouco conhecidos de peixes, como reprodução, migração e interações tróficas. Silvano e Valbo-Jorgensen (2008) apresentaram 29 hipóteses baseadas no LEK dos pescadores sobre hábitos alimentares, migração, reprodução e padrões de abundância de peixes marinhos e de água doce do Brasil e do sudeste da Ásia. Estes autores sugerem a utilidade do LEK como fonte de hipóteses a serem testadas cientificamente ou no sentido de contribuir com novas informações sobre espécies raras e ameaçadas, que poderiam complementar o conhecimento científico atual. Marques (1995) coletou uma informação inédita sobre o hábito alimentar de uma espécie de peixe (*Arius herzbergii*) ao pesquisar sobre a Etnoecologia de pescadores no sistema lagunar Mundaú-Manguaba, no Nordeste do Brasil. Os pescadores afirmavam que esta espécie estuarina alimenta-se sazonalmente de "mariposas" (insetos efemerópteros) de água doce. Um estudo do conteúdo estomacal destes peixes confirmou a afirmação dos pescadores, exemplificando o potencial do LEK em trazer novas informações para a ciência (Marques 1995). Estudos realizados por Begossi *et al.* (2011) sobre dieta e reprodução de peixes da família Lutjanidae no nordeste e no sudeste do Brasil confirmam que os pescadores têm um conhecimento mais preciso sobre as espécies-alvo da pesca local.

Além de complementar as lacunas de conhecimento sobre aspectos ecológicos das espécies estudadas, o LEK pode documentar espacial e temporalmente o efeito das mudanças climáticas nos ecossistemas e em espécies vulneráveis ou de grande importância econômica, cultural ou científica. Carter e Nielsen (2011) em um estudo recente sobre as mudanças ecológicas em Cook Inlet (Alaska) utilizaram o LEK dos pescadores e antigos caçadores para identificar as causas do declínio das populações de beluga (*Delphinapteras leucas*) e as informações que obtiveram apontaram impactos que já haviam sido previamente identificados por meio de estudos científicos.

Outra possibilidade de contribuição do conhecimento local é sua integração nas políticas de manejo, quando se pretende o manejo comunitário ou co-manejo.

Uma vez que o LEK reflete a experiência dos usuários locais dos recursos naturais, muitos autores recomendam que seria extremamente pertinente que este conhecimento fosse considerado ao se tratar de políticas de manejo (Johannes 2003; Ruddle 2007; Berkes 2009; Silvano *et al.* 2009; Begossi 2010).

2. A Pesca

A pesca pode ser considerada como a última atividade humana extrativista em grande escala realizada a nível mundial (Diegues 1983). A pesca começou a ser praticada antes mesmo do aparecimento da agricultura e se desenvolveu muito na Idade Média, deixando de ser apenas uma atividade de subsistência e tornando-se também uma importante atividade comercial (Diegues 1983).

O desenvolvimento da pesca ao longo dos séculos é resultado da evolução das embarcações pesqueiras em relação ao tamanho dos barcos, e também ao sistema de propulsão, que passa do remo e da vela para a propulsão a vapor e posteriormente para a utilização de motores movidos a combustíveis derivados do petróleo. Os apetrechos de pesca e equipamentos das embarcações têm evoluído continuamente, fazendo com que os pescadores aumentem muito sua produção e tenham acesso a áreas cada vez mais distantes.

O resultado desta expansão em escala global na pesca, somada à falta de um manejo adequado e de fiscalização às regulamentações existentes, entre outros fatores, tem levado à diminuição dos estoques das principais espécies comerciais exploradas, tornando a pesca uma atividade insustentável em termos ambientais, sociais e econômicos (Pauly 2006).

Segundo o relatório da FAO “The State of World Fisheries and Aquaculture - 2008” (FAO 2009), a captura mundial de pescado alcançou cerca de 92 milhões de toneladas em 2006, sendo que 77% deste total foram utilizados para consumo humano. Cerca de 30 milhões de pessoas trabalhavam na pesca em 2006, gerando uma renda estimada em 91 bilhões de dólares. A China, o Peru e os Estados Unidos foram os países que apresentaram as maiores capturas de pescado. Este relatório nos informa ainda que apenas 20% dos estoques pesqueiros estão subexplotados ou moderadamente explotados. Um pouco mais da metade dos estoques (52%) está totalmente explotado, enquanto 19% estão sobrexplotados, 8% estão reduzidos e 1% está se recuperando.

Em um estudo recente, Pauly (2009) destaca que as três principais causas que estão levando a pesca mundial ao declínio são as capturas sub-reportadas, a falta de manejo baseado em informações científicas e a idéia de que o meio ambiente esteja causando o declínio da pesca. Segundo esse autor, alguns fatores influem diretamente no declínio das capturas: o excesso de barcos pesqueiros devido ao aumento dos subsídios governamentais, o fato de 1/3 das capturas mundiais de peixes pelágicos (sardinha e manjuba) serem usados para alimentar animais em empreendimentos de aqüicultura, a constatação de que cerca de 50% das capturas são comercializadas internacionalmente, ameaçando a segurança alimentar dos países pobres e o fato da pesca de pequena escala não ser incluída de forma sistemática na estatística pesqueira global. Pauly (2009) sugere que a crise na pesca pode ser uma oportunidade de mudança, e que a redução do esforço de pesca e a criação de áreas marinhas protegidas podem contribuir para a solução, adotando-se o manejo baseado no ecossistema, que visa proteger o potencial produtivo do sistema como um todo e não apenas um estoque individual.

Na mesma linha de argumentação, Crowder *et al.* (2008) destacam que a pesca tem reduzido a biodiversidade, a produtividade e os serviços proporcionados pelos ecossistemas, por meio do uso de equipamentos impactantes como as redes de arrasto, as dragas, as armadilhas, as redes de fundo e os espinhéis de fundo. Esses autores sugerem o co-manejo simultâneo de recursos múltiplos, ou seja, de todas as atividades desenvolvidas em determinada área além da pesca, como o turismo náutico, o transporte de navios cargueiros e atividades petrolíferas. Além disso, Crowder *et al.* (2008) propõem o zoneamento marinho, para que as atividades humanas sejam sustentáveis e permitam manter a resiliência dos serviços dos ecossistemas, ou seja, a capacidade destes serviços em se manter operacionais mesmo após impactos no ecossistema.

Outra possibilidade, segundo Begossi *et al.* (2011), seria agregar os pescadores às políticas de co-manejo dos recursos pesqueiros por meio de duas estratégias. A primeira seria combinar o conhecimento ecológico local dos pescadores ao conhecimento científico, de forma que os pescadores sintam-se realmente inseridos no processo de co-manejo. Outra opção seria oferecer aos pescadores pagamentos por serviços ambientais (PSA) para que estes, em troca, participem de monitoramentos de áreas de pesca ou de desembarques pesqueiros de espécies pouco conhecidas, além de respeitarem as áreas restritas à pesca.

A pesca artesanal envolve múltiplas técnicas de captura e apetrechos de pesca, visando a captura de diversas espécies-alvo em áreas de pesca dispersas ao longo da costa (Johannes 2003). Essas características tornam o manejo desse tipo de pesca muito complexo, resultando na falta de estatísticas pesqueiras confiáveis (Ruddle e Hickey 2008; Pauly 2009). O ideal seria que o manejo da pesca artesanal fosse realizado regionalmente ou específicamente à arte de pesca (Crowder *et al.* 2008). Cerca de 90% dos pescadores mundiais são pescadores artesanais que contribuem com mais de 50% da produção de pescado por ano, tendo, portanto, um papel fundamental na segurança alimentar mundial (Berkes *et al.* 2001; Crowder *et al.* 2008; Begossi 2010).

Atualmente o Brasil ocupa a 24ª posição no ranking mundial de capturas de pescado (FAO 2008), com uma produção de cerca de 775.000 toneladas. A pesca artesanal é praticada por cerca de 2 milhões de pescadores brasileiros, que produzem mais de 50% do pescado capturado no país (Vasconcelos *et al.* 2007).

Algumas comunidades pesqueiras artesanais praticam seu próprio sistema de manejo, baseados no conhecimento ecológico local desenvolvido pelos pescadores (Berkes *et al.* 2001, Castro 2002). Contudo, o manejo inadequado da pesca artesanal, apesar de sua pequena escala, pode levar a depleção dos recursos pesqueiros, da mesma forma que acontece com a pesca industrial. De Boer *et al.* (2001) compararam comunidades de peixes bentônicos em duas áreas de pesca em uma baía em Inhaca Island em Moçambique. Em uma das áreas comprovaram a ocorrência de sobrepesca, causando alterações nas comunidades de peixes tais como a diminuição da ocorrência de peixes piscívoros, alta densidade de peixes pequenos e desaparecimento dos grandes predadores. Apesar de algumas evidências, dada a grande quantidade de pescadores artesanais no Brasil e no mundo, torna-se difícil avaliar o impacto da pesca artesanal sobre os estoques explorados, devido à variedade de equipamentos e condições locais.

3. **Os Cetáceos**

As baleias e os golfinhos são mamíferos aquáticos da Ordem Cetacea, que evoluíram de ancestrais terrestres a cerca de 55 milhões de anos atrás. Seus parentes mais próximos, segundo evidências moleculares, são os hipopótamos (ordem Artiodactyla) (Bastida *et al.* 2007, Jefferson *et al*. 2008). Os cetáceos dividem-se nas Subordens Mysticeti (espécies com cerdas bucais), representados pelas grandes baleias e Odontoceti (espécies com dentes), representados pelos golfinhos, botos, cachalotes e baleias bicudas.

Em seu processo evolutivo, os cetáceos sofreram adaptações fisiológicas, anatômicas e ecológicas notáveis, acompanhando as mudanças que ocorriam no ambiente marinho e que lhes possibilitou uma vida exclusivamente aquática. As principais adaptações foram o desenvolvimento da ecolocação (sistema de localização por sons) nos odontocetos e da alimentação por filtração nos misticetos, mudanças no esqueleto axial e apendicular, telescopização do crânio (extensão das mandíbulas), modificações no sistema respiratório para aumentar o fôlego durante os mergulhos e resistir a alterações de pressão e migração das narinas para o alto do crânio para possibilitar a respiração fora d’água. Todas estas modificações estão relacionadas à necessidade de forrageio em ambiente subaquático, indicando que a ecologia alimentar dos cetáceos foi determinante na sua evolução (Uhen 2007).

Existem atualmente 86 espécies viventes de cetáceos, distribuídas em todos os oceanos, grandes rios e alguns lagos do mundo. Algumas espécies são cosmopolitas, como a orca (*Orcinus orca*), enquanto a maioria está restrita a determinadas regiões. Os misticetos (grandes baleias), o cachalote e algumas espécies de baleias bicudas realizam migrações, geralmente para áreas reprodutivas no inverno e áreas de alimentação no verão (Bastida *et al.* 2007, Jefferson *et al*. 2008).

A produção de sons para ecolocação e comunicação é uma das principais adaptações dos cetáceos. Na ecolocação, os odontocetos emitem sons que ao serem refletidos por outros organismos no meio aquático lhe fornecem a noção exata da localização do organismo. A ecolocação é utilizada em atividades vitais como alimentação e reprodução. Os misticetos e odontocetos também emitem outros tipos de sons (assovios, nos casos dos golfinhos ou pulsos sonoros, no caso das baleias), por meio dos quais os indivíduos de cada espécie se comunicam.

A reprodução dos cetáceos é totalmente subaquática, desde a cópula até o parto e o período de amamentação do filhote. O período de gestação dura ao redor de um ano para a maioria das espécies e a fêmea dá a luz a um filhote por gestação. A lactação pode durar de seis meses a dois anos, conforme a espécie. No primeiro ano os filhotes dobram de comprimento e ganham cerca de cinco vezes o seu peso. O período entre gestações é geralmente de dois a três anos (Bastida *et al.* 2007).

As grandes baleias são filtradoras, alimentando-se de cardumes de pequenos peixes e invertebrados. Os odontocetos se alimentam principalmente de peixes e lulas, localizando-as através da sua capacidade de ecolocação (Jefferson *et al*. 2008). Estratégias de alimentação cooperativa em grupos são comuns para a maioria dos odontocetos e têm sido observadas também para as jubartes (*M. novaeangliae*) (Clapham 2000). A orca é a única espécie de cetáceo capaz de predar outros cetáceos, além de outros grupos de mamíferos marinhos, como lontras e pinípedes (Baird 2000).

A maioria dos cetáceos vive em grupos sociais mutualísticos, que se formam em função do risco de predação ou de agressão por outros grupos (Connor *et al.* 2000). Mesmo as espécies consideradas solitárias, como as grandes baleias, costumam se agregar nas áreas de alimentação ou de reprodução (Fig. 1). Alguns golfinhos oceânicos podem formar grupos de centenas a milhares de indivíduos, como os golfinhos-comuns (*Delphinus delphis*) (Jefferson *et al*. 2008).

No Brasil ocorrem cerca de 40 espécies de cetáceos, que habitam a costa, incluindo os grandes rios e estuários amazônicos (IBAMA 2001). Conforme a classificação proposta pela IUCN (2010), três dessas espécies são consideradas "em perigo" de extinção (*Balaenoptera musculus*, *B. borealis* e *B. physalus*), quatro estão "vulneráveis" à extinção (*Megaptera novaeangliae*, *Physeter macrocephalus*, *Pontoporia blainvillei* e *Inia geoffrensis*), e outras 17 são classificadas como espécies que apresentam "falta de dados", e, portanto, não foram categorizadas quanto ao risco de extinção. As principais causas de mortalidade dos cetáceos no mundo são: captura acidental em redes de pesca ("bycatch"), exploração direta, destruição ou poluição de seus habitats, colisão com embarcações e impactos acústicos de sonares de embarcações, operações sísmicas e exercícios militares (Reeves *et al.* 2003).

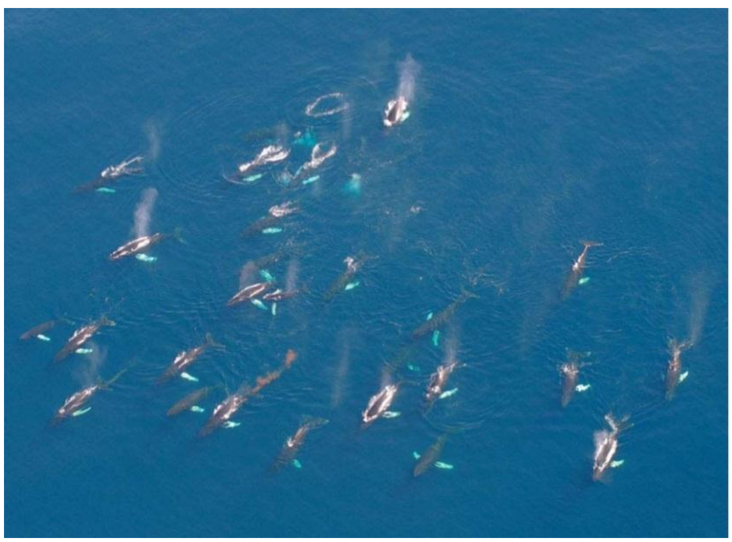


Figura 1 – Agregação alimentar excepcionalmente grande de baleias jubarte (*M. novaeangliae*) na Groenlândia Ocidental em 2005. (Foto de Lars Witting, retirada de Simon 2010)

Várias espécies de baleia vêm sendo caçadas desde o século XI até hoje, como por exemplo, a baleia-minke (*B. acutorostrata*), a baleia-fin (*B. physalus*) e a jubarte (*M. novaeangliae*). Após a constatação da drástica redução nas populações de algumas das espécies caçadas, a International Whaling Commission estabeleceu uma moratória contra a caça comercial de baleias em

1986. Entretanto, alguns países ainda continuam a caçar baleias por meio de uma polêmica cota que permite caçar um número determinado de indivíduos para pesquisas científicas. Felizmente, o Brasil respeitou a moratória, interrompendo as atividades baleeiras na década de 80 e publicou a Lei 7643/87, que proíbe "a pesca, ou qualquer forma de molestamento intencional de toda espécie de cetáceo nas águas jurisdicionais brasileiras", salvando a tempo a baleia franca austral do perigo de extinção (IBAMA 2001).

A captura acidental de cetáceos em equipamentos de pesca tem sido uma das principais causas de mortalidade para as espécies de menor porte no mundo, causando a morte de cerca de 300.000 indivíduos anualmente (Reeves *et al.* 2005). Devido a suas baixas taxas reprodutivas e crescimento lento, a mortalidade por captura acidental resulta em grande impacto às populações de cetáceos. O impacto das capturas realizadas pela pesca industrial tem sido monitorado há alguns anos e programas com observadores de bordo têm sido utilizados como forma de inibir as capturas. Entretanto, em relação à pesca artesanal, não há um monitoramento efetivo das capturas acidentais, embora haja indícios de impactos muito negativos sobre os pequenos cetáceos (Moore *et al.* 2010). Soykan *et al.* (2008) alertam para o fato de que apesar de anos de pesquisas sobre captura acidental no mundo, ainda não se tem um conhecimento global de quais são as espécies mais afetadas e em que grau.

Por serem espécies muito carismáticas, os cetáceos têm maior valor de conservação do que valor comercial, o que pode dificultar na implementação de medidas mitigadoras da captura acidental junto aos pescadores, que em geral não percebem o impacto que estas capturas podem ter nas populações de cetáceos (Campbell e Cornwell 2008). As redes de espera são as principais responsáveis pela captura de pequenos cetáceos no Brasil, em vários países da África, no Caribe e nos Estados Unidos (Moore *et al.* 2009; Moore *et al.* 2010; Rocha-Campo *et al.* 2010). As medidas mitigadoras mais comumente aplicadas são a utilização de dispositivos acústicos acoplados às redes de pesca para afugentar os cetáceos e o estabelecimento de períodos de defeso nas áreas e épocas mais críticas de captura. Entretanto, estas medidas geralmente acabam sendo prejudiciais à pesca, afetando a sobrevivência dos pescadores, e com isso não são efetivamente implantadas.

Dentre as espécies de cetáceos mais estudadas no Atlântico Sul Ocidental estão a baleia-franca (*E. australis*), a baleia-jubarte (*M. novaeangliae*), a toninha (*P. blainvillei*), o boto-cinza (*S. guianensis*) e o boto-rosa (ou boto amazônico) (*I. geoffrensis*). Estes estudos em sua maioria referem-se à distribuição, estimativas populacionais, migração, reprodução, hábitos alimentares e interações com a pesca (Payne *et al.* 1990; Best e Da Silva 1993; Di Beneditto *et al.* 2001; Ott *et al.* 2002; Zerbini *et al.* 2004; Azevedo *et al.* 2005; Zerbini *et al.* 2006; Santos e Rosso 2008; Danilewicz *et al.* 2009; Flores e Da Silva 2009; Da Silva e Martin 2010).

Pesquisas etnobiológicas envolvendo cetáceos ganharam força a partir da década de 90, sendo realizadas em comunidades pesqueiras em várias partes do mundo. Huntington *et al*. (1999, 2004) e Mymrin *et al.* (1999) estudaram o LEK dos caçadores árticos sobre as belugas (*Delphinapterus leucas*) reunindo informações sobre a ecologia desta espécie e comparando as informações obtidas com o conhecimento científico. Noogwook *et al.* (2007) estudaram o conhecimento dos caçadores de baleias sobre os movimentos sazonais da baleia-da-Groenlândia (*B. mysticetus*).

No Brasil, estudos etnobiológicos com cetáceos começaram no início da década de 2000, em comunidades costeiras dos estados de Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Bahia, Maranhão e Pará. O foco principal destas pesquisas tem sido as interações entre cetáceos e a atividade pesqueira, bem como o conhecimento dos pescadores sobre a classificação, nomenclatura e aspectos ecológicos das espécies: boto-cinza (*S. guianensis*), golfinho-nariz-de-garrafa (*T. truncatus*), toninha (*P. blainvillei*), boto-rosa (*I. geoffrensis*) e jubarte (*M. novaeangliae*) (Pinheiro e Cremer 2003; Peterson 2005; Oliveira e Monteiro-Filho 2006; Souza e Begossi 2006; Souza e Begossi 2007; Rodrigues 2008; Alarcon 2009; Zappes *et al.* 2009 e 2011).

4. **Objetivos**

Esta pesquisa tem como objetivo geral estudar o conhecimento ecológico local dos pescadores sobre cetáceos em relação à Etnotaxonomia e Etnoecologia, em quatro áreas distintas da costa brasileira: Ilha do Marajó (região norte), Natal (região nordeste), São Sebastião (região sudeste) e Florianópolis (região Sul), visando obter um registro deste LEK em uma escala geográfica e cultural mais ampla.

Como objetivos secundários pretendemos:

a) comparar e discutir as variações do LEK entre as áreas estudadas
b) comparar o LEK em relação à literatura científica especializada;
c) obter informações, oriundas do LEK dos pescadores, que possam complementar as lacunas de conhecimento existentes em relação as espécies de cetáceos e aos tópicos menos estudados cientificamente, como por exemplo a reprodução;
d) encontrar soluções alternativas para os impactos causados por interações negativas entre as atividades pesqueiras e os cetáceos, como a captura acidental, por meio da análise do LEK.

5. **Metodologia**

Com o objetivo de registrar o conhecimento ecológico local sobre cetáceos, entrevistamos pescadores artesanais de comunidades situadas na Ilha do Marajó, Natal, São Sebastião e Florianópolis (Fig. 2), aplicando a seguinte metodologia:

a. previamente às entrevistas, foi explicado a cada entrevistado o teor do projeto e o tipo de questionário a que seriam submetidos e somente participaram os entrevistados que deram seu consentimento verbal;
b. as entrevistas seguiram um questionário oral padronizado, parcialmente estruturado (com perguntas fechadas e abertas) sobre:
    - aspectos sócio econômicos da pesca local (idade do pescador, tempo de pesca, tempo de residência na área de estudo, escolaridade, prática de outras atividades

complementares, tipo de embarcação e apetrechos de pesca utilizados, espécies-alvo da pesca local, pontos de pesca utilizados)

- a identificação, classificação, nomenclatura e diversos aspectos da ecologia dos cetáceos (Apêndice 1).

c. Foram mostradas figuras das espécies de cetáceos, sem identificação, para que os pescadores pudessem fazer o reconhecimento das mesmas (Apêndice 2);
d. os primeiros entrevistados foram os pescadores líderes de cada comunidade, e os seguintes foram selecionados pelo método "bola-de-neve" onde cada pescador indica outro de conhecida competência nas artes de pesca;
e. a fim de verificarmos o conhecimento dos pescadores mais experientes, entrevistamos apenas aqueles acima de 35 anos de idade, com mais de 15 anos de tempo dedicado à pesca e residindo naquela comunidade por mais de 10 anos;
f. as espécies de cetáceos incluídas nas entrevistas foram aquelas de ocorrência registrada pela literatura especializada em cada área (Best e Da Silva 1993; Siciliano 1994; Araújo *et al.* 2001; Flores e Bazzalo 2004; Moreno *et al.* 2005; Siciliano *et al.* 2006; Bastida *et al.* 2007; Siciliano *et al.* 2008; Da Silva 2009; Flores e Da Silva 2009; Santos *et al.* 2010);
g. as respostas fornecidas pelos pescadores para cada tópico e cada espécie foram quantificadas, inclusive as respostas "não sei / não conheço", que foram um indicativo do nível de dúvida (ou seja, ausência de conhecimento) em relação ao tópico e à espécie, conforme utilizado em outros estudos (Silvano e Begossi 2002, Silvano *et al.* 2006);
h. foram realizadas análises estatísticas no sentido de facilitar a interpretação matemática dos resultados. Por exemplo: usamos teste de qui-quadrado para checar as diferenças no conhecimento dos

pescadores sobre as espécies em relação aos tópicos perguntados e à área de estudo; correlação linear de Pearson para relacionar o conhecimento dos pescadores à idade, tempo de pesca e escolaridade dos mesmos, ou ao número de espécies mencionadas para cada tópico perguntado; matriz linear para correlacionar o conhecimento dos pescadores aos diferentes tópicos estudados; análise de componentes principais para determinar os critérios dominantes usados nas classificações taxonômicas em cada área. Entretanto, para estes testes, foram considerados apenas os resultados correspondentes às respostas fornecidas por 20% dos entrevistados em cada área.

i. as informações obtidas dos pescadores foram comparadas com as informações encontradas sobre os mesmos tópicos e para cada espécie na literatura científica, a fim de verificar o grau de concordância entre as mesmas.

6. Áreas de estudo

As comunidades pesqueiras estudadas situam-se em Soure (Ilha do Marajó, Pará), Ponta Negra (Natal, Rio Grande do Norte), São Sebastião (São Paulo) e Pântano do Sul (Florianópolis, Santa Catarina) (Fig. 2).

Estas comunidades estão localizadas em regiões geograficamente distintas do Brasil e suas características sócio-econômicas são sumarizadas na Tabela 1.

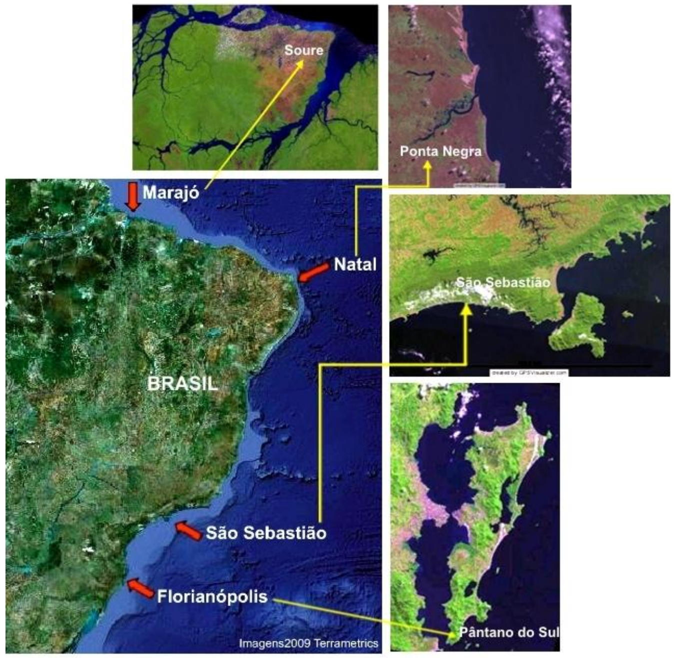


Figura 2 – Áreas de estudo na costa brasileira. (Soure: 00° 43' 00" S, 48° 31' 24" W, Ponta Negra: 05° 47' 42" S, 35° 12' 34" W, São Sebastião: 23º48'08" S, 45º24'07" W, Pântano do Sul: 27° 35' 48" S - 48° 32' 57" W) (Fonte: Terrametrics e Google Earth).

Tabela 1 – Aspectos sócio-econômicos das áreas estudadas.

Parâmetros sócio-econômicos	**Soure (Marajó)**	**Ponta Negra (Natal)**	**São Sebastião**	**Pântano do Sul (Florianópolis)**
População	22.995	± 30.000 (Natal - 803.811)	73.833	± 5.000 (Florianópolis – 421.203)
Distância de metrópole mais próxima	87 km (4 hs de barco)	4,5 km (20 min de ônibus)	112 km (2 hs de ônibus)	30 km (40 min de ônibus)
Serviços básicos (saneamento básico)	37%	100%	100%	25%
Serviços básicos (água)	58%	100%	100%	100%
Serviços básicos (eletricidade)	100%	100%	100%	100%
HDI (Índice de Desenvolvimento Humano - educação,saúde e renda per capita)	0.723	0.788	0.798	0.875
Índice de pobreza (proporção de pessoas de baixa renda na cidade)	48.21%	40.86%	21.58%	23.49%
N. Turistas/ano	± 410.000, 7% internacional, 93% nacional	1.350.000, 14,5% internacional, 85,5% nacional	± 200.000, 8,9% internacional, 91,1% nacional	± 800.000, 18,5% internacional, 81,5% nacional
Origem dos turistas	EUA, Alemanha - 34,7% América do Norte, 28,7% América do Sul, 24,3% Europa	Portugal, Espanha, Itália, Holanda - 70% Europa	EUA - 15%, Argentina - 12%, São Paulo - 20%	Argentina - 41,5%

(Dados sobre população, serviços básicos, HDI e Índice de pobreza: IBGE 2010; dados sobre turismo: Governo do Pará 2001; Hafermann 2004; Ministério do Turismo – Brasil 2010).

A. Soure – Ilha do Marajó

A Ilha do Marajó situa-se entre a foz dos rios Amazonas e Pará, sendo banhada ao norte pelo Oceano Atlântico (Fig. 2). Ocupa uma área de mais de 49.606 km^2, sendo considerada a maior ilha flúvio-marinha do mundo (Cruz 1999). Possui uma população de cerca de 355.000 habitantes, distribuídos entre seus 12 municípios. O clima nesta região apresenta duas estações bem marcadas: o inverno, com chuvas intensas de dezembro a junho e o verão, de julho a novembro, que é a estação seca. A paisagem da Ilha do Marajó é caracterizada pelo estuário amazônico, mangues e campos, que na época das chuvas tornam-se alagados. O clima é quente e úmido, com temperatura média de 29°C.

As águas na foz amazônica apresentam temperatura superficial média de 28°C e salinidade média de 32 pss, abaixo da média para o litoral brasileiro que fica entre 35 e 36 pss, denotando a influência dos rios amazônicos na salinidade marinha da região. Esta influência também se faz sentir na largura da plataforma continental do litoral paraense, que é influenciada pelo delta amazônico, apresentando uma largura média de 200 km e profundidade média de apenas 20 m (NOAA 2005; Souza-Filho 2005; DHN 2010).

Soure está localizada a leste da Ilha do Marajó às margens do Rio Paracauarí e da Baía do Marajó e é considerada a principal cidade da ilha. Possui 22.995 habitantes que descendem da nação indígena Nuaruaque, estabelecida na ilha antes de 1100 AC, bem como de colonizadores portugueses (IBGE 2010). A população de Soure vive basicamente da pesca, da pecuária extensiva, da extração de produtos da floresta e dos serviços locais (Cruz 1999). Os pescadores são organizados localmente pela Colônia de Pescadores Z-1, que foi a primeira a ser fundada no Brasil, em 1918. De acordo com informações obtidas junto à colônia e aos pescadores entrevistados, a região de Soure possui mais de 1.000 pescadores artesanais (Fig.3).

Figura 3 – Pescador lançando a tarrafa em um igarapé em Soure (Ilha do Marajó, Pará). (Foto: Shirley P. de Souza)

As espécies de cetáceos com ocorrência registrada no litoral paraense são: baleia-jubarte, baleia-de-Bryde, baleia-minke-Antártica, cachalote, orca, golfinho-nariz-de-garrafa, golfinho-de-dentes-rugosos, boto-cinza, golfinho-pintado-do-Atlântico e boto-rosa (Best e Da Silva 1993; Siciliano 1994; Bastida *et al.* 2007; Siciliano *et al.* 2008; Da Silva 2009) (Apêndice 3).

B. Ponta Negra – Natal

Natal é a capital do Estado do Rio Grande do Norte, situada na costa nordeste brasileira (Fig. 2). O Rio Grande do Norte possui uma linha de costa de 400 quilômetros, com cerca de 80 comunidades pesqueiras (IDEMA 2004). Seu clima tropical é caracterizado pelos ventos alísios que sopram predominantemente da direção sudeste no Hemisfério Sul e da direção nordeste no Hemisfério Norte, durante o ano todo. Como Natal está localizada na latitude de 05^{0} 47' 42" S (logo abaixo da linha do Equador), tanto os alísios de nordeste, quanto os de sudeste alcançam seu litoral, trazendo grande quantidade de umidade do oceano. Durante o inverno a temperatura do ar desce para 18°C, mas no resto do ano a temperatura gira em torno de 28°C, chegando ao máximo de 33°C. As chuvas são comuns de março a agosto e a pluviosidade média é de 1700 mm/ano (www.climabrasileiro.hpg.ig.com.br). Na prática, o clima local pode ser definido em duas estações predominantes: verão (meses secos, setembro a fevereiro) e inverno (meses chuvosos, março a agosto), não ocorrendo a sazonalidade definida, característica das quatro estações.

A temperatura superficial da água do mar está entre 26 e 30°C, com pouca variação entre o verão e o inverno e a salinidade média é de 36 pss. Entretanto, existe uma grande variação na termoclina, cuja temperatura cai de 25 para 10° C na mudança de verão para inverno. Esta termoclina é permanente na costa nordeste brasileira, impedindo a mistura vertical das massas de água do mar (ou ressurgência), resultando em águas oligotróficas. A plataforma continental nesta parte do litoral brasileiro é muito estreita, rasa e menos produtiva, se comparada àquela do litoral sul brasileiro (Tabosa e Vital 2002, Oliveira 2005).

Natal é rodeada por dunas de areia, muitas delas declaradas áreas de proteção ambiental. É uma cidade de porte médio, com cerca de 800.000 habitantes, em sua maioria descendentes de índios nativos e portugueses, com pequena participação de invasores franceses e holandeses que viveram naquela região por algumas décadas no século 16. A economia local é movimentada principalmente pelo turismo, que emprega cerca de 25% da população (IBGE 2010).

A comunidade pesqueira estudada situa-se no bairro de Ponta Negra, um bairro extremamente turístico de Natal, com cerca de 30.000 habitantes e um dos pontos de desembarque pesqueiro de Natal (Fig. 4). Os ranchos dos pescadores artesanais localizam-se muito próximos ao maior atrativo turístico da praia, uma duna conhecida como “Morro do Careca”. De acordo com informações obtidas na Colônia de Pescadores Z-4, responsável pela representação dos pescadores em Natal, Ponta Negra conta com cerca de 120 pescadores artesanais cadastrados, porém apenas cerca de 40 encontram-se em atividade.

Pesquisando na literatura especializada em cetáceos, encontramos que as espécies de ocorrência possível no litoral de Natal são: baleia-jubarte, baleia-minke-anã, baleia-minke-Antártica, cachalote, baleia-piloto-de-nadadeiras-curtas, falsa-orca, baleia-cabeça-de-melão, golfinho-nariz-de-garrafa, golfinho-de-

dentes-rugosos, boto-cinza, golfinho-de-Clymene, golfinho-pintado-pan-tropical e golfinho-rotador (Siciliano 1994; Araújo *et al*. 2001; Moreno *et al.* 2005; Bastida *et al.* 2007) (Apêndice 3).

Figura 4 – Pescadores de Ponta Negra, Natal, Rio Grande do Norte, voltando da pesca em suas jangadas. (Foto: Shirley P. de Souza)

C. São Sebastião – São Paulo

São Sebastião é uma cidade localizada no litoral norte do Estado de São Paulo (Fig. 5). Situa-se em um município homônimo, que compreende uma faixa litorânea de cerca de 80 km, incluindo 34 praias. Este litoral apresenta escarpas cristalinas, com planícies costeiras estreitas e margeadas pela Mata Atlântica, compondo uma paisagem de inúmeras praias recortadas ao longo da costa (SMA - SP 1996). São Sebastião possui 73.630 habitantes, e esta população duplica durante as férias de verão devido ao intenso fluxo de turistas na região (IBGE 2010). A região central da cidade abriga o maior terminal petrolífero da América do Sul (TEBAR – TRANSPETRO), cujas atividades geram um expressivo aporte de renda ao município, seguidas por atividades turísticas e pesqueiras.

A área do Canal de São Sebastião, formado pela presença da Ilha de São Sebastião em frente ao continente, é fortemente influenciada por condições oceanográficas características, sendo que ao norte deste Canal o litoral apresenta-se mais protegido, devido à presença da ilha, enquanto que a área a sudoeste do Canal caracteriza-se por litoral mais suscetível às ondulações oriundas do sul (Silva 1995). O clima apresenta quatro estações bem demarcadas, sendo a estação chuvosa durante o verão (janeiro a março). A temperatura média do ar é de 24 °C. Esse litoral é banhado pela massa de Água Costeira, que resulta da mistura das Massas de Água Tropical com a Massa de Água Central do Atlântico Sul, e apresenta temperaturas entre 19 e 29°C e salinidade entre 35 e 36 pss. A plataforma continental apresenta-se com uma largura média de 120 km e profundidade média de 80 m (Rossi-Wongtschowski e Madureira 2006).

Em função da grande dispersão dos pescadores artesanais ao longo do litoral de São Sebastião, escolhemos 14 comunidades como foco deste estudo, localizadas nas seguintes praias: Enseada, Cigarras, São Francisco, Pontal da Cruz, Barequeçaba, Toque-Toque Grande, Toque-Toque Pequeno, Paúba, Maresias, Boiçucanga, Barra do Sahy, Juqueí, Barra do Una e Boracéia (Fig. 5). Estimativas obtidas da Colônia de Pescadores Z-14 na ocasião do estudo (2006) apontavam para mais de 800 pescadores cadastrados em São Sebastião, embora uma grande porcentagem deles não estivesse em atividade.

Figura 5 – Comunidades pesqueiras de São Sebastião, São Paulo, contempladas neste estudo (1- Enseada, 2- Cigarras, 3- São Francisco, 4- Pontal da Cruz, 5-

Barequeçaba, 6- Toque-Toque Grande, 7- Toque-Toque Pequeno, 8- Paúba, 9- Maresias, 10- Boiçucanga, 11- Barra do Sahy, 12- Juqueí, 13- Barra do Una e 14- Boracéia).

Os cetáceos de ocorrência conhecida para o litoral norte do Estado de São Paulo são: baleia-franca, baleia-jubarte, baleia-minke-anã, baleia-de-Bryde, orca, golfinho-nariz-de-garrafa, golfinho-de-dentes-rugosos, boto-cinza, golfinho-pintado-do-Atlântico, golfinho-comum-de-bico-longo e toninha (Siciliano 1994; Siciliano *et al.* 2006; Santos *et al.* 2010) (Apêndice 3).

D. Pântano do Sul – Florianópolis

Florianópolis é a capital do Estado de Santa Catarina, e uma de suas cidades mais turísticas. Ela está situada na Ilha de Santa Catarina, que apresenta uma grande diversidade de ecossistemas, como a Mata Atlântica, montanhas, dunas de areia, lagoas e várias baías com praias recortadas (Fig. 2). O clima dessa região apresenta quatro estações bem marcadas, com temperatura média do ar de 21 ^{o}C. A temperatura superficial do mar apresenta uma média de 22 ^{o}C e a salinidade média gira em torno de 35 pss. Durante o inverno observa-se uma diminuição na temperatura da água do mar, em função do avanço da corrente fria das Malvinas que ganha força nesta época do ano. A plataforma continental apresenta-se com uma largura média de 130 km e profundidade média de 100 m, sendo a mais profunda entre as quatro áreas de estudo (Rossi-Wongtschowski e Madureira 2006).

Pântano do Sul é uma comunidade de pescadores situada em uma praia ao sul de Florianópolis, com forte influência de portugueses vindos dos Açores, que ali se instalaram a partir do século XIII, trazendo consigo a tradição pesqueira daquelas ilhas portuguesas (Fig. 6). Esta comunidade vive basicamente da pesca e do turismo, sendo a pesca da tainha um evento cultural e turístico que ocorre anualmente nesta praia há cerca de 100 anos (Medeiros 2001).

Figura 6 – Pescadores entrando no mar com bote a remo, embarcação comum em Pântano do Sul, Florianópolis, Santa Catarina. (Foto: Shirley P. de Souza)

De acordo com a literatura consultada, os cetáceos já registrados para o litoral de Florianópolis são: baleia-franca, baleia-jubarte, baleia-minke-anã, baleia-minke-Antártica, baleia-de-Bryde, cachalote, baleia-piloto-de-nadadeiras-curtas, orca, falsa-orca, golfinho-nariz-de-garrafa, golfinho-de-dentes-rugosos, boto-cinza, golfinho-pintado-do-Atlântico, golfinho-comum-de-bico-longo e toninha (Flores e Bazzalo 2004; Siciliano 1994; Flores e Da Silva 2009; Santos *et al.* 2010) (Apêndice 3).

7. Estrutura da Tese

Esta tese está dividida em quatro capítulos. O primeiro capítulo é uma caracterização da pesca artesanal nas áreas de estudo, conforme dados obtidos das entrevistas com os pescadores. Os demais capítulos, abordando respectivamente a Etnotaxonomia de Cetáceos, Etnoecologia de Cetáceos e Interações de Cetáceos com a Pesca, foram redigidos em inglês no formato de artigos científicos, para serem submetidos a periódicos internacionais. As conclusões finais integram as conclusões de cada capítulo, focalizando nos pontos mais importantes para a conservação dos cetáceos e manejo pesqueiro.

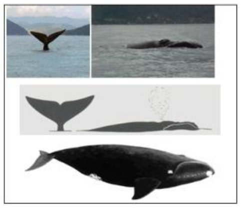
APÊNDICE 1

Questionário aplicado aos pescadores sobre aspectos ecológicos dos cetáceos.

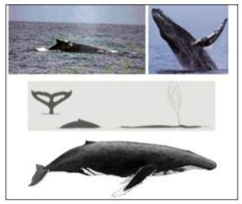
1-	Que tipo de animal são as baleias e os golfinhos? Por que você os classifica assim?
2-	Você conhece esse animal? Como você o chama?
3-	Onde você já viu esse animal?
4-	Em que época do ano você vê esse animal?
5-	O que esse animal come?
6-	Onde ele vive?
7-	Ele anda sozinho ou em grupo? Grupo de quantos animais?
8-	Você já viu filhotes junto com o grupo? Em que época do ano?
9-	Qual seria um predador para esse animal?
10-	Como são as interações (relações) entre esse animal e as atividades de pesca?
11-	Você pensa que esses diferentes tipos de baleias e golfinhos formam algum tipo de grupo? Quais e como? Porquê? (Nesta pergunta são mostradas as figuras de várias espécies de cetáceos juntas, para que os pescadores as agrupem ou não).

APÊNDICE 2

Figuras mostradas aos pescadores para cada espécie de cetáceos pesquisada (Desenhos retirados de Jefferson *et al.* 1993).



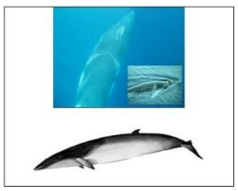
Eubalaena australis



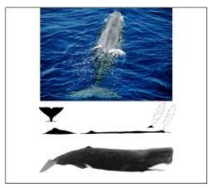
Megaptera novaeangliae

Balaenoptera edeni

Balaenoptera acutorostrata



Balaenoptera bonaerensis



Physeter macrocephalus

Orcinus orca

Globicephala macrorhynchus

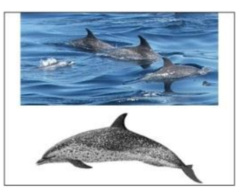
Peponocephala electra

Pseudorca crassidens

Tursiops truncatus

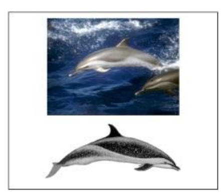
Steno bredanensis

Sotalia guianensis



Stenella frontalis

Stenella clymene

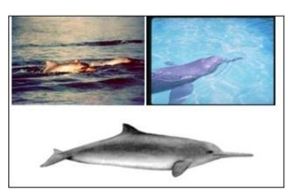


Stenella attenuata

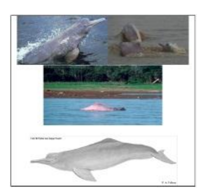
Stenella longirostris

Delphinus capensis

Delphinus delphis



Pontoporia blainvillei



Inia geoffrensis

APÊNDICE 3

Espécies de cetáceos registradas nas áreas de estudo, de acordo com publicações especializadas (Best e Da Silva 1993; Siciliano 1994; Araújo *et al.* 2001; Flores e Bazzalo 2004; Moreno *et al.* 2005; Siciliano *et al.* 2006; Bastida *et al.* 2007; Siciliano *et al.* 2008; Da Silva 2009; Flores e Da Silva 2009; Santos *et al.* 2010).

Nome comum	Nome científico	Marajó	Natal	São Sebastião	Pântano do Sul
1. Baleia-Franca-do-Sul	*Eubalaena australis* (Desmoulins, 1822)			X	X
2. Baleia-Jubarte	*Megaptera novaeangliae* (Borowski, 1781)	X	X	X	X
3. Baleia-de-Bryde	*Balaenoptera edeni* (Anderson, 1878)	X		X	X
4. Baleia-Minke-Anã	*Balaenoptera acutorostrata* (Lacépède, 1804)	X	X	X	X
5. Baleia-Minke-Antárctica	*Balaenoptera bonaerensis* (Burmeister, 1867)		X		X
6. Cachalote	*Physeter macrocephalus* (Linnaeus, 1758)	X	X		X
7. Orca	*Orcinus orca* (Linnaeus, 1758)	X		X	X
8. Baleia-Piloto-de-nadadeiras-curtas	*Globicephala macrorhynchus* (Gray, 1846)		X		X
9. Falsa-Orca	*Pseudorca crassidens* (Owen, 1846)		X		X
10. Baleia-Cabeça-de-Melão	*Peponocephala electra* (Gray, 1846)		X		
11. Golfinho-Nariz-de-Garrafa	*Tursiops truncatus* (Montagu, 1821)	X	X	X	X
12. Golfinho-de-Dentes Rugosos	*Steno bredanensis* (Lesson, 1828)	X	X	X	X
13. Golfinho-Pintado-do-Atlântico	*Stenella frontalis* (Cuvier, 1829)	X		X	X
14. Golfinho-Clymene	*Stenella clymene* (Gray, 1850)		X		
15. Golfinho-Pintado-Pantropical	*Stenella attenuata* (Gray, 1846)		X		
16. Golfinho-Rotador	*Stenella longirostris* (Gray, 1828)		X		
17. Golfinho-Comum-de-Bico-Curto	*Delphinus delphis* (Linnaeus, 1758)				X
18. Golfinho-Comum-de-Bico-Longo	*Delphinus capensis* (Gray, 1828)			X	
19. Boto-Cinza	*Sotalia guianensis* (van Bénéden, 1864)	X	X	X	X
20. Franciscana	*Pontoporia blainvillei* (Gervais e d'Orbigny, 1844)			X	X
21. Boto-vermelho	*Inia geoffrensis* (de Blainville, 1817)	X			

Capítulo 1

A Pesca e os Pescadores nas Áreas de Estudo

CAPÍTULO 1

A Pesca e os Pescadores nas Áreas de Estudo

Neste capítulo apresentaremos uma breve caracterização sócio-econômica dos pescadores entrevistados e da pesca praticada por eles em Soure, Ponta Negra, São Sebastião e Pântano do Sul. Estes dados foram obtidos por meio de entrevistas com um total de 171 pescadores e embasaram a análise dos resultados obtidos nas pesquisas sobre Etnotaxonomia (Cap.2), Etnoecologia (Cap. 3) e Interações dos cetáceos com as atividades pesqueiras (Cap. 4).

A pesca praticada pelas comunidades estudadas enquadra-se na categoria de pesca artesanal ou de pequena escala, que pode ser definida como a pesca praticada com o auxílio de pequenas embarcações, sem muitos recursos tecnológicos, envolvendo unidades familiares e com pouco investimento de capital e grande investimento no trabalho individual (FAO 2005-2011). Geralmente, os locais de pesca estão próximos a comunidade pesqueira, e uma parte do produto pescado é reservada para o consumo dos pescadores, sendo que a outra parte geralmente é comercializada. A seguir apresentamos os resultados obtidos para cada área estudada, que serão discutidos nos contextos dos capítulos seguintes.

1. Soure (Ilha do Marajó)

Em maio de 2007, 40 pescadores foram entrevistados em Soure, cidade da Ilha do Marajó. As idades desses pescadores variaram entre 35 e 80 anos, com uma média de 59 anos (dp = 10.24). O tempo de residência destes pescadores em Soure foi em média de 53 anos (dp = 14.55) e o tempo dedicado à pesca foi em média de 44 anos (dp = 11.12) (Fig. 1). Em sua maioria (57%) nasceram em Soure e 27% concluíram o 3º ano do Ensino Fundamental I (Fig. 2). Quanto ao envolvimento familiar com a pesca, 90% dos entrevistados são filhos de pescadores e 45% têm filhos participando da pesca. Mais de 90% dos pescadores de Soure dedicam-se exclusivamente à pesca.

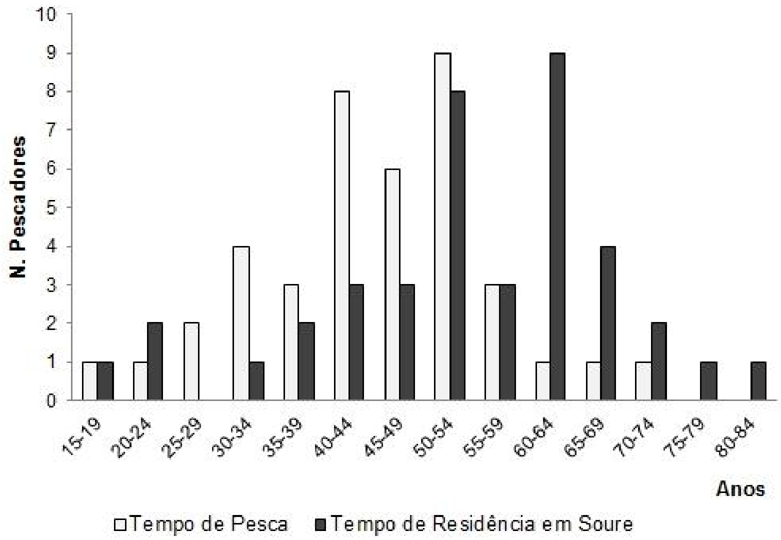


Figura 1. Tempo de pesca e de residência dos pescadores em Soure, Pará, segundo os 40 pescadores entrevistados (n = números de pescadores em cada categoria de anos).

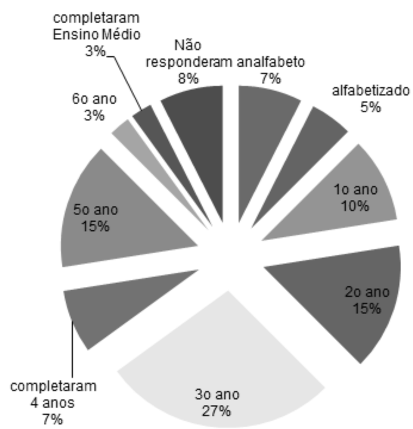


Figura 2. Escolaridade dos pescadores de Soure, Pará, segundo os entrevistados (n = 40), números referem-se a % de entrevistados que citou cada informação.

Os pescadores de Soure utilizam 39 pontos de pesca, oito dos quais são usados por mais de três pescadores (Fig. 3A). Estes pontos localizam-se principalmente na região costeira de Soure e na Baía do Marajó.

As redes de espera, incluindo a caçoeira, são os apetrechos de pesca mais utilizados, seguidas pela rabiola e redes de arrasto (Fig. 3B). No Apêndice 1, apresentamos uma listagem das principais artes de pesca e a porcentagem de pescadores que as citaram. A rabiola é um tipo de rede de espera, colocada transversalmente nas entradas dos igarapés, em que uma extremidade da rede fica presa a uma estaca de madeira, enquanto a outra ponta da rede fica boiando, apenas presa ao fundo por uma pedra, e pescando de acordo com a subida e a descida da maré. É usada para capturar peixes de pequeno porte como a pratiqueira (*Mugil curema*).

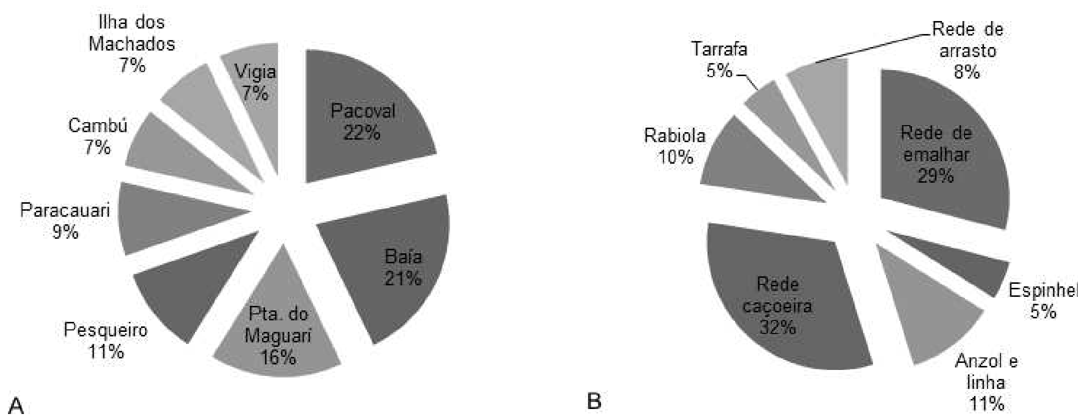


Figura 3 – A. Principais pontos de pesca em Soure, Pará. B. Apetrechos de pesca mais utilizados, segundo os 40 entrevistados (números referem-se a % de entrevistados que citou cada informação).

Vários tipos de embarcações são usados pelos pescadores, como 'montarias' (canoas) a vela e a remo, canoas e botes a motor. A maioria deles (53%) utiliza montarias a vela e a remo (Fig. 4).

As principais espécies-alvo capturadas pelos pescadores entrevistados e identificadas com base em Froese e Pauly (2011) são: dourada (*Brachyplatystoma flavicans*), tainha (*Mugil* sp.), pratiqueira (*Mugil curema*), bagre (*Bagre bagre*), pescada-amarela (*Cynoscion acoupa*), filhote (*Brachyplatystoma filamentosum*), piramutaba (*Brachyplatystoma vaillantii*) e pescada-branca (*Cynoscion leiarchus*).

No Apêndice 2 apresentamos uma listagem das principais espécies-alvo e suas respectivas porcentagens de citação pelos pescadores. Os pescadores desembarcam sua produção em suas praias de origem (Pesqueiro, Matinha, São Pedro, Araruna).

Figura 4 – Montaria a vela e a remo utilizada em Soure, Ilha do Marajó, Pará.

Segundo um diagnóstico publicado por Vasconcelos *et al.* (2007) sobre a pesca artesanal no Brasil, dados obtidos da estatística pesqueira de 2002 indicam que a pesca artesanal na região norte é responsável por cerca de 80% da produção total de pescado naquela região.

2. Ponta Negra (Natal)

Em Natal, em janeiro de 2007, entrevistamos 36 pescadores de Ponta Negra, cujas idades variaram entre 35 e 68 anos, com uma média de 47 anos (dp = 8.78), tendo vivido em Ponta Negra em média 41 anos (dp = 12.93). A maioria deles (61%) nasceu em Ponta Negra e, em média, tem se dedicado à pesca por 35 anos (dp = 9.87) (Fig. 5).

Em relação à escolaridade, 13% dos pescadores de Ponta Negra são analfabetos, 42% freqüentaram o ensino fundamental I (antigo primário), sendo que somente 8% o concluíram. Apesar de outros 17% dos pescadores terem cursado até o 6º ano, somente 8 % dos entrevistados concluiu o Ensino Médio (Fig. 6).

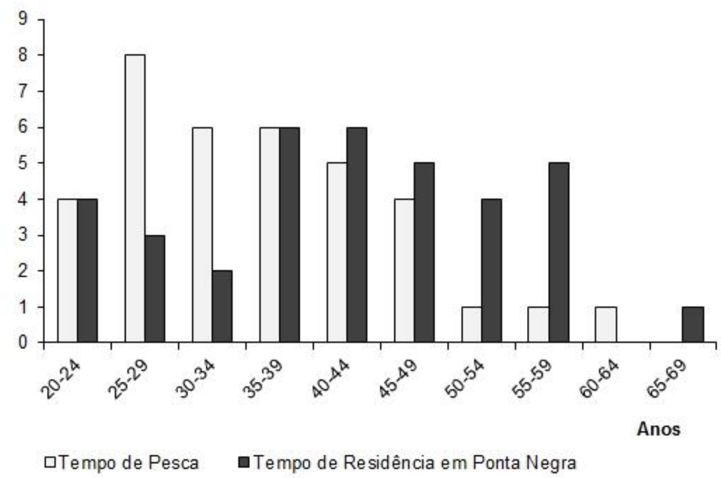


Figura 5. Tempo de pesca e de residência dos 36 pescadores entrevistados em Ponta Negra, Natal, Rio Grande do Norte (n = números de pescadores em cada categoria de anos).

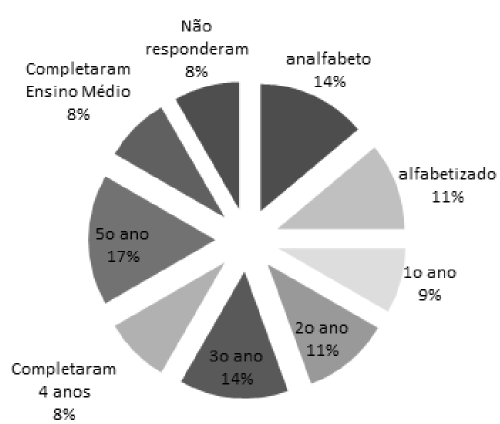


Figura 6. Escolaridade dos 36 pescadores de Ponta Negra, Natal (números referem-se a % de entrevistados que citou cada informação).

Muitos dos pescadores entrevistados (58%) dedicam-se exclusivamente à pesca, enquanto outra parte deles (42%) está envolvida em várias atividades para complementar sua renda (Fig. 7). Segundo os entrevistados, 66% deles são filhos de pescadores, contudo apenas 13% deles têm filhos que estão trabalhando na pesca atualmente.

Figura 7 – Outras ocupações exercidas pelos 36 pescadores de Ponta Negra, Natal (números referem-se a % de entrevistados que citou cada informação).

Os pescadores mencionaram 37 pontos de pesca utilizados por eles, 13 dos quais são usados por três ou mais pescadores (Fig. 8A). Estes pontos localizam-se entre a praia de Ponta Negra e o limite entre a Plataforma Continental e o Talude Continental, que é chamado por eles de “Paredes”.

As redes de espera (de emalhar) de fundo são os apetrechos mais utilizados, seguidas pelo anzol e linha e redes de arrasto de praia (Fig. 8B) (Apêndice 1). Os pescadores utilizam vários tipos de embarcações, como jangadas a vela e a remo, canoas e botes a motor. Entretanto, a maioria deles (83%) utiliza a jangada, que é um barco com casco feito, geralmente, de seis *paus* (tábuas de madeira convexas), que possui um mastro para içar uma vela de algodão, e uma bolina que equilibra a embarcação. (Fig.9).

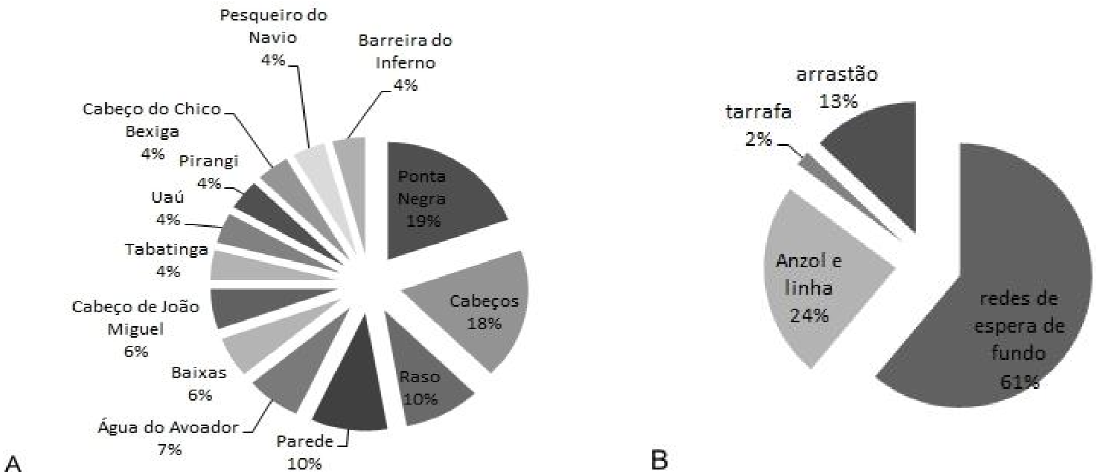


Figura 8 – A. Pontos de Pesca mais mencionados pelos 36 pescadores de Ponta Negra, Natal. B. Principais apetrechos utilizados pelos pescadores de Ponta Negra (números referem-se a % de entrevistados que citou cada informação).

Figura 9 – A jangada, principal embarcação utilizada na pesca artesanal em Ponta Negra, Natal, Rio Grande do Norte.

As principais espécies-alvo citadas pelos pescadores entrevistados são: pescadas (*Cynoscion acoupa* e *C. leiarchus*), serra (*Scomberomorus brasiliensis*), cioba (*Lutjanus analis*), garajuba (*Caranx latus*) e robalo (*Centropomus undecimalis*) (Froese e Pauly 2011) (Apêndice 2). Todos os entrevistados desembarcam sua produção na praia de Ponta Negra. A pesca artesanal na região nordeste, conforme estatística pesqueira de 2002, responde por 88% da produção total de pescado naquela região (Vasconcelos *et al.* 2007).

3. São Sebastião (São Paulo)

Em São Sebastião, no litoral norte de São Paulo, entrevistamos 70 pescadores, de março a agosto de 2006. As idades dos entrevistados variaram entre 35 e 97 anos, com uma média de 59 anos (dp = 13.16), tendo vivido em São Sebastião em média 40 anos (dp = 14.38). A maioria deles (66%) nasceu em São Sebastião e, em média, tem se dedicado à pesca por 46 anos (dp = 20.70) (Figura 10).

Quanto à escolaridade, 6% dos pescadores de São Sebastião são analfabetos, 27% concluíram o Ensino Fundamental I (antigo primário) e 10% completaram o Ensino Médio (Figura 11).

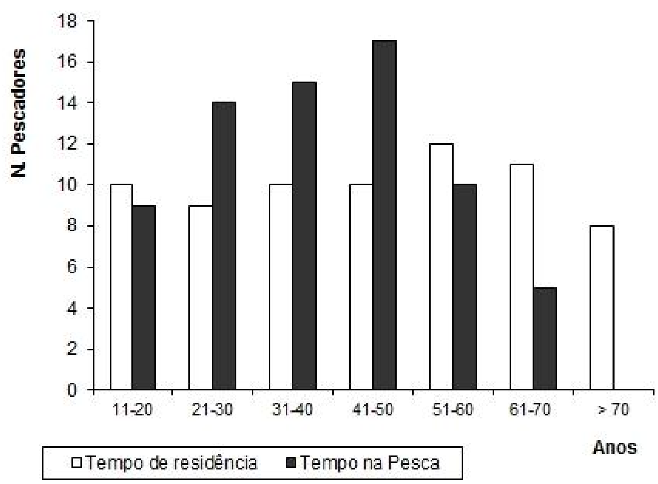


Figura 10. Tempo de pesca e de residência dos 70 pescadores entrevistados em São Sebastião, São Paulo (n = números de pescadores em cada categoria de anos).

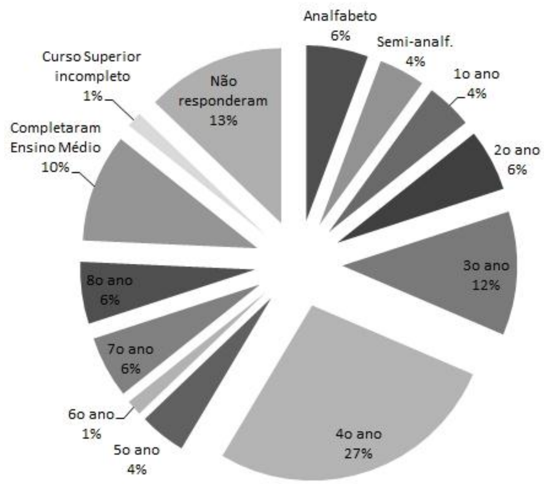


Figura 11. Escolaridade dos 70 pescadores entrevistados em São Sebastião, São Paulo (números referem-se a % de entrevistados que citou cada informação).

Os pescadores mencionaram 45 pontos de pesca utilizados por eles, oito dos quais são usados por mais de 20% dos pescadores (Figura 12A). Estes pontos localizam-se no Canal de São Sebastião e nas ilhas adjacentes.

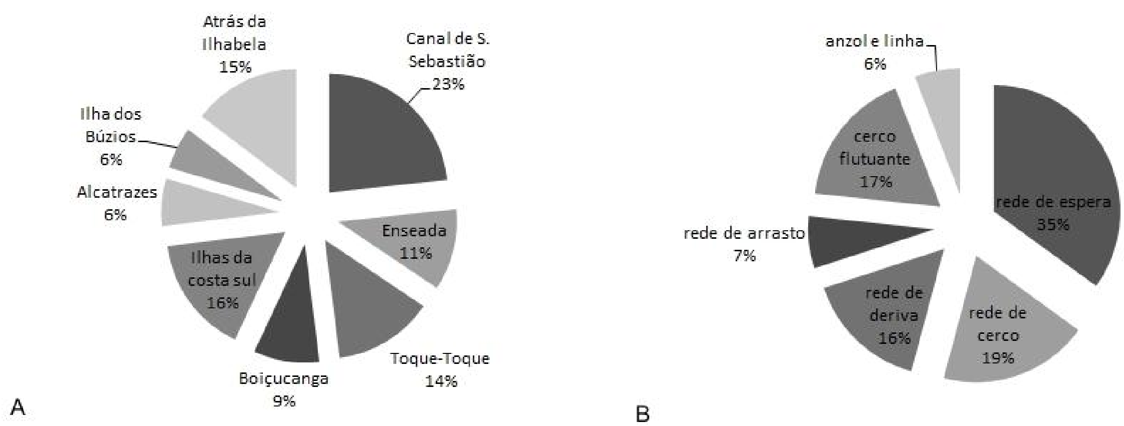


Figura 12 – A. Pontos de pesca citados pelos pescadores de São Sebastião, São Paulo. B. Principais apetrechos de pesca utilizados. Números referem-se a % de entrevistados que citou cada informação.

As redes de espera de fundo são os apetrechos mais utilizados, seguidas pela rede de cerco e pelo cerco-flutuante (Figura 12B) (Apêndice 1). Vários tipos de embarcações são usados pelos pescadores, como canoas a vela, a remo e a motor, botes a motor, baleeiras e barcos de arrasto. A maioria deles (93%) utiliza a canoa caiçara, que é uma embarcação com até 9 metros de comprimento, feita de *um pau só* (um tronco de árvore de grande porte como guapuruvú, cedro, ingá) e propulsionada por remo ou motor (Fig. 13).

Figura 13 - Canoas caiçaras, típicas da pesca artesanal de São Sebastião, São Paulo. (Foto: Shirley P. de Souza)

As principais espécies-alvo mencionadas pelos pescadores entrevistados são: pescadas (Scianidae), corvina (*Micropogonias curvieri*), enchova (*Pomatomus saltatrix*), espada (*Trichiurus lepturus*), xaréu e xarelete (*Caranx sp.*), tainha (*Mugil platanus*), parati (*Mugil curema*) e camarão-7-barbas (*Xiphopenaeus kroyeri*) (Froese e Pauly 2011) (Apêndice 2). Os desembarques pesqueiros são realizados em vários pontos no litoral de São Sebastião (Cigarras, São Francisco, Barequeçaba, Toque-Toque, Boiçucanga, entre outros). A produção artesanal da região sudeste brasileira responde por 34% do total, sendo ultrapassada pela produção da pesca industrial, com 66% do total de pescado produzido para a região (Vasconcelos *et al.* 2007).

4. **Pântano do Sul (Florianópolis)**

Em fevereiro de 2008, entrevistamos 25 pescadores na praia de Pântano do Sul, em Florianópolis. Suas idades variaram entre 32 e 87 anos, com uma média de 55 anos (dp = 13.73), tendo vivido em Pântano do Sul em média 40 anos (dp = 14.95). A maioria deles (76%) nasceu em Pântano do Sul e tem se dedicado à pesca, em média, por 50 anos (dp = 15.18) (Figura 14).

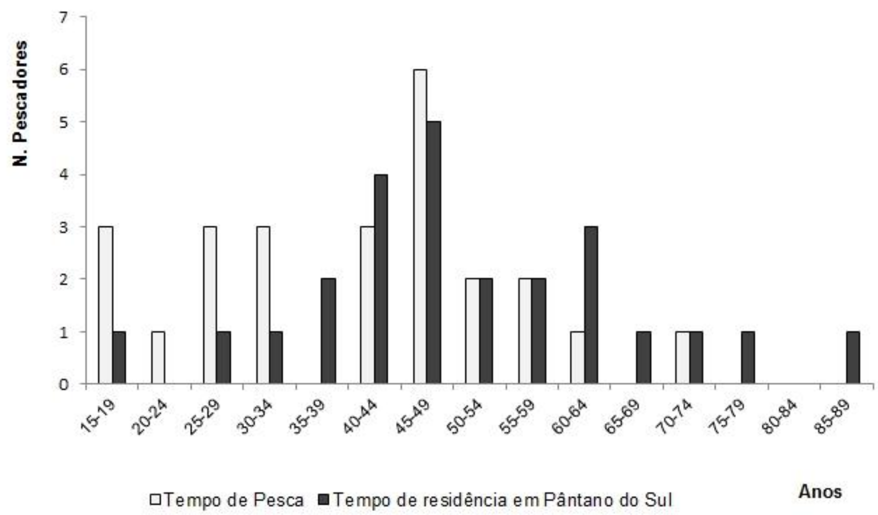


Figura 14. Tempo de pesca e de residência dos 25 pescadores entrevistados em Pântano do Sul, Florianópolis, Santa Catarina (n = números de pescadores em cada categoria de anos).

Em relação à escolaridade, 8% dos pescadores de Pântano do Sul são analfabetos, 24% concluíram o ensino fundamental I (antigo primário) e somente 8 % dos entrevistados concluíram o Ensino Médio (Figura 15).

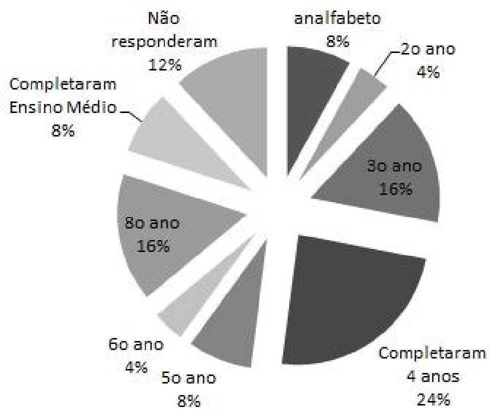


Figura 15. Escolaridade dos 25 pescadores de Pântano do Sul, Florianópolis (números referem-se a % de entrevistados que citou cada informação).

Os pescadores mencionaram 17 pontos de pesca utilizados por eles, sete dos quais são usados por mais de 15% dos pescadores (Figura 16A). Estes pontos localizam-se na Baía de Pântano do Sul e nas ilhas próximas.

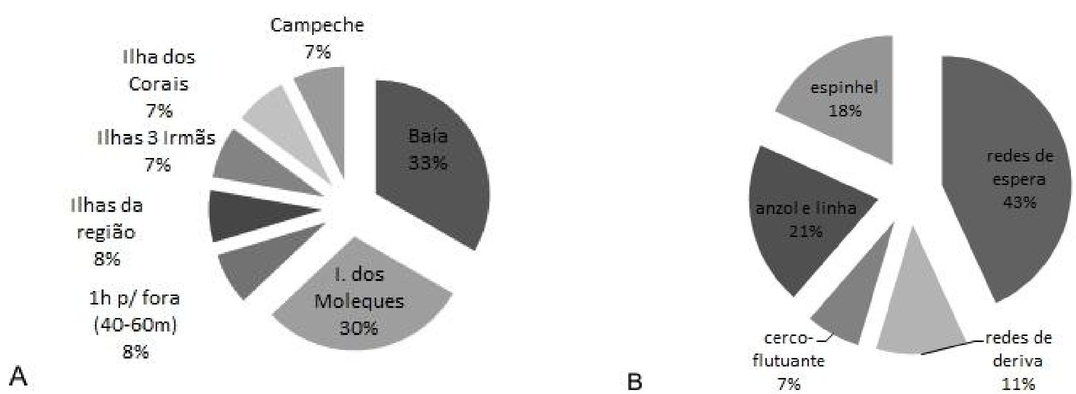


Figura 16 – A. Pontos de pesca mencionados pelos pescadores de Pântano do Sul, Florianópolis. B. Apetrechos de pesca mais utilizados. Números referem-se a % de entrevistados que citou cada informação.

As redes de espera são os apetrechos mais utilizados, seguidas pelo anzol e linha e pelo espinhel (Figura 16B) (Apêndice 1). Vários tipos de embarcações são usadas pelos pescadores, como bote, botes a remos e a motor, e canoas, que são muito maiores e com desenho diferente das canoas caiçaras, possuindo a borda muito alta (Fig. 17). A maioria deles (43%) utiliza bote a motor.

Figura 17 – Canoa a motor sendo empurrada por pescadores de Pântano do Sul, Florianópolis. (Foto: Shirley P. de Souza)

As principais espécies-alvo dos pescadores entrevistados são: enchova (*Pomatomus saltatrix*), tainha (*Mugil platanus*), corvina (*Micropogonias curvieri*), abrótea (*Urophycis brasiliensis*), cação (*Carcharhinus* sp.) e camarão-7-barbas (*Xiphopenaeus kroyeri*) (Froese e Pauly 2011) (Apêndice 2). O desembarque da produção é na praia de Pântano do Sul. A produção artesanal da região sul brasileira é muito pequena, se comparada à produção industrial, que responde por 91% do total, enquanto que a pesca artesanal corresponde à apenas 9% do total produzido para a região (Vasconcelos *et al.* 2007).

APÊNDICE 1

Principais artes de pesca utilizadas pelos pescadores entrevistados (números referem-se à porcentagem dos pescadores que citou cada arte de pesca).

Principais artes de pesca	Soure	Ponta Negra	São Sebastião	Pântano do Sul
Rede de espera (emalhe) em geral	29	---**	35	43
Rede de espera de fundo	---	61	---	---
Rede caçoeira*	32	---	---	---
Rabiola*	10	---	---	---
Rede de caceio (deriva)*	---	---	16	11
Rede de cerco	---	---	19	---
Rede de arrastão de praia	---	13	---	---
Rede de arrasto	8	---	7	---
Cerco-flutuante	---	---	17	7
Tarrafa	5	2	---	---
Anzol e linha	11	24	---	21
Espinhel	5	---	---	18

*Redes caçoeira, rabiola e de caceio são tipos específicos de rede de espera, com dimensões e funcionamento característicos. **O fato de um determinado equipamento de pesca não ser citado na tabela, significa apenas que não está entre os mais utilizados pelos pescadores daquela área.

APÊNDICE 2

Principais espécies-alvo e porcentagem dos pescadores que as mencionaram em cada área (consideradas apenas espécies citadas por mais de 10% dos pescadores).

Principais espécies-alvo	Nome Científico	Soure	Ponta Negra	São Sebastião	Pântano do Sul
Bagre, bandeirado	*Bagre bagre (Linnaeus, 1766)*	33	---	---	---
Dourada	*Brachyplatystoma flavicans* (Castelnau, 1855)	65	---	---	---
Piramutaba	*Brachyplatystoma vaillantii* (Valenciennes, 1840)	28	---	---	---
Filhote	*Brachyplatystoma filamentosum (Lichtenstein, 1819)*	30	---	---	---
Tainha	*Mugil* sp., *Mugil platanus* (Günther, 1880)	50	11	25	80
Pratiqueira, parati	*Mugil curema* (Valenciennes, 1836)	35	11	16	---
Pescada-amarela	*Cynoscion acoupa* (Lacépède, 1802)	30	---	---	---
Pescada-branca	*Cynoscion leiarchus* (Cuvier, 1830)	28	58	---	---
Pescadas em geral	(Scianidae)	20	---	41	---
Corvina	*Micropogonias furnieri* (Desmarest, 1823)	---	---	32	92
Garajuba	*Caranx latus* (Agassiz, 1831)	---	19	---	---
Xaréu, xarelete	*Caranx crysos* (Mitchill, 1815), *Caranx* sp.	28	11	24	---
Robalo	*Centropomus undecimalis* (Bloch, 1792)	---	17	---	---
Serra	*Scomberomorus brasiliensis* (Collete *et al.*, 1978)	10	53	---	---
Cioba	*Lutjanus analis* (Cuvier, 1828)	---	28	---	---
Enchova	*Pomatomus saltatrix* (Linnaeus, 1766)	---	---	32	92
Sardinha	*Sardinella brasiliensis* (Steindachner, 1879)	---	---	45	
Espada	*Trichiuris lepturus* (Linnaeus, 1758)	---	---	30	---
Abrótea	*Urophycis brasiliensis* (Kaup, 1858)	---	---	---	52
Cação	(*Carcharhinus* sp.)	---	---	---	16
Camarão-sete-barbas	*Xiphopenaus kroyeri* (Heller, 1862)	---	---	34	---

(Obs.: Nome científico dos peixes consultado em Froese e Pauly 2011).

Capítulo 2

Folk taxonomy of Cetaceans by fishers in the coast of Brazil: knowledge on biodiversity

Golfinhos-pintados-do-Atlântico próximo a Ilha dos Búzios (SP) em agosto de 2005.

Capítulo 2

Fishers' Folk taxonomy of Cetaceans in the coast of Brazil: knowledge on biodiversity

Shirley P. Souza[1,2,3] and Alpina Begossi[2,3,4]

1 – PPG Ecologia – UNICAMP
2- CAPESCA/PREAC and CMU - UNICAMP
3 – FIFO
4- UNISANTA

[1,2]UNICAMP (PPG Ecologia, CAPESCA/PREAC, CMU), CP 6023, 13.083-970, Campinas, SP, Brazil
[3]FIFO - Fisheries and Food Institute
[4]ECOMAR, UNISANTA, SANTOS, SP, Brazil
(shirleypacheco@yahoo.com)

Abstract

Folk taxonomies are the result of biological classification of organisms according to the users of local resources. Several criteria take part in the folk classification process, reflecting the level of contact between humans and nature. Cetaceans are among the vulnerable megafauna impacted by bycatch in fisheries. We studied fishers' knowledge on cetaceans' classification and nomenclature in four areas along the Brazilian coast: Soure (at Marajó Island, northern coast), Ponta Negra (at Natal, northeastern coast), São Sebastião (at southeastern coast) and Pântano do Sul (at Florianópolis, southern coast). Fishers recognized 17 cetacean species and included them in four folk genera and 37 folk species. Environmental and cultural factors, such as oceanographic variations at the study areas, and variation in resources use, influenced fishers' knowledge and the local folk taxonomies. Despite the high variability among the folk specific names given for the studied species, the degree of concordance about one specific folk name was higher for eight species, which are the most known by the fishers. Folk taxonomic studies can be an opportunity not only to record fishers' knowledge on cetacean species but also to consider it in fisheries management policies.

Keywords: local ecological knowledge, ethnobiology, fisheries management, cetaceans' ecology, marine mammals.

Introduction

The local ecological knowledge (LEK) observed in many traditional populations, including fishers, can be described as a mixture of knowledge, practice and belief that is transmitted through generations, as well as observations accumulated and exchanged by individuals along their lifetimes (Johannes 1998; Ruddle 2000; Gilchrist, Mallory and Merkel 2005; Berkes 2008).

One of the first steps to record and organize LEK is through ethnobiological research, studying folk classification and folk taxonomies (Atran 1990; Berlin 1992; Johannes 1993; Berkes *et al.* 2001). All human societies group and classify animals and plants according to their similarities or differences (Brown 1984; Berlin 1992; Atran, Medin, and Ross 2004). Cognitive and utilitarian factors can take part in the classification process, which results in taxonomic systems based on morphological, behavioral, ecological, utilitarian and other multiple aspects of the classified organisms (Hunn 1982; Berlin 1992; Clement 1995; Atran, Medin, and Ross 2004; Begossi *et al.* 2008, Newmaster *et al.* 2007).

Berlin (1973) proposed six mutually exclusive ranks to ethnobiological classifications: unique beginner, life form, intermediate, generic, specific and varietal. The generic rank (folk genus) would be the most prominent of them, generally composed by a prototype member, around which less typical members would be grouped (Berlin 1992). The idea of prototypes comes back to typological taxonomy, having sources in Plato and following to taxonomy through Aristotle: typology is a mental framework used by diverse schools of thought (Simpson, 1961). The prototype is the most characteristic species of that genus. It is probable that folk taxonomy relies on typology, since folk taxonomy is essentially based on morphology, ecology and behavior, among other diagnostic characters (Begossi *et al.* 2008). However, we still do not have data to build up a mental model of folk taxonomy. We have clues based on sparse data sets from the literature on different groups of organisms, such as plants, birds, and fish, citing the most common groups studied (Atran 1999; Begossi *et al.* 2008).

Another interesting point of folk taxonomy is the relation it can have with the level of nature´s perception and urbanization. Atran, Medin, and Ross (2004) argue that the level of contact with nature results in variation of human's perception and classification of animals and plants (when individuals lose their contact with nature, their folk taxonomy tend to be less detailed, thus showing a predominance of life forms compared to generic or specific names). Thus, urban people tend to name plants and animals by forms of life, while indigenous people tend to name by generic or specific names. Many of the specific names can be composite terms, called binomials, the first related to the general category where the organism belongs and the second related to a special characteristic of the organism (Brown 1985).

Folk classification and taxonomies of animals have been surveyed around the world for a relative long time, offering a substantive literature, including information on ethnobiology of Brazilian rural populations (Diamond 1966; Anderson 1969; Berlin 1973; Posey 1984; Brown 1985; Begossi and Figueiredo 1995; Atran 1999; Dupré 1999; Marques 2001; Begossi *et al.* 2008). In particular, studies on the folk taxonomy of marine animals in Brazil started nearly two decades ago, and have been focused mainly on fishes, with a few studies on mollusks, crustaceans and cetaceans (Begossi and Garavello, 1990; Marques 1995; Paz and Begossi 1996; Seixas and Begossi 2001; Mourão and Montenegro 2006; Souza and Begossi 2007).

Cetaceans are a well-known group of aquatic mammals, widely distributed in the world's oceans and rivers (Jefferson, Webber, and Pitman 2008). Nearly half of the 88 species currently recorded occurs along the Brazilian coast, rivers and estuaries (Bastida *et al.* 2007). Some of them are classified as threatened by IUCN red list, such as *Balaenoptera musculus* (endangered) and *Pontoporia blainvillei* (vulnerable) (IUCN 2010). Other species have also been considered as bio-indicators of coastal environmental pollution along the Brazilian rivers and coast, such as *Inia geoffrensis, Sotalia guianensis, Tursiops truncatus, Steno bredanensis* and *Pontoporia blainvillei* (Lailson-Brito Jr. *et al.* 2008; Moura *et al*. 2008).

As other groups of marine mega fauna, cetaceans have been vulnerable to bycatch in fisheries around the world. About 300.000 whales and dolphins die every year in fishing gear, especially set and drift gillnets (Reeves *et al.* 2005, Moore *et al.* 2009). Despite that, these negative interactions among cetaceans and fisheries activities are not globally understood in terms of critical areas and impacts on the demography of caught species (Soykan *et al.* 2008). Studies on cetaceans' folk taxonomy could help to identify the most commonly caught species, considering that bycatch events call the fishers' attention to those species.

Our objective was to record and analyze cetaceans' folk classification and taxonomy in four fishing areas along the Brazilian coast: Soure (northern coast), Ponta Negra (northeastern coast), São Sebastião (southeastern coast) and Pântano do Sul (southern coast) (Fig.1).

We were interested in knowing about cetaceans' genera and species recognized by local fishers, and which of these agree to the scientific classification. We address the questions:

a) What are the criteria used in the folk classification of the four study areas? We expect that these criteria will be common to all the study areas.
b) Do fishers group the recognized cetacean species in higher rankings? Which ones? Our expectation is that the most morphologically species will be grouped together.
c) Are the most recognized species named by fewer names than the least recognized species? This last hypothesis was confirmed by Begossi *et al.* (2008) in studies about fish folk taxonomy in Brazil's Atlantic Forest coast and in the Amazon.

Methods

Study areas

Fishers from four areas of the Brazilian coast were surveyed in relation to folk taxonomy of cetaceans: Soure, at Marajó Island; Ponta Negra, in Natal; São Sebastião, on the coast of São Paulo State and Pântano do Sul, in Florianópolis (Fig. 1). Each place is geographically and oceanographically different from the other, as seen from data on continental shelf width and depth, local climate and sea surface temperature and salinity (Tabosa and Vital 2002; Souza-Filho 2005; World Ocean Atlas 2009; Rossi-Wongtschowski and Madureira 2006; Marinha do Brasil 2010) (Fig. 2). Figure 3 displays data about socioeconomic and demographic characteristics that contribute to increase or not the isolation degree of each area, such as basic services, distance from big cities, touristic influx, poverty and illiteracy indexes (Governo do Pará 2001; Hafferman 2004; IBGE 2010; Ministério do Turismo 2010).

Figure 1 – Fishers' communities studied along the Brazilian coast.

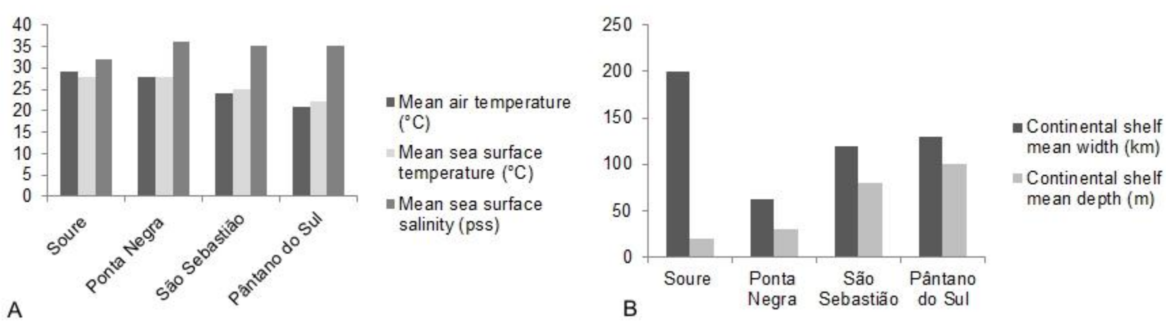


Figure 2. Environmental characteristics of the study areas on the Brazilian coast: A – Air and sea surface temperature and sea surface salinity; B – Width and depth of continental shelf.

Soure (00° 43' 00"S - 48° 31' 24"W) is the main city at Marajó Island (Pará State), situated in the estuaries of the Amazon River and Pará-Tocantins Rivers. Its climate is characterized by two seasons: one rainy (December to June) and another dry. The continental shelf is wider and shallower than in the other study areas. Due to the influence of Amazon and Pará-Tocantins Rivers, the mean sea surface salinity ranges from 28 to 35 pss (practical salinity scale). In May, 2007, we interviewed 40 fishers, nearly 10% of the total of active fishers in four communities of Soure: Matinha, São Pedro, Pesqueiro and Araruna.

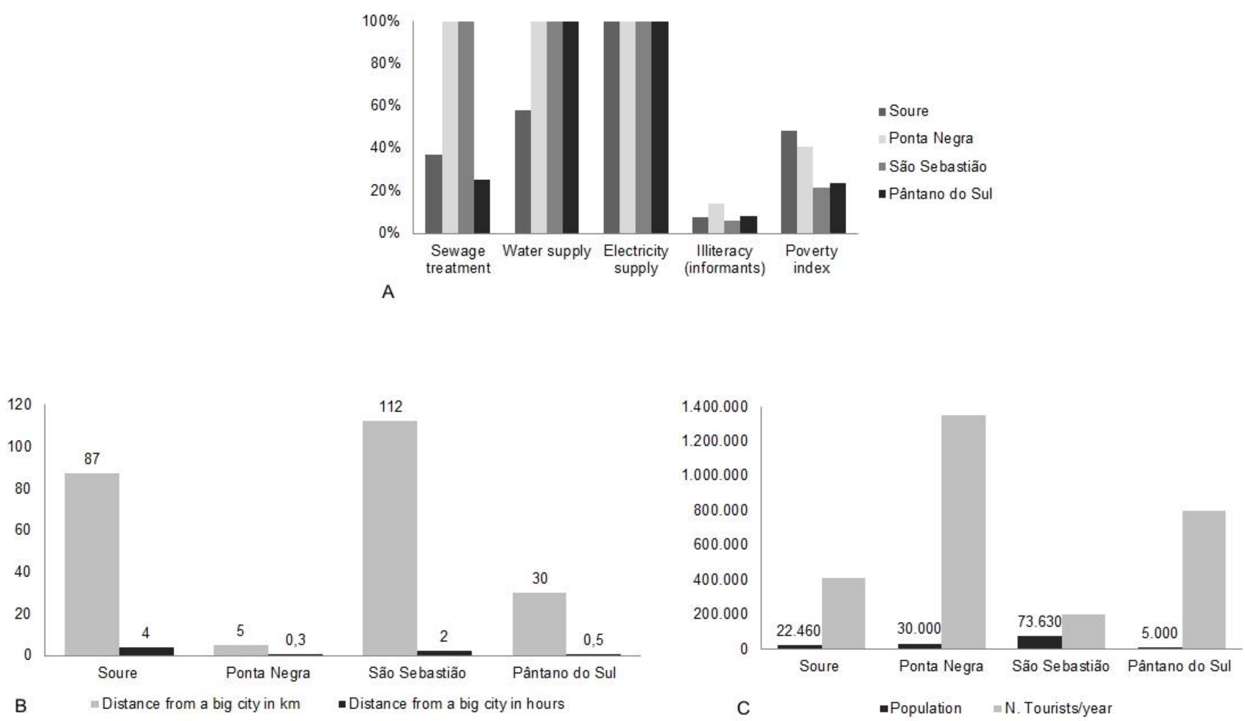


Figure 3. Socioeconomic and demographic data on the interviewed fishers in each studied place. A – Basic services in the study areas, illiteracy and poverty index of local inhabitants; B – Distance from a big city (> 500.000 inhabitants); C – Number of inhabitants and tourists/year for each area.

Ponta Negra (05° 47' 42" S - 35° 12' 34" W) is a famous touristic beach in Natal, the capital of Rio Grande do Norte State, where we find a fishing community in the southern side of the beach. Natal is characterized by a diversity of ecosystems, such as patches of coastal Atlantic forest, mangroves and dunes. The climate is locally defined by two seasons, and the rainy season is from March to July. The continental shelf is narrower than in the other areas. We interviewed 36 fishers (30% of the total) of this community in January, 2007.

São Sebastião (23° 45’ 36” S - 45° 24’ 35” W) is a small city located between the Atlantic Ocean and the slopes of Atlantic Forest. There is four well defined seasons, and the rainy season is from January to March. From March to August, 2006, we interviewed 70 fishers (20% of the active fishers) in 14 communities (Enseada, Cigarras, São Francisco, Pontal da Cruz, Barequeçaba, Toque-Toque Grande, Toque-Toque Pequeno, Paúba, Maresias, Boiçucanga, Barra do Sahy, Juqueí, Barra do Una and Boracéia).

Pântano do Sul (27° 35' 48" S - 48° 32' 57" W) is a fishing community located at the south of Florianópolis, the capital of Santa Catarina State and the most touristic city in the state. It is situated on an island with a high diversity of ecosystems: Atlantic forest, mountains, sand dunes, lagoons and a coast with several beaches and bays. The climate in this area is similar to that in São Sebastião. In February, 2008, we interviewed 25 fishers in this community, nearly 20% of the local active fishers.

There is a latitudinal gradient of air and sea surface temperatures, with higher temperatures at the Equator region (Soure and Ponta Negra) and lower temperatures on the tropics (São Sebastião and Pântano do Sul) (Fig. 2).

Methodology

We compiled the records of sightings, accidental catches and strandings of cetaceans from the specialized literature and chose the species occurring in each study area (Siciliano 1994; Martuscelli *et al.* 1996; Flores and Bazzalo 2004; Zerbini *et al.* 2004; Moreno *et al.* 2005; Spinelli *et al.* 2006; Bastida *et al.* 2007; Siciliano *et al.* 2008). After giving their personal consent, fishers were selected through the “snow-ball” method. We chose those fishers older than 35 years old, who have been fishing for more than 15 years and living in the community for more than 10 years. Semi-structured interviews trough standardized questionnaires and unlabeled pictures and photos of 21 cetaceans' species were used to obtain information on cetaceans' ethnobiological classification and folk taxonomy. Additional socioeconomic data, such as time spent fishing, time spent in school, isolation degree of the studied communities, among others, were also collected.

The interviews occurred on the beach, in fishers' boats or in their "ranchos" (places to keep their fishing gear). In previous surveys on cetaceans in São Sebastião, we noted that many fishers considered that cetaceans are a kind of fish (Souza and Begossi 2007). In this regard, we decided to ask two direct questions related to cetaceans' classification in general ('*Are whales and dolphins fish*?' and '*If yes / no, why?*'), in order to quantify the proportion of fishers who considered (or not) cetaceans as fishes. We also asked the fishers if they recognize each cetacean species and how they name and classify each species. Following Begossi *et al.* (2008), we showed the pictures of all the species surveyed in the same order to all the fishers, and asked them to group the species and explain why they were grouping them in such way. Between 10 and 15 species were surveyed in each community (Appendix 1).

Data analysis

The answers of each fisher were numerically quantified, so we could proceed on comparisons among species, topics and informants. For many questions, more than one citation (answer) was obtained per fisher. In order to study the dominant perception per community, and to compare the dominant perceptions of fishers on cetaceans among the communities studied, we only considered in the statistical analysis the species cited by more than 20% of the informants in each place. For statistical tests (correlations), we tested the normality of the data.

We used Test G to check if the fishers' life-form classification into different categories depended on its classification as a whale or a dolphin. Answers related only to the life form categories "fish" and "not fish" attributed to cetaceans in general were tested using Chi-square test, to check if they were statistically different among the study areas.

We used Pearson correlation coefficient to check if the level of illiteracy was correlated to the level of fishers' knowledge on cetaceans (considering the number of "do not know" answers), following other studies (Silvano and Begossi 2002; Silvano *et al.* 2006). In order to check if the most recognized species received fewer folk names when compared to those least recognized, we tested the relation between the number of cited folk species per area and the degree of knowledge ("do not know" answers / species) using Pearson (or Spearman, in case of non-normal data) correlation coefficient. Where we found correlation, a linear regression test was carried out.

Cetaceans' species identification and its English common names followed Bastida *et al.* (2007) and Jefferson, Webber, and Pitman (2008). All statistical tests were performed using the software Biostat 5.0 (Ayres *et al.* 2007).

Results

We interviewed 171 fishers, in 20 communities distributed among Soure, Ponta Negra, São Sebastião and Pântano do Sul. Small-scale fisheries are practiced in all these places, but the target species and boats vary from place to place (Table 1).

The fishers were on average 55 years old, and 64% of them were born in those communities. Nearly 8% of them were illiterate, 57% went to school just for four years and only 7% completed high school. The interviewees have been fishing for about 40 years.

We did not find any significant correlation between the level of fishers' knowledge in each area with the level of fishers' illiteracy ($r = -0.1559$, $p = 0.8441$).

Soure (Marajó Island) seems to be the most isolated community, where fishers survive basically by fisheries and extraction of forest resources. In contrast, Ponta Negra and Pântano do Sul are located in big cities and São Sebastião is close to big cities (Fig. 3).

The interviewed fishers use different types of small boats and fishing nets to catch several species of fishes, crustaceans and mollusks (Table 1). These fishers use mostly rafts, sail and paddled canoes and small motor boats, especially to set gillnets (bottom and surface). The main target species vary from place to place due to the variation in the habitat and oceanographic parameters, such as sea water salinity, currents, depth and width of the continental shelf, which lead the fishers to use different fishing spots according to the concentration of fish stocks and their seasonality. In fact, one to 13 fishing spots are used in each area by they interviewed fishers (average= 3). Twenty-four percent of all the interviewees are part-time fishers, also selling coconuts on the beach, taking tourists in boat tours, working in house' construction or in public institutions.

Table 1 - Fishing characterization of the study areas (including the percentage of fishers that mention each category. Soure: n= 40, Ponta Negra: n=36, São Sebastião: n= 70, Pântano do Sul: n= 25).

Study areas	**Soure**	**Ponta Negra**	**São Sebastião**	**Pântano do Sul**
Type of boat	sail and row canoes (63), motor boats	sail and row raft (80), motor boats	row canoes (61), motor canoes,	row boat (44), motor boat (43)
Fishing gear	gillnets (72), line and hook, long-lines, pull nets	bottom gillnets (91), line and hook, pull nets	gillnets (83), encircling nets, fixed circle nets, drifiting nets	gillnets (100), line and hook, long-lines
Main target species	*Brachyplatystoma flavicans* (65), *Mugil sp.* (50), *Mugil curema* (35), *Bagre bagre* (33), *Cynoscion acoupa* (30), *Brachyplatystoma filamentosum* (30), *Brachyplatystoma vaillantii* (28), *Cynoscion leiarchus* (28), *Caranx crysos* (28)	*Cynoscion leiarchus* (58), *Scomberomorus brasiliensis* (53), *Lutjanus analis* (28), *Caranx latus* (19), *Centropomus undecimalis* (17)	*Sardinella brasiliensis* (45), *Cynoscion* sp. (45), *Xiphopenaeus kroyeri* (34), *Micropogonias furnieri* (32), *Pomatomus saltatrix* (32), *Mugil platanus* (25)	*Pomatomus saltatrix* (92), *Micropogonias furnieri* (92), *Mugil platanus* (80), *Urophycis brasiliensis* (52)

Cetaceans' recognition

Among the 21 species of cetaceans surveyed, 17 were recognized, and the most cited (in decreasing order) were:

- In Soure: *Sotalia guianensis* ('tucuxi') and *Inia geoffrensis* ('boto-malhado')
- *In Ponta Negra: Megaptera novaeangliae* ('baleia'), *S. guianensis* ('boto') and *Stenella clymene* ('tuninha')
- In São Sebastião: *Tursiops truncatus* ('boto'), *S. guianensis* ('boto'), and *Pontoporia blainvillei* ('toninha')
- In Pântano do Sul: *Eubalaena australis* ('baleia'), and *P. blainvillei* ('toninha').

Among these species, three were common to the four studied areas *(M. novaeangliae*, *T. truncatus* and *S. guianensis)* (Appendix 1). The percentage of cetacean species recognized by the informants varied from 40% in Pântano do Sul to 91% in São Sebastião. The average number of cetacean species cited per fisher ranged from four in Soure to six in Ponta Negra and São Sebastião (Appendix 1).

On the other hand, fishers did not recognize some cetacean species (*Balaenoptera bonaerensis, Pseudorca crassidens, Peponocephala electra* and *Delphinus delphis*).

Two of the most recognized species were not seen in nature by the informants, as it is the case of *M. novaeangliae* (humpback whale) in Soure, where 87% of fishers who identified it have only seen this species on TV programs. The same happened in relation to *O. orca* (killer whale), which was also known by fishers from Soure, São Sebastião and Pântano do Sul through TV programs (93%, 69% and 31% of the fishers, respectively for each place).

Cetaceans' folk classification

Life form classification of cetaceans resulted in more than one folk taxon mentioned during the interviews (Fig. 4). Among the 171 fishers, 56% identified cetaceans as "fish", and 41% classified them as "not fish". Unlike the other areas, in Ponta Negra the proportion of citations for "fish" and "not fish" is statistically different (χ^2=9.757, p = 0.0031), with 78% of the fishers considering cetaceans included in the life form "fish", and naming five folk species following fish species ("tubarão" - shark, "peixe das águas fundas" – deep water fish, "cação-chatinho" –

bull shark, “tubarão-baleia” – whale shark and “peixe-meca” - swordfish). In Soure, São Sebastião and Pântano do Sul the life form “fish” got 60%, 44% and 48% of the citations, respectively (Fig. 4).

In general, the life form “mammal” represents 23% of the answers, and is included in the life form “not fish”. Life form “mammal” was more mentioned by fishers from São Sebastião (29%) and Pântano do Sul (32%).

The number of citations for life form classification was not statistically different between dolphins and whales (Fig.4), which means that life form classification is not influenced by the biological classification of a whale or a dolphin. (Soure: G= 0.3482, p= 0.9865; Ponta Negra: G= 1.6081, p= 0.8073; São Sebastião: G= 1.1165, p= 0.8916; Pântano do Sul: G= 2.927, p= 0.7112).

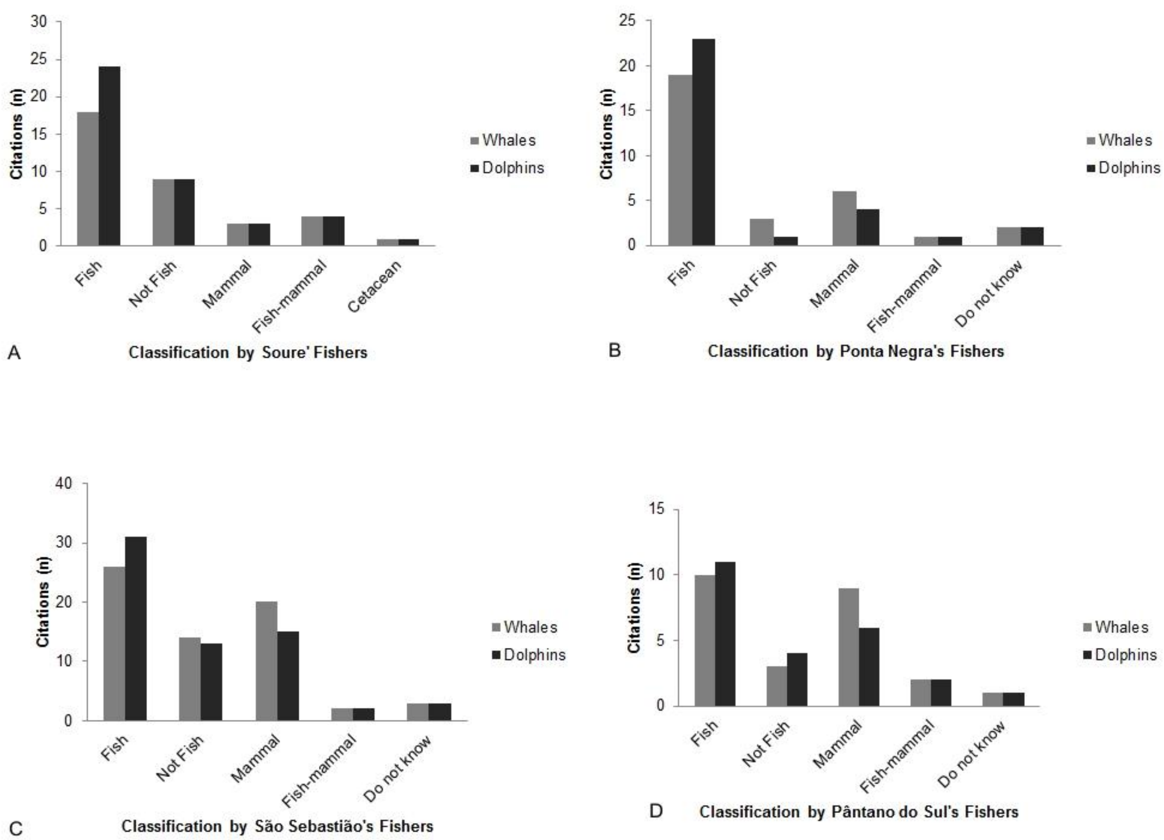


Figure 4 - Cetaceans’ life form classification by the interviewed fishers in the four studied areas: A – Soure, B – Ponta Negra, C – São Sebastião, D – Pântano do Sul.

Fishers used five categories to classify the cetaceans in life forms: morphological (size, weight, color, shape and function of salient parts of the body), behavioral (feeding and migration habits, mother-calf link, social interactions and competition), utilitarian (use of the meat and other body parts), ecological (types of habitat, seasonality) and sensorial (smell, taste) (Fig. 5). In general, morphological characteristics were mentioned in more than 45% of the answers, except for Pântano do Sul. In Pântano do Sul the morphological category represented only 12% of fishers' citations. Meanwhile, the most cited category in Pântano do Sul was the ecological one (28%, related to cetaceans' habitat), which was much less cited in Soure, Ponta Negra and São Sebastião (18% in each area).

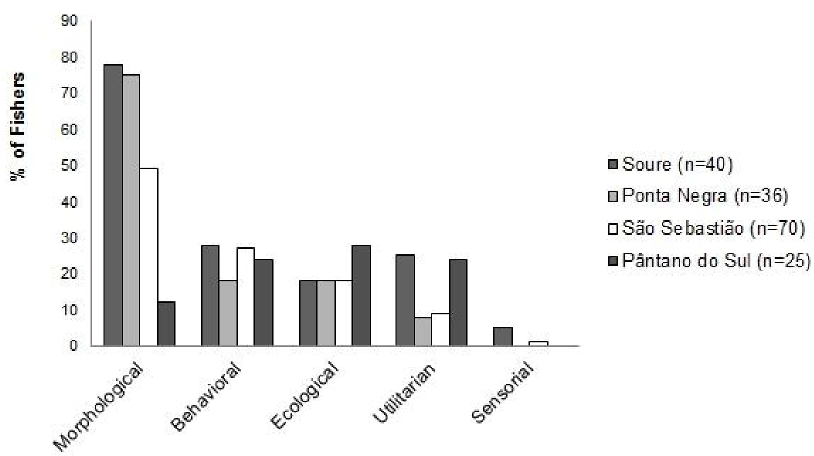


Figure 5 - Categories of life form classification used by the fishers.

Some of the cetacean species were grouped in folk families and most of the informants considered such species as "relatives", because "they are very alike, so they must be from the same family". The percentage of fishers who group the cetaceans in folk families varied from 37% in Soure to 80% in Ponta Negra, where fishers mentioned 16 different groups, and the most cited were: "*S. clymene* + *S. guianensis*", "*T. truncatus* + *S. guianensis*" and "*S. clymene* + *S. guianensis* + *T. truncatus*" (n = 5 for each group). These groups contain species morphologically very similar to each other, in comparison to the other dolphins' species surveyed.

Cetaceans' folk nomenclature

The nomenclature given by the fishers concerning cetaceans' genera and species resulted in local folk taxonomies, as shown in Table 2 and Figure 6. A total of four folk genera and 37 folk species were mentioned by the fishers, and many of the folk species were named as binomials.

Table 2 – Folk taxonomies of cetaceans according to the fishers from Soure (n=40), Ponta Negra (n=36), São Sebastião (n=70) and Pântano do Sul (n=25). (Generic names in bold and italic, prototypical species in parenthesis, *occurrence area of prototypical species. The total number of folk names for each species corresponds to the answers of 20% or more fishers in each area).

Scientific name	English common name	Folk name (Generic and specific)	Soure (Marajó) citations (n)	Ponta Negra (Natal) citations (n)	São Sebastião citations (n)	Pântano do Sul (Florianópolis) citations (n)
Eubalaena australis	Right Whale	***baleia*** (baleia)			37	*16
		baleia-franca				9
Balaenoptera edeni	Bryde's whale	***baleia***			18	
		baleia-branca			1	
Balaenoptera acutorostrata	Dwarf minke whale	***Baleia***		6		
		baleia-cação		1		
		cachalote		1		
		orca		1		
		peixe das águas fundas		1		
Megaptera novaeangliae	Humpback whale	***baleia*** (baleia)	*27	*24	13	3
		jubarte, jibarte, jubarta	2	4	23	2
		baleia-cinza	1			
		cachalote		4	2	2
		baleia-do-sul		1		
		tubarão		1		
Physeter macrocephalus	Sperm whale	***baleia***		6		
		cachalote		4		
		baleia-de-cabeça-chata		1		
Orcinus orca	Killer whale	***baleia***	23		15	1
		boto			2	
		orca, baleia-orca	3		39	6
		boto-baleia	1			
		baleia-malhada	1			
		baleia-branca			1	1
		cachalote				1
		toninha-da-costa				4

Globicephala macrorhynchus	Short-finned pilot whale	***baleia***		6		
		boto		1		
		baleote		1		
		cachalote		1		
		cação-chatinho		1		
		peixe-meca		1		
		tubarão-baleia		1		
Steno bredanensis	Rough-toothed dolphin	***tuninha***		5		
		boto		2	14	
		golfinho			2	
		baleote		1		
Tursiops truncatus	Bottlenose dolphin	***boto*** (boto)	1	15	*47	12
		golfinho	1	5	9	
		antonina, tunina, tuninha, toninha	7	8		
		boto-caldeirão, caldeirão			10	9
		boto-baleia	9			
		tucuxi	1			
		boto-tintureira	1			
		boto-branco	1			
		golfinho-fliper			1	
Delphinus capensis	Long-beaked Common dolphin	***boto***			17	
		golfinho			1	
		toninha			2	
Sotalia guianensis	Guiana dolphin	***boto*** (boto)	3	*26	*45	*15
		golfinho	4	4	12	3
		tuninha, toninha		2	8	
		boto-tucuxi, tucuxi	36			
		boto-pretinho	8	3	1	
		tuninha-cachorro		1		
Stenella frontalis	Atlantic spotted dolphin	***boto***	1		25	
		tuninha	2			
		golfinho			2	
		boto-de-escama	1			
		boto-pintado	1		1	
		boto-malhado	1			
		boto-baleia	1			
		boto-rajado			2	
		boto-caldeirão			1	
		golfinho-malhado			1	
		tintureira	1			
Stenella clymene	Clymene dolphin	***tuninha*** (tuninha)		*24		
		boto		4		
		golfinho		2		
		tuninha-cachorro		2		
		tuninha-branca		1		
		boto-branco		2		
Stenella attenuata	Pantropical spotted dolphin	***tuninha***		9		
		golfinho		2		
		tuninha-pintada		3		
		tuninha-rajada		1		
Stenella longirostris	Spinner dolphin	***tuninha***		11		
		golfinho		7		

		boto		3		
Pontoporia blainvillei	Franciscana	***toninha*** (toninha)			*51	*21
		boto			6	
		golfinho			14	1
		boto-branco			1	
Inia geoffrensis	Amazon river dolphin	boto-malhado, malhado	40			
		boto-rosa	12			
		boto-baleia	1			
% of binomials / Area			**48%**	**30%**	**30%**	**31%**

The number of species recognized by the fishers, named and included in folk genera and folk species were:

- Soure: six cetacean species recognized (among ten species shown to them), grouped in four folk genera and subdivided in 14 folk species (12 of them as binomials).
- Ponta Negra: ten species recognized (among 13 species), grouped in four folk genera and subdivided in 21 folk species (13 of them as binomials).
- São Sebastião: ten species recognized (among 11 species), grouped in four folk genera and subdivided in 13 folk species (ten of them as binomials).
- Pântano do Sul: six species recognized (among 15 species), grouped in four folk genera and subdivided in ten folk species (five of them as binomials).

The four folk taxonomies show a relative high number of folk species. The number of folk species increased in relation to the number of scientific species as follows: 133% in Soure, 110% in Ponta Negra, 30% in São Sebastião and 67% in Pântano do Sul. Fishers cited an average of three folk species for each scientific species. However, for eight cetacean species (*E. australis*, *M. novaeangliae*, *O. orca*, *T. truncatus*, *S. guianensis*, *S. clymene*, *P. blainvillei* and *I. geoffrensis*), one folk species were cited for more than 30% of the fishers, showing a preference for the use of one folk specific name for each species (Table 2). However, we did not find correspondence 1:1 between folk and scientific species.

Among these cases, *S. guianensis* and *T. truncatus* were prototypical and sympatric, and were cited by most of the fishers from Ponta Negra, São Sebastião and Pântano do Sul (> 50% in average) by the same name ('boto'). In fact, due to the great morphological similarity of these species, fishers grouped them as being of 'the same family' and discriminated them by the size and behavior, *S. guianensis* is the smaller and shier 'boto' and *T. truncatus* is the bigger and acrobatic 'boto'. Two other cases of prototypical species, but living far from each other and very different morphologically and behaviorally, are *S. clymene* and *P. blainvillei*. The first is named as 'tuninha' (by fishers from Ponta Negra) and the second is named as 'toninha' (by fishers from São Sebastião and Pântano do Sul), the same folk name with a local variation in its spelling. The other four species (*E. australis*, *M. novaeangliae*, *O. orca* and *I. geoffrensis*) received different folk names by the fishers, respectively, 'baleia-franca', 'jubarte', 'orca', and 'boto-malhado'.

In order to better illustrate the folk taxonomies of each area, we plotted Venn's diagrams, based on fishers' answers, which display the cetacean species included in folk genera and named as folk specific names (Fig. 6). In the cases where one species had more than one folk specific name we chose only the most mentioned folk name. Prototypical species are hatched circles and their folk names are underlined. Some species were recognized but not named by the fishers, so they just appear with their biological names.

Fishers included all the bigger whales, including the delphinids *O. orca* and *G. macrorhynchus*, in the folk genus "baleia" (whale), whereas the small cetaceans were included in the folk genera "boto", "tuninha" or "golfinho" (different names for dolphins), in many cases with overlapping of these folk genera for some species.

Fishers did not assign any specific name to a few species (*S. longirostris* and *T. truncatus*, in Ponta Negra and *E. australis*, *S. bredanensis* and *D. capensis* in São Sebastião). They were included in their folk genera by answers such as "it's a kind of baleia" or "it's a kind of boto".

In each study area, some species (*E. australis*, *M. novaeangliae*, *T. truncatus*, *S. guianensis*, *S. clymene* and *P. blainvillei*) were more salient than others, being recognized and named by more than 60% of the fishers, by the same name as their folk genus. For example: when asked about the dolphin *S. guianensis*, 72%, 64% and 60% of the fishers from Ponta Negra, São Sebastião and Pântano do Sul, respectively, named this dolphin as “boto” (Table 2 and Fig. 6). “Boto” is also the name of a folk genus, which includes several species of small cetaceans. However, *S. guianensis* was considered by many of the fishers (50%) as “the boto”, or the true “boto” (therefore, a prototype) according to their answers. On the other hand, in Soure the same species (*S. guianensis*), recognized by more than 90% of the fishers, was not identified as the true “boto”. During the interviews, fishers from Soure named this species as “tucuxi” or “boto-tucuxi” (Table 2).

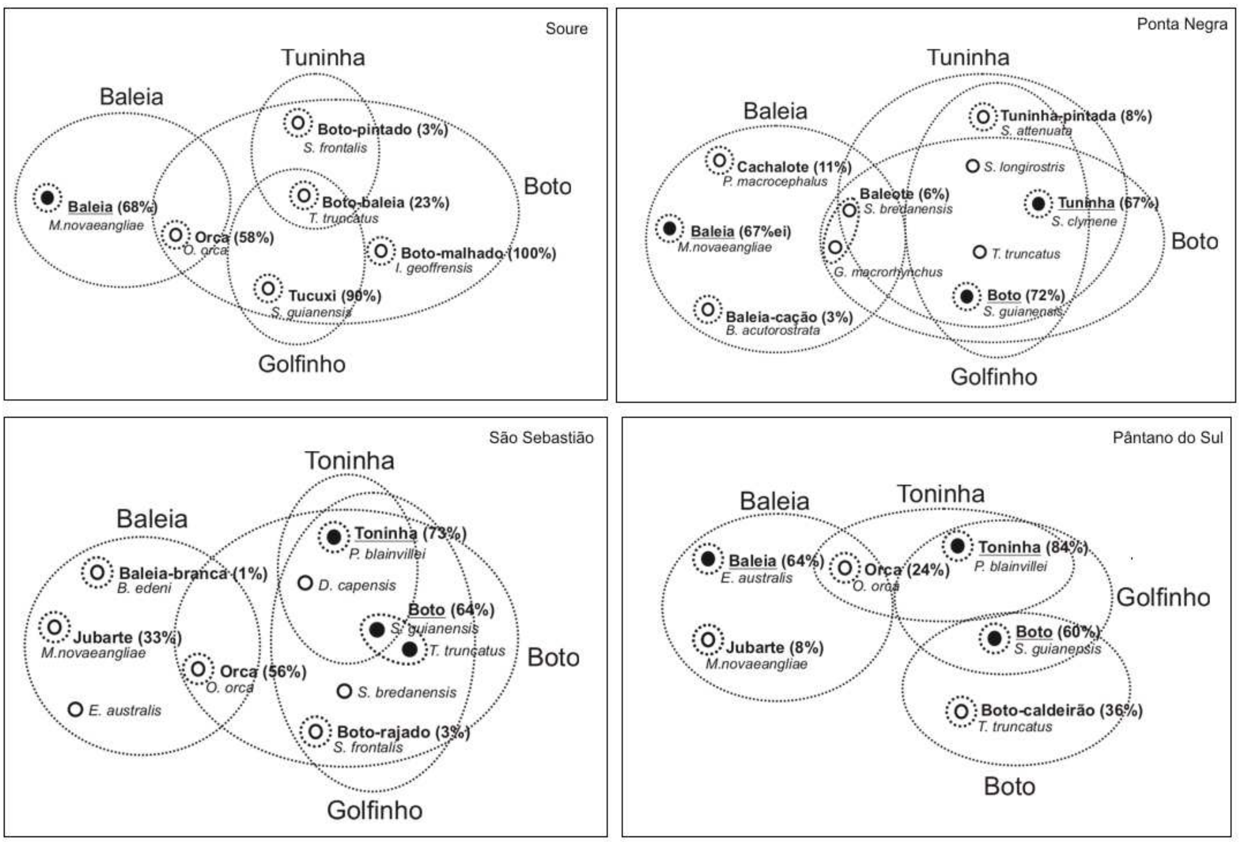


Figure 6 – Folk taxonomies of cetaceans according to the fishers from Soure, Ponta Negra, São Sebastião and Pântano do Sul. Cetacean species (circles) are included in folk genera (bigger circles or elipses). Folk species are in black dotted circles, the full black circles are prototypical folk species. Percentages refer to the percentage of fishers who cited that folk name, in each area.

Some cases of synonymy among studied areas were found in generic names, such as “tuninha” “tunina”, “antoninha” and “toninha”, and also in specific names, such as “jibarte”, “jubarte” and “jubarta”.

In relation to the hypothesis correlating the recognition and identification of cetaceans’ species with the number of folk names attributed to them, in Soure (Marajó) we found a positive correlation between the number of folk species and the lack of knowledge about these species (r = 0.93, p = 0.006). The number of folk species increased for less recognized species. In the other study areas we found no correlation between these two variables (Fig. 7).

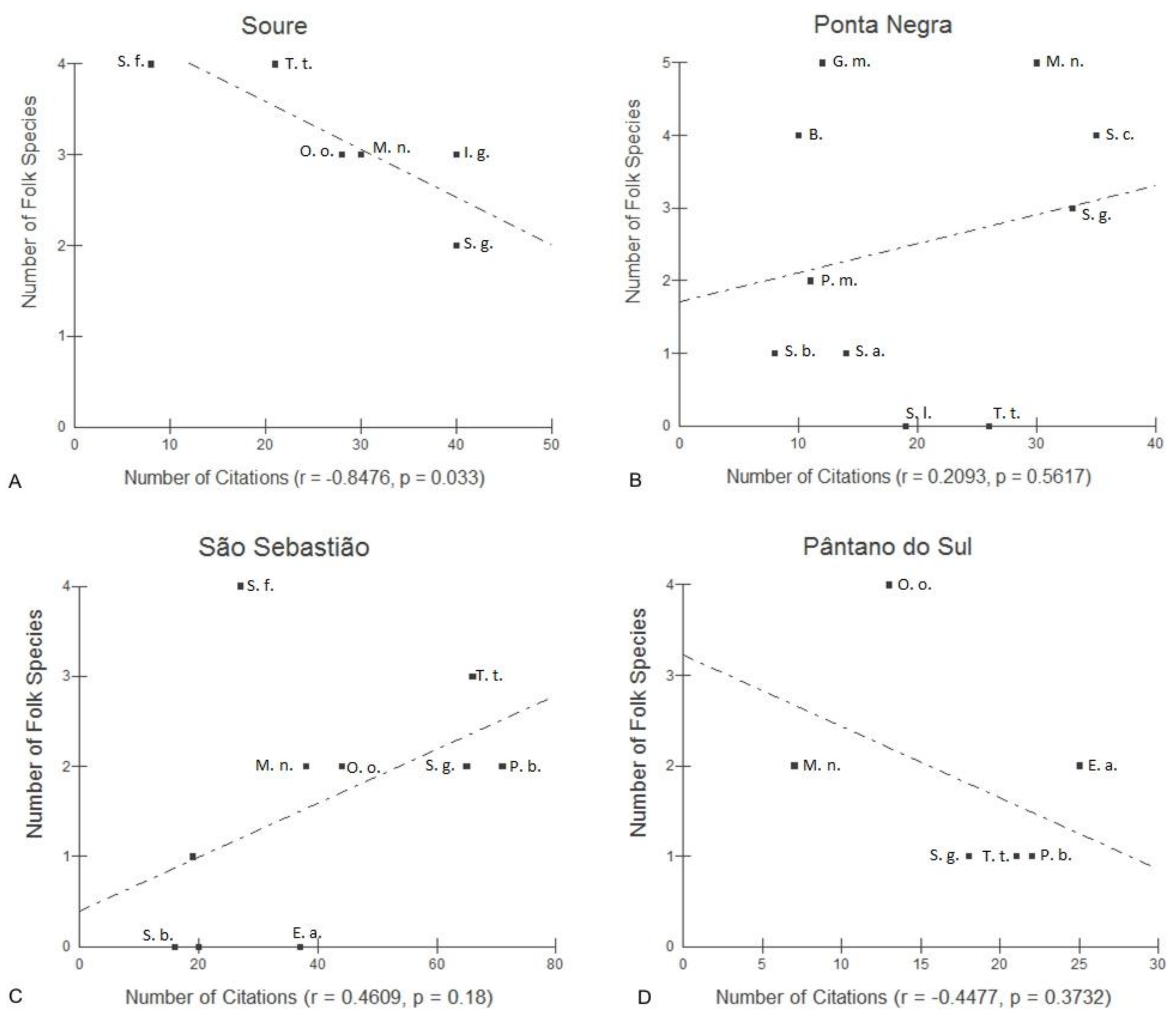


Figure 7 – Cetaceans’ folk species cited by the fishers from A: Soure, B: Ponta Negra, C: São Sebastião, D: Pântano do Sul, compared to the number of

citations for each scientific species (E.a.– *E. australis*, B.e.– *B. edeni*, B.a.– *B. acutorostrata*, M.n.– *M. novaeangliae*, P.m.– *P. macrocephalus*, G.m.– *G. macrorhynchus*, O.o.– *O. orca*, T.t.- *T. truncatus*, S.b.- *S. bredanensis*, S.g.- *S. guianensis*, S.f.- *S. frontalis*, S.c.- *S. clymene*, S.a.- *S. attenuata*, S.l.- *S. longisrostris*, P.b.- *P. blainvillei*, I.g. – *I. geoffrensis*).

Discussion

Pringent *et al.* (2008) argue that the variation in fishing techniques and in the use of several fishing spots can lead to different environmental perception levels by the fishers. Additionally, Brown (1985) argues that the degree of biodiversity in a region affects people's perception. We observed variation of environmental and socioeconomic parameters, biological and cultural diversity in the four study areas. However, in this study we did not find significant variation in fishers' perception about cetaceans. We expected that fishers from more isolated areas that are inserted in the natural surroundings would show a more detailed knowledge on the local cetacean species. In spite of the greater isolation of Soure from big urban centers, fishers there did not recognize more species or show more knowledge about them when compared to fishers from the other areas (Appendix 1).

Cetaceans' recognition

Despite the inclusion of a great number of cetacean species (21) in this survey, our results showed that fishers recognized mainly the most salient and the most common species. According to Hunn (1982), the folk classification is highly selective, and the utility of the organisms is one of the main factors considered in the selection process. Studies on fishers in Brazil have showed a tendency to recognize salient species, compared to less salient ones (Begossi and Garavello 1990; Begossi and Figueiredo 1995). Abundance is a criteria for saliency, since the most abundant and widely distributed organisms will probably be the most noted, not only because of their spatial and temporal distribution (ecological salience), but also because they can be potentially used as food or in medicine and in other ways, which will turn them culturally salient to people (Hunn 1999). However, the informant's familiarity and his expertise on the studied species are important factors in the perception of an animal's salience (Berlin 1992). Our results agreed with that expectation, so species not recognized (*D. delphis, P. crassidens, P. electra,* and *B. bonaerensis*) and species mentioned by less than 20% of the informants, were those that occurred less frequently in coastal areas, or were not salient enough to be classified according to the criteria used by the fishers. Indeed, many cetacean species are not easily observed in their natural habitat, due to their great mobility and wide occurrence areas (Williams, Hedley and Hammond 2006).

Local oceanographic features can also be related to the recognition process of cetacean species by fishers. During the interviews, fishers from Ponta Negra said to be used to fish beyond the outer limit of continental shelf, unlike fishers from the other areas. This is possible due to the narrower continental shelf at this part of Brazilian coast. Therefore, these fishers are more exposed to oceanic species, increasing the recognition of species such as *P. macrocephalus, G. macrorhynchus, S. bredanensis, S. longirostris, S. attenuata* and *S. clymene*. On the contrary, the greater width of the continental shelf of Marajó Island can be responsible for the low occurrence and recognition rates of oceanic cetacean species in Soure. The influence of geographic, oceanographic and seasonal factors in fishers' LEK has been mentioned in other ethnobiological studies around the world (Berlin 1992; Johannes, Freeman and Hamilton 2000; Silvano and Begossi 2005).

The media may affect the knowledge of fishers on species, and in many cases can be difficult to locate the sources of media and of other forms of knowledge. In this study the media's role was evident through the high percentage of recognition of two cetacean species not so common in the study areas, such as *M. novaeangliae* in Soure and *O. orca* in Soure, São Sebastião and Pântano do Sul. Even in remote areas, as Marajó Island, fishers have the possibility to learn about rarely occurring species through TV documentaries and use this knowledge when necessary. Transmission of knowledge through TV programs can be considered a way of oblique or indirect cultural transmission. Boyd and Richerson (1985) discussed the importance of vertical (father to sons, for example), horizontal (from peers) and oblique (from nonparental adults) transmission of culture in sharing and spreading knowledge that can be valuable to human adaptation. What we do not know, and is beyond the scope of this study, is the comparative importance of vertical transmission, and of the media on the folk taxonomy of fishers. That is a subject to be investigated, especially regarding organisms so attractive to media, as cetaceans are.

Cetaceans' folk classification

Fishers recognized, named and classified the cetacean species using several criteria, and the morphological one was the most cited in our study, which agrees with other ethnobiological surveys and with biological taxonomy (Berlin 1992; Atran 1999; Mourão and Nordi 2003; Newmaster *et al.* 2006). Newmaster *et al*. (2006), after analyzing studies on ethnobiological classification in the last 40 years, found that morphological characteristics predominated in 31% of the surveyed literature, followed by sensory perception (28%), utility (25%), and ecology (12%). Begossi *et al.* (2008) using cluster analysis confirmed that morphological and ecological variables are important criteria used in folk classification of fishes.

Cetaceans' life form classification by the fishers resulted in different folk taxa ("fish", "not fish", "mammal", "fish-mammal", "cetacean"), unlike the Linnean classification, where all cetaceans are included in the Class Mammalia. In general, the informants associated the life form "fish" to the aquatic habitat of the cetaceans or to their morphological similarity to fishes. On the other hand, fishers who chose the life form "mammal" associated it with behavioral characteristics of these animals.

The doubt on the nature of cetaceans (if they are fish or not) dates back to Aristotle (350 BC), who despite naming the dolphins as "fishes", described them as breathing through blow-holes instead of gills and suckling their young. Brown (1984) defined life forms as discontinuities in nature, and the major life form taxa, such as 'tree', 'grass', 'bird' and 'fish' are found in most folk biological classifications. Regarding to the life form 'fish', Brown (1984) defined it as a taxon including animals that share some features such as fins, gills, stream-lined body, and adaptation to aquatic environment, which could include whales, dolphins and other aquatic animals. However, life form is considered by some authors as an artificial category, since it groups classes biologically diverse, not always agreeing to the biological taxonomy (Hunn 1982; Atran 1990; Berlin 1992).

Only in Ponta Negra we found a dominance of the life form “fish”, which could explain why some fishers associated a few cetacean species to fish names (e.g. ‘peixe-das-águas-fundas’ - deep water fish, ‘tubarão’ - shark, ‘cação-chatinho’ - bull shark, ‘peixe-meca’ - swordfish, ‘tubarão-baleia’ - whale shark. Similarly, Paz and Begossi (1996), studying a fishers’ community at Sepetiba Bay, southeastern Brazilian coast, found the “boto” (a dolphin species not identified) included in the sharks’ family. Anderson (1969) also observed the inclusion of cetaceans in the life form “fish”, by boat people of Hong Kong. Dupré (1999) discussed the pluralism in the whales and dolphins’ folk classification, and he argues that as long as the scientific knowledge on cetaceans is divulgated, there is a trend to stop considering these animals as “fishes” and start considering them as mammals. Such a tendency we observed in São Sebastião and Pântano do Sul, where we found more citations attributing the life form “mammal” to cetaceans and where the fishers’ schooling level is higher than in the other areas.

Cetaceans’ folk nomenclature

The four folk genera mentioned by the fishers included more than one folk species (polytypy), unlike most of the folk taxonomies studied around the world, where nearly 80% of folk genera are generally monoespecific, according to Atran (1999) and Berlin (1992). However, this could be due to the great morphological similarity between many of the surveyed species, which would only be recognized after a detailed exam, as suggested by Atran (1990) and Begossi *et al.* (2008). In the case of cetaceans, this detailed examination by fishers seldom occurs, just when the animal is found stranded on the beach or is accidentally caught by fishing nets. Begossi *et al.* (2008), studying fishes’ folk taxonomy, also found 18% and 30% of polytypic folk genera mentioned, respectively, by fishers from Atlantic Forest Coast and from Negro River in Amazon, Brazil.

In the Linnean taxonomy, the 17 recognized cetacean species are distributed in 13 biological genera. However, the obtained folk taxonomies show that folk names for the same species suffer local variations, which can explain the higher number of folk species if compared to the biological species (Table 2 and Fig. 6). Local variations in the dolphins' common names used by biologists also occur around the world (Bastida *et al.* 2007; Jefferson, Webber, and Pitman 2008).

As proposed by Berlin (1973), over-differentiation occurs when two or more folk species refer to a single scientific species, as in the case of the folk species 'tuninha-pintada' and 'tuninha-rajada' referring to *Stenella attenuata*, and 'boto-pintado', 'boto-rajado' and 'boto-malhado' referring to *S. frontalis* (Appendix 2). In these cases, the folk species mentioned ('boto-pintado', 'boto-malhado', 'boto-rajado' for *S. frontalis* and 'tuninha-pintada', 'tuninha-rajada' for *S. attenuata*) were synonyms to the fishers.

Under-differentiation type II, according Berlin (1973), is when a single folk species refers to two or more scientific species of two or more genera, as in the case of 'baleia', quoted for 3 species of whale (order Mysticeti) and *for O. orca* (order Odontoceti), 'baleia-branca' mentioned to *B. edeni* and for *O. orca*, 'boto' quoted for seven species of dolphins (order Odontoceti), 'golfinho' mentioned for six species of dolphins, and folk species 'toninha' cited for three species of dolphins and 'boto-caldeirão' quoted for two species of dolphin. The percentage of folk species involved in under-differentiation varied from 10% at Pântano do Sul to 21% at Soure (Appendix 2). We did not find correspondence 1:1, where only one folk species refer to one scientific species.

In relation to the species recognized but not named by the fishers (*S. longirostris* and *T. truncatus*, in Ponta Negra and *E. australis*, *S. bredanensis* and *D. capensis* in São Sebastião), we considered them as "covert" species, as proposed by Berlin (1992). Despite lacking a name, they were perceived and recognized by the fishers, due to their morphological or behavioral characteristics similar to other named folk species, considered as being "of the same family". Further investigations are necessary to understand why these species, despite being recognized, were not named by the fishers.

The obtained folk taxonomies show a high percentage of binomials (Table 2). According to Brown (1985), binomial names are used to label organisms of lower salience, if compared to organisms named by unitary lexemes. So, less salient organisms are named by binomials, which increase the chances for these organisms to be remembered. One explanation for the high percentage of binomials found in the study areas could be, as proposed by Brown (1985), that societies that are more sedentary, such as small-scale agriculturalists, tend to have larger taxonomies, with more binomially named taxa, than hunters and gatherers. As argued by Begossi and Figueiredo (1995) and Hanazaki *et al.* (2007), fishers living along Brazilian coast can be considered as small-scale agriculturalists, since they may depend not only on fishing, but also on vegetal resources cultivated and collected in the forest for their subsistence. This is the case for fishers in Soure and in the rural communities of São Sebastião.

We expected that, where uncertainty of identification is high, there should be a higher number of folk names cited, since different fishers can identify through different names the same organism (Begossi *et al.* 2008). In Soure, the results confirmed this trend, showing that species less known by the fishers received more folk names.

There were overlapping names among all the folk genera, which can be explained by the great morphological similarity among the studied species (lower distinctiveness) and also due to the difficulty of their direct observation on the sea (Berlin 1992; Diamond and Bishop 1999). At the same time, there were overlapping of species in the folk genera "boto", "tuninha" and "golfinho" (including all the dolphins). Cetaceans' identification in the sea can be a hard task also to biologists, even those that are directed to taxonomy. To help researchers to identify cetacean species, Jefferson, Webber, and Pitman (2008) included in their marine mammals' guide some summaries of identifying features for similar-appearing species.

The prototypical species in each area were those with higher frequency of occurrence, as confirmed by the fishers' citations and the records in literature (Flores and Bazzalo 2004; Zerbini *et al.* 2004; Moreno *et al.* 2005; Siciliano *et al.* 2008; Santos *et al.* 2010). Frequency of occurrence, along with taxonomic distinctiveness and cultural importance are, according to Berlin (1992), the main factors contributing to the prototypicality of a species. Some of the prototypical species showed a high cultural salience to the fishers, such as *S. clymene* (tuninha-cachorro), considered a ferocious and frightening species, *P. blainvillei* (toninha), which is frequently caught by the fishing nets and *T. truncatus* and *S. guianensis* (boto) which frequently interact socially with the fishers, following the boats, performing acrobacies and sometimes coming closer after fishers' whistles, according to some fishers.

Among the most cited species, not all can be considered prototypical. This is the case of Soure, where "tucuxi" (*S. guianensis*) and "boto-malhado" (*I. geoffrensis*) were known by 100% of the interviewed fishers, due to their great cultural salience. Soure is the only surveyed area where these two species are still used by some fishers as bait, and for medicinal and ritualistic purposes. Additionally, "boto-malhado" is a regional myth, feared by most of the local inhabitants. It also seems that the fishers have a necessity to differentiate two species which show overlapping distribution during part of the year. Besides, these two species are very different morphologically and behaviorally from each other.

As LEK is empirical, based on daily experiences of fishers, and considering the environmental and biodiversity variation in the four areas, we expected some heterogeneity in LEK among these areas, which was demonstrated by the different levels of recognition and different folk taxonomies obtained. Other factors, such as variation in the number of interviewed fishers per study area and in cetaceans' distribution in each area, probably contributed to LEK heterogeneity. In Pântano do Sul, the smallest of the studied communities and with less interviewed fishers, we obtained a lower recognition degree (40%), contrasting with São Sebastião, where the number of informants was much bigger, as well as the recognition degree (91%). The spatial and temporal variation in the distribution of some cetacean species could explain why the same species is well known by one community and poorly known by the other, as was the case of humpback whales (*M. novaeangliae*), which occur seasonally in both areas and are much more cited by fishers from São Sebastião (49% of fishers) than from Pântano do Sul (24% of fishers). In Pântano do Sul, according to 20% of the fishers, humpback whales pass far from the bay, near the islands, while in São Sebastião, 30% of fishers reported that these whales pass through the Channel of São Sebastião or coasting the nearby beaches, increasing the chance of sightings.

Regarding the influence of resources use on LEK, Gilchrist, Mallory, and Merkel (2005) studying Inuit communities in the Arctic, also found that LEK varied among species, and suggest that the relationship of the species to the communities can explain that variation. Although in all the areas, except in Soure, fishers affirmed that they do not use cetaceans as a resource anymore, this use was practiced by the communities in past times, and was embedded in the LEK transmitted through generations. There were whales' hunting stations near Ponta Negra, São Sebastião and Pântano do Sul during the first half of the last century. This can explain why some species, such as big whales (e.g. *E. australis* and *M. novaeangliae*), are still culturally salient to the fishers, despite their lower occurrence around the year in the studied areas.

Comparing folk biological classification to scientific classification, Newmaster *et al.* (2007) observed that the first is easier and quicker to use, which can help to access biodiversity in developing countries. Despite all the advantages of using LEK to complement biological research, some authors suggest that, due to its locally and culturally specificity, it should be tested and validated, as scientific and other source of information are, to confirm its credibility and establish a standard in ethnobiological research (Huntington 2000; Gilchrist and Mallory 2007; Begossi 2008; Berkes 2008).

The importance of LEK to local management, community empowerment and conservation makes the ethnobiological research worthwhile. Researchers and local fishers should become partners to promote local biological and cultural conservation (Berkes 2008, Silvano and Valbo-Jorgensen 2008; Silvano and Begossi 2010).

Conclusion

Cetaceans' folk taxonomical information provided by fishers can be very useful to understand cognitive processes, the interactions of people and natural resources, and to improve biological knowledge, among others.

Among the 17 species named and classified by the fishers, two are considered by IUCN vulnerable to extinction (*P. macrocephalus* and *P. blainvillei*), and other nine were considered as "data deficient" species (*B. edeni, O. orca, G. macrorhynchus, S. guianensis, S. longirostris, S. frontalis, S. clymene, D. capensis* and *I. geoffrensis*), so all additional information about them is very valuable (IUCN 2010).

We compared the folk taxonomies from the four study areas and discussed the similarities and differences based on local resource uses and oceanographic variations. Cetaceans' temporal and spatial distributions, associated to the fishing areas' characteristics were influenced in cetaceans' recognition. The media also influenced fishers' LEK, bringing them information on seasonal species occasionally sighted. The most ecologically and culturally salient species were the most cited, including the two most common species in the four study areas: *S. guianensis* and T. *truncatus*. Cetacean's morphological characteristics and behavior were the main factors influencing their classification into life forms and groups. We found a high percentage (73%) of binomials, among the 37 folk specific names, which can be explained by the people's necessity to differentiate species morphologically very similar.

These results show that for nine of the cetacean species, generally the least known, fishers did not agree about their folk names, probably reflecting the degree of fishers' knowledge on these species. For eight species, from 35 to 100% of fishers (depending on the species) agreed on the specific name for each one, and the degree of concordance about one specific folk name was higher for the species better known by the fishers.

Folk taxonomic surveys can be an efficient method to investigate local interactions between fisheries and cetaceans, since most of the fishers recognized the most common species, which have a bigger potential of interaction with them.

Another useful application of folk taxonomic studies is to increase the opportunities to dialogue with the fishers about cetacean species, introducing environmental education topics related to cetaceans' conservation and considering fishers knowledge in future management actions.

Acknowledgements

We are grateful to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a doctoral scholarship to S.P.S., and for fellowships to AB (301957/2007-0 and 151084/2009-2), to FAPESP, for the grant # 06/50435-0 to AB, to PIATAM Mar and PIATAM Oceano Projects, S. Siciliano and A. L. F. Rodrigues for all the help during the research in Marajó Island, and to the fishers from Soure, Ponta Negra, São Sebastião and Pântano do Sul, for their cooperation and participation in this research.

Appendix 1

Cetaceans' species surveyed in the study areas. (Percentage of fishers that recognized each species.NR – species surveyed but not recognized by fishers. At the end of the table: percentage of recognition in each area and average number of species/fisher).

Species common name	Biological name	Marajó (n=40)	Natal (n=36)	São Sebastião (n=70)	Pântano do Sul (n=25)
1. Southern right whale	*Eubalaena australis* (Desmoulins, 1822)			53	100
2. Humpback whale	*Megaptera novaeangliae* (Borowski, 1781)	75	83	53	28
3. Bryde's whale	*Balaenoptera edeni* (Anderson, 1878)	10		26	4
4. Dwarf minke whale	*Balaenoptera acutorostrata* (Lacépède, 1804)	5	28	1	NR
5. Antarctic minke whale	*Balaenoptera bonaerensis* (Burmeister, 1867)		11		NR
6. Sperm whale	*Physeter macrocephalus* (Linnaeus, 1758)	3	31		NR
7. Killer whale	*Orcinus orca* (Linnaeus, 1758)	70		64	52
8. Short-finned pilot whale	*Globicephala macrorhynchus* (Gray, 1846)		33		NR
9. False killer whale	*Pseudorca crassidens* (Owen, 1846)		4		16
10. Melon-headed whale	*Peponocephala electra* (Gray, 1846)		19		
11. Common bottlenose dolphin	*Tursiops truncatus* (Montagu, 1821)	53	72	90	84
12. Rough-toothed dolphin	*Steno bredanensis* (Lesson, 1828)	3	22	23	NR
13. Atlantic spotted dolphin	*Stenella frontalis* (Cuvier, 1829)	20		39	16
14. Clymene dolphin	*Stenella clymene* (Gray, 1850)		97		
15. Pantropical spotted dolphin	*Stenella attenuata* (Gray, 1846)		39		
16. Spinner dolphin	*Stenella longirostris* (Gray, 1828)		53		
17.Short-beaked common dolphin	*Delphinus delphis* (Linnaeus, 1758)				4
18. Long-beaked common dolphin	*Delphinus capensis* (Gray, 1828)			29	
19. Guiana dolphin	*Sotalia guianensis* (van Bénéden, 1864)	100	92	89	72
20. Franciscana	*Pontoporia blainvillei* (Gervais e d'Orbigny, 1844)			91	88
21. Amazon river dolphin	*Inia geoffrensis* (de Blainville, 1817)	100			
Total of surveyed species		10	13	11	15
% of species recognized by more than 20% of fishers/area		60	77	91	40
Average number of species /fisher		4.2	5.5	5.5	4.3

Appendix 2

Correspondence between folk species and scientific species for cetaceans' names in Soure, Ponta Negra, São Sebastião and Pântano do Sul.

	Soure	Ponta Negra	São Sebastião	Pântano do Sul
Over-differentiation type II (Synonyms)		1 case (1 species / 2 folk species): *S. attenuata* – tuninha-pintada, tuninha-rajada.	1 case (1 species / 3 folk species): *S. frontalis* – boto-pintado, boto-rajado, boto-malhado.	
Total of folk species involved in over-differentiation		2	3	
Under-differentiation type II (Polytypy)	3 cases (3 folk species / 5 species): Boto-baleia – *O. orca, T. truncatus, S. frontalis, I. geoffrensis.* Malhado - *I. geoffrensis, S. frontalis.* Tucuxi – *S. guianensis, T. truncatus.*	3 cases (3 folk species / 7 species): Cachalote – *B. acutorostrata, M. novaeangliae, P. macrocephalus, G. macrorhynchus.* Baleote - *G. macrorhynchus, S. bredanensis.* Tuninha-cachorro – *S. clymene, S. guianensis*	2 cases (2 folk species /4 species): Boto-caldeirão - *T. truncatus, S. frontalis.* Baleia-branca - *O. orca, B. edeni.*	1 case (1 folk species / 2 species): Cachalote - *M. novaeangliae, O. orca.*
Total of folk species involved in under-differentiation	3	3	2	1

Capítulo 3

Local ecological knowledge on cetaceans by Brazilian fishers

Golfinhos-nariz-de-garrafa em São Sebastião em abril de 2010. (Foto: Júlio Cardoso)

Capítulo 3

Local ecological knowledge on cetaceans by Brazilian fishers

Shirley P. Souza[1,2,3] and Alpina Begossi[2,3,4]
1 – PPG Ecologia – UNICAMP
2- CAPESCA/PREAC and CMU - UNICAMP
3 – FIFO
4- UNISANTA

[1,2]UNICAMP (PPG Ecologia, CAPESCA/PREAC, CMU), CP 6023, 13.083-970, Campinas, SP, Brazil
[3]FIFO - Fisheries and Food Institute
[4]ECOMAR, UNISANTA, SANTOS, SP, Brazil
(shirleypacheco@yahoo.com)

Abstract

Fishers' local ecological knowledge (LEK) is empirical, practical-oriented, and includes biological, ecological and cultural information. Nearly half of the cetacean species occurring in Brazil (n=42) are classified by the IUCN Red List as "data deficient", due to the lack of information about them. We interviewed 171 fishers, recording their knowledge on cetaceans' ecology, such as occurrence areas, preferential habitats, seasonality, group size, and reproduction in four areas of the Brazilian coast: Soure (North), Ponta Negra (Northeast), São Sebastião (Southeast) and Pântano do Sul (South). Fishers answered questions about 18 cetacean species (four in Soure, nine in Ponta Negra, nine in São Sebastião and seven in Pântano do Sul), reporting 112 occurrence areas (varying from 17 to 44 areas), and mentioning different categories of preferential habitats (n = 7), seasonality patterns (n = 5), group sizes (n = 8) and additional information on the reproduction of some species. The Guiana dolphin (*Sotalia guianensis*) and the bottlenose dolphin (*Tursiops truncatus*) are the most cited species. There were variations among fishers' LEK in the study areas, regarding the number of recognized cetacean species and the degree of knowledge on these species, probably influenced by the level of communities' dependence on natural resources and by variations in oceanographic parameters. Most of the obtained information agrees to the scientific literature and could complement the local biological information on cetaceans, contributing for their conservation.

Keywords: artisanal fishers, cetaceans' occurrence, seasonality, habitats, group size, reproduction, conservation, incidental catch.

Introduction

Nearly 90% of fishers in the world, almost 30 million of people, are small-scale fishers (Berkes *et al.* 2001; Pauly 2006; FAO 2009). Besides their contribution to the world's economy, small-scale fishers have been the focus of increasing studies about their interactions with natural resources and on the knowledge resulting from these processes (Johannes 2003a; Crowder *et al.* 2008; Begossi 2010).

In fact, small-scale fisheries in Brazil, practiced by nearly two million of fishers, is responsible for more than 50% of the national fishing production (Vasconcelos *et al.* 2007; Begossi 2010), playing an essential role in relation to food security.

The local ecological knowledge (LEK) accumulated by people during their lifetime and transmitted through generations encompasses biological, ecological and cultural information. Such ecological knowledge has been intensively studied by Ethnoecology, an interdisciplinary branch of Human Ecology that studies how nature is perceived by human societies through a framework of knowledge, beliefs and practices resulting in strategies for the use of natural resources (Berkes *et al.* 2000; Toledo 2002; Begossi 2004).

The importance of LEK has been highlighted by many authors, who argue that cultural transmission has a central role in shaping society and culture (Boyd and Richerson 1985; Berkes 2008; Ruddle 2000).

Fishers' LEK is empirical, practical-oriented, and embedded with long-term records on local species or environmental events, but it is also dynamic and adaptable to a changing world (Johannes *et al.* 2000; Ruddle 2000; Berkes 2008). Among other uses, local ecological knowledge can record data on distribution of rare and threatened species and long term environmental changes, suggesting new hypothesis to be investigated and providing important contribution to the fisheries and environmental management, especially in tropical areas (Johannes

1998; Gadgil *et al.* 2003; Johannes 2003b; Rosa *et al.* 2005; Silvano and Valbo-Jorgensen 2008; Begossi *et al.* 2010).

Surveys assessing cetaceans' ecology using LEK started in the 80's in the Arctic, analyzing the hunters' knowledge on the beluga (*Delphinapterus leucas*) and narwhal (*Monodon monoceros*) (Richard and Pike 1993; Mymrin *et al.* 1999; Huntington *et al*. 1999, 2004). These studies were done in indigenous communities in the Eastern Arctic and Northern Bering Sea (Chukotka, Russia and Alaska, USA, respectively). In Brazil, studies using fishers' knowledge on cetaceans began in the end of the 90's, mainly focusing on the local interaction between cetaceans and fishing gear (accidental catch) (Pinheiro and Cremer 2003; Peterson *et al.* 2008; Souza and Begossi 2006; Souza and Begossi 2007; Alarcon *et al*. 2009).

Half of the 88 cetacean species currently recorded occurs along the Brazilian coast, rivers and estuaries and two of them are particularly affected by incidental catch: the small dolphin Franciscana (*Pontoporia blainvillei*) and the Guiana dolphin (*Sotalia guianensis*). Indeed, cetaceans have been vulnerable to bycatch in fisheries around the world, among other threats such as pollution, ship strikes and prey depletion caused by overfishing. Over 300.000 whales and dolphins die every year trapped in gillnets (WWF 2004; Reeves *et al.* 2005; Jefferson *et al.* 2008; Moore *et al.* 2009).

Nearly half of the species occurring in Brazil (21) are classified by the IUCN Red List as "data deficient" (IUCN 2010). Considering the lack of information about these species we proposed this survey, in order to gather more information on cetacean's ecology by studying fishers' LEK in a broader scale along the Brazilian coast. Among other studies on cetaceans' Ethnoecology, this is the first to bring a regional comparison on Brazilian fishers' LEK.

Studies comparing fishers' LEK about Ethnoicthiology in a regional scale, addressing diet, migration and reproductive aspects were carried out by Silvano *et al.* (2006) and Begossi *et al.* (2011) in fishing communities in the Southeastern and Northeastern Brazilian coast.

Considering this regional approach, our goal was to record and analyze fishers' knowledge on cetaceans' ecology, such as occurrence areas, preferential habitats, seasonality, group size, and reproduction in four areas of the Brazilian coast: Soure (Marajó Island, North), Ponta Negra (Natal, Northeast), São Sebastião (Southeast) and Pântano do Sul (Florianópolis, South). We also discussed the differences in each area regarding fishers' LEK and compared fishers' LEK with the available scientific literature.

Methods

Study areas

Four areas along the Brazilian coast were surveyed about cetaceans' ethnoecology (Fig. 1):

1. Soure (00° 43' 00"S - 48° 31' 24"W) is the main city at Marajó Island (Pará State), the biggest estuarine island of the world, situated in the Amazon River and Pará-Tocantins Rivers' estuaries. In May, 2007, we interviewed 40 fishers in four communities: Matinha (n = 12), São Pedro (n = 10), Pesqueiro (n = 16) and Araruna (n = 2).
2. Ponta Negra (05° 47' 42" S - 35° 12' 34" W) is a famous touristic beach in Natal, the capital of Rio Grande do Norte State, where there is a fishing community in the southern side of the beach. We interviewed 36 fishers of this community in January, 2007.
3. São Sebastião (23° 45' 36" S - 45° 24' 35" W) is a small city located between the sea and the slopes of Atlantic Forest on the coast of São Paulo State. From March to August, 2006, we interviewed 70 fishers in 14 communities (Enseada (n = 5), Cigarras (n = 3), São Francisco (n = 16), Pontal da Cruz (n = 4), Barequeçaba (n = 3), Toque-Toque Grande (n = 5), Toque-Toque Pequeno (n = 7), Paúba (n = 3), Maresias (n = 2), Boiçucanga (n = 11), Barra do Sahy (n = 5), Juqueí (n = 1), Barra do Una (n = 3) and Boracéia (n = 1)).
4. Pântano do Sul (27° 35' 48" S - 48° 32' 57" W) is a fishing community located at the south of Florianópolis Island, the capital of Santa Catarina State and a famous touristic city. In February, 2008, we interviewed 25 fishers in this community.

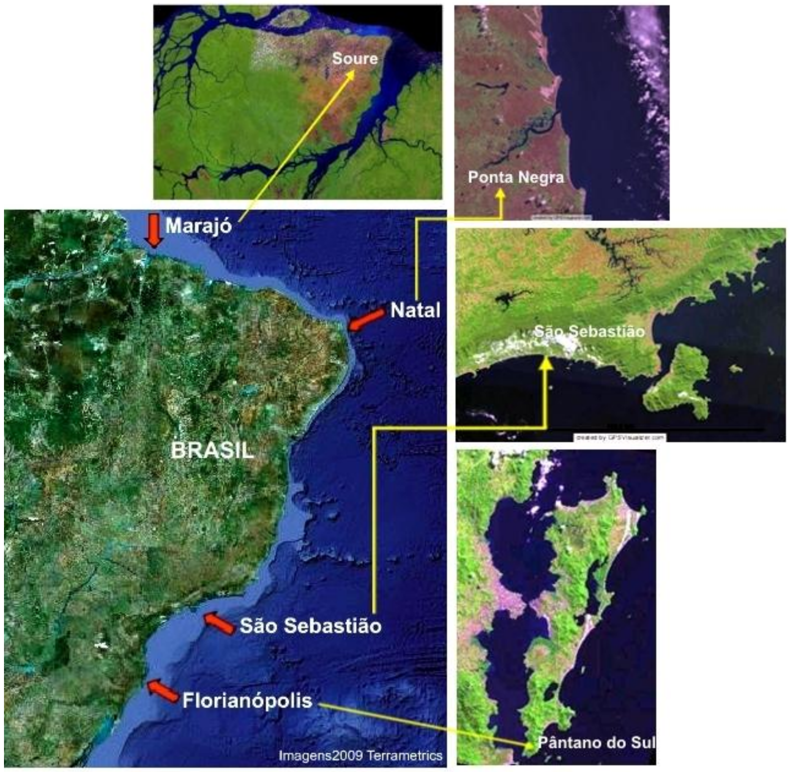


Figure 1 – Fishers' communities studied along the Brazilian coast (Soure: 00° 43' 00" S, 48° 31' 24" W, Ponta Negra: 05° 47' 42" S, 35° 12' 34" W, São Sebastião: 23º48'08" S, 45º24'07" W, Pântano do Sul: 27° 35' 48" S - 48° 32' 57" W) (Source: Terrametrics and Google Earth).

The climatic, geomorphological, oceanographic, socioeconomic and demographic characteristics of the four study areas are summarized at Tables 1 and 2.

Table 1 – Physical characteristics of the study areas.

Geographic / Oceanographic characteristics	**Soure (Marajó)**	**Ponta Negra (Natal)**	**São Sebastião**	**Pântano do Sul (Florianópolis)**
Climate	two seasons (rainy season - December to June)	two seasons (rainy season - March to July)	four well defined seasons (rainy season from January to March)	four well defined seasons (rainy season from January to March)
Mean air temperature	29°	28°	24°	21°
Ecoregion	Amazonic estuary, mangrove and savannas	coastal Atlantic Forest, mangroves, sand dunes	coastal Atlantic Forest and mangroves	coastal Atlantic Forest
Continental shelf mean width [a]	200 a 300 km	63 km	120 km	130 km
Continental shelf mean depth [b]	20m	30 m	80m	100m

Mean sea surface temperature [c]	28°	28°	25°	22°
Mean sea surface salinityc [c]	28 - 36 pss	36 pss	35 pss	35 pss

[a] Continental shelf width from Rossi-Wongtschowski and Madureira 2006; Souza-Filho 2005; Tabosa and Vital 2002. [b] Continental shelf depth from DHN – Marinha do Brasil 2010. [c] Sea surface temperature and salinity data from NOAA 2009.

Table 2- Communities' socioeconomic characterization.

Socioeconomic parameters	**Soure (Marajó)**	**Ponta Negra (Natal)**	**São Sebastião**	**Pântano do Sul (Florianópolis)**
Population [a]	22.995	± 30.000 (Natal - 803.811)	73.833	± 5.000 (Florianópolis - 421.203)
N. of fishers interviewed [b]	40	36	70	25
N. of communities [b]	4	1	14	1
Mean age of interviewed fishers [b]	59 (± 10.24)	48 (± 8.78)	59 (± 13.16)	56 (± 13.73)
Fishing time in years (mean of all fishers)[b]	44.5 (± 11.12)	35 (± 9.87)	40 (± 14.38)	40 (± 14.95)
% of part-time fishers [b]	10	39	21	24
Distance from a big city (> 500.000 inhabitants)[b]	87 km [d]	4,5 km [d]	112 km [d]	30 km [d]
Basic services (sewage treatment)[a]	37%	100%	100%	25%
Basic services (water supply)[a]	58%	100%	100%	100%
Basic services (electricity supply)[a]	100%	100%	100%	100%
Access to TV (More than 50% of interviewees)[b]	Yes	Yes	Yes	Yes
Schooling (more than 50% of the interviewed fishers completed...)[b]	3rd grade (55%)	2rd grade (58%)	completed elementary school (56%)	completed elementary school (60%)
Illiteracy (among interviewed fishers)[b]	7.5%	13.8%	5.7%	8%
HDI (Human Development Index - education, health and income per capita - 0 the lowest, 1 the highest)[a]	0.723	0.788	0.798	0.875
Poverty index (head count index - proportion of poor people in the city)[a]	48.2%	40.8%	21.6%	23.5%
N. Tourists/year[c]	± 410.000	1.350.000	± 200.000	± 800.000
International tourists[c]	7% international	14,5% international	8,9% international	18,5% international
National tourists[c]	93% national	85,5% national	91,1% national	81,5% national
Main origin of the tourists[c]	USA, Germany – (34,7% north america, 28,7% South America, 24,3% Europe)	Portugal, Spain, Italy, Holland – (70% Europe)	USA - 15%, Argentina - 12%, São Paulo - 20%	Argentina - 41,5%
Resources uses - extraction of forest products for subsistence [b]	Yes	No	No	No
Resources uses - subsistence fisheries[b]	Yes	Yes	Yes	Yes

[a] Data of population, basic services, HDI and Poverty Index from: IBGE 2010. [b] Data obtained in this survey. [c] Data about tourism from: Governo do Pará 2001; Hafermann 2004; Ministério do Turismo – Brasil 2010. [d] Soure: 4 hours by boat, Ponta Negra: 20 min. by bus, São Sebastião: 2 hours by bus, Pântano do Sul: 40 min. by bus.

Studying Fishers' LEK

Initially we selected the cetaceans species to be surveyed including all species that have been previously recorded (sighted, stranded or captured) in each area, according to the specialized literature (Siciliano 1994; Martuscelli *et al.* 1996; Araújo *et al*. 2001; Flores and Bazzalo 2004; Zerbini *et al.* 2004; Moreno *et al.* 2005; Bastida *et al.* 2007; Siciliano *et al.* 2008; Santos *et al.* 2010). Between 10 and 15 species were surveyed in each community (Appendix 1).

We used semi-structured interviews and unlabeled pictures and photos (of cetaceans' dorsal fins and flukes) of 21 cetacean species to ask questions about where and when cetacean species are sighted, the direction of their movements, where they prefer to live, what are the size of the sighted groups and if fishers know about cetaceans' reproduction. The same questionnaire was applied in the four study areas. We also collected additional socio-economic data about the interviewed fishers.

We first asked for the personal consent of the fishers before they were interviewed. We first interview the leading fishers of each community, then using the "snow-ball" method, we selected those fishers older than 35 years old, living in the community for more than 10 years, and fishing for more than 15 years to be interviewed.

Data analysis

The answers obtained for each question asked to the interviewed fishers were numerically quantified, in order to allow comparisons among species, topics and informants. The answers "I don't know" were also quantified, since they represent the lack of fishers' knowledge in relation to the species or topic surveyed, as indicated in previous studies by Silvano and Begossi (2002) and Silvano *et al.* (2006). For many questions more than one citation (answer) was obtained per fisher. In order to study the dominant perception in each community, and to compare the dominant perceptions of fishers on cetaceans among the studied communities, we only considered in the statistical analysis the species cited by more than 20% of the fishers interviewed in each place. We compared fishers' LEK on cetacean species with information from the specialized literature through a comparative table following Marques (2001). For statistical tests (correlations), we tested the normality of the data.

We used Pearson correlation coefficient (r) or Spearman correlation coefficient to test the relation between:

1. The age, the time spent fishing, the schooling (in years) of each fisher and the number of 'do not know' (DNK) answers given by each fisher, to check if these factors affect their knowledge on cetaceans.
2. The number of fishing spots cited by the fishers and the number of cetaceans' occurrence areas mentioned by them, to check if differences in number of fishing spots per fisher affect the fishers' knowledge about occurrence areas. This test was carried out separately in each study area.

We used a Two-Way ANOVA to check the variation in fishers' knowledge on the species in relation to the surveyed topics and areas, comparing the average of DNK answers cited by fishers. A Correlation Matrix was used to analyze the correlation of different factors (% of informants/study areas, % of widely and restricted distributed or migratory species, isolation degree of each area) and fishers' knowledge, represented by the percentage of recognized species. We used Chi-square to test differences in fishers' citations regarding the topics 'Habitat', 'Seasonality', 'Group size' and 'Reproduction' (specifically the presence of calves). We also tested the differences in fishers' citation for the most cited habitats for each species, using Chi-square.

Cetaceans' species identification and its English common names followed Bastida *et al.* (2007) and Jefferson *et al.* (2008). All statistical tests were performed using the software Biostat 5.0 (Ayres *et al.* 2007).

Results

We interviewed 171 fishermen, in 20 communities distributed among Soure, Ponta Negra, São Sebastião and Pântano do Sul (Table 2). The mean age of these fishers is 55 years old, most of them have spent about 40 years fishing along their lives, and 64% of them were born in the studied communities. Nearly 8% of them are illiterate, 57% completed elementary school and only 7% completed high school. An average of 24% of all interviewees are part-time fishers, dedicating some time to selling coconuts on the beach, taking tourists in boat tours, working in houses' construction or in public institutions. Table 2 displays a summary of socioeconomic and demographic characteristics that contribute to increase or not the isolation degree of each area, such as distance from big cities, touristic influx, poverty and human development indexes.

Soure (Marajó Island) seems to be the most isolated community, and fishers survive basically from fisheries and extraction of forest resources, mainly 'andiroba' nuts (*Carapa guianensis*) collected by the women to extract its oil. In contrast, Ponta Negra, São Sebastião and Pântano do Sul are located into or near metropolitan areas.

The interviewed fishers use different types of small boats, such as sail and paddled canoes, and fishing nets, line and hook and long-lines to catch several species of fishes, crustaceans and mollusks (Appendix 2). Among the fishing nets, the most used are gillnets (bottom and surface), followed by encircling nets, pull nets, drifting nets and fixed trap and gillnets ('cerco', and 'rabiola') (Appendix 3).

The main target species vary from place to place because of the variation in the habitat and oceanographic parameters, such as sea water salinity, currents, depth and width of the continental shelf (Appendix 2). In face of these variations, fishers use different fishing spots according to the concentration of fish stocks and their seasonality. In fact, they reported using a range of one to 13 fishing spots (average = 3 spots/fisher) during their fisheries (Fig. 2). Other factors, such as market demands, could be causing the variation in the target species among the study areas, but these factors were not surveyed.

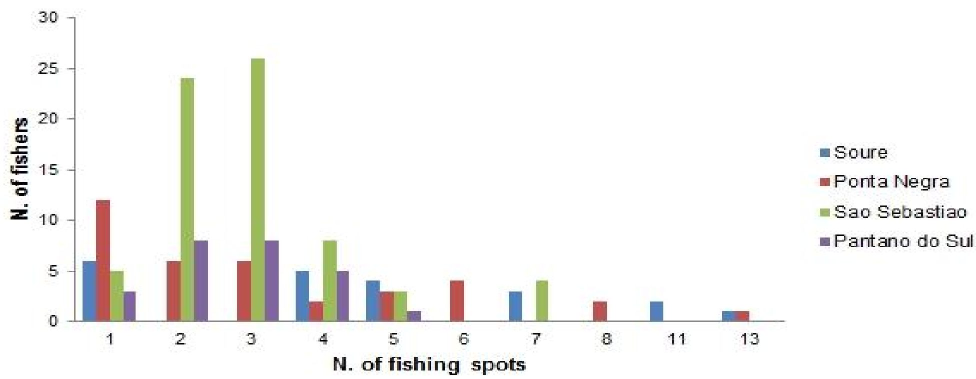


Figure 2 – Number of fishing spots cited by each fisher in Soure, Ponta Negra, São Sebastião and Pântano do Sul.

Among the 21 recognized cetacean species, fishers gave information in relation to occurrence areas, habitats, seasonality, group size and reproduction for 18 species (Figs. 3 and 4). In São Sebastião, fishers recognized 81% of the cetacean species that were presented to them, while in Ponta Negra, Soure and Pântano do Sul fishers recognized respectively 77%, 50% and 47% of cetacean species.

Species of wider occurrence (*M. novaeangliae, T. truncatus* and *S. guianensis*) were among the most cited in all topics surveyed, as well as species of geographically restricted occurrence to one or two areas, such as *I. geoffrensis*, *P. blainvillei* and *E. australis*.

According to the fishers, the species *Sotalia guianensis* and *Tursiops truncatus* were common to the four studied areas.

The most mentioned species in each studied area were, in Soure: *S. guianensis, I. geoffrensis* and *T. truncatus;* in Ponta Negra: *S. guianensis, M. novaeangliae, S. clymene* and *T. truncatus*; in São Sebastião: *S. guianensis, P. blainvillei,* and *T. truncatus* and in Pântano do Sul: *E. australis, T. truncatus, S. guianensis* and *P. blainvillei*.

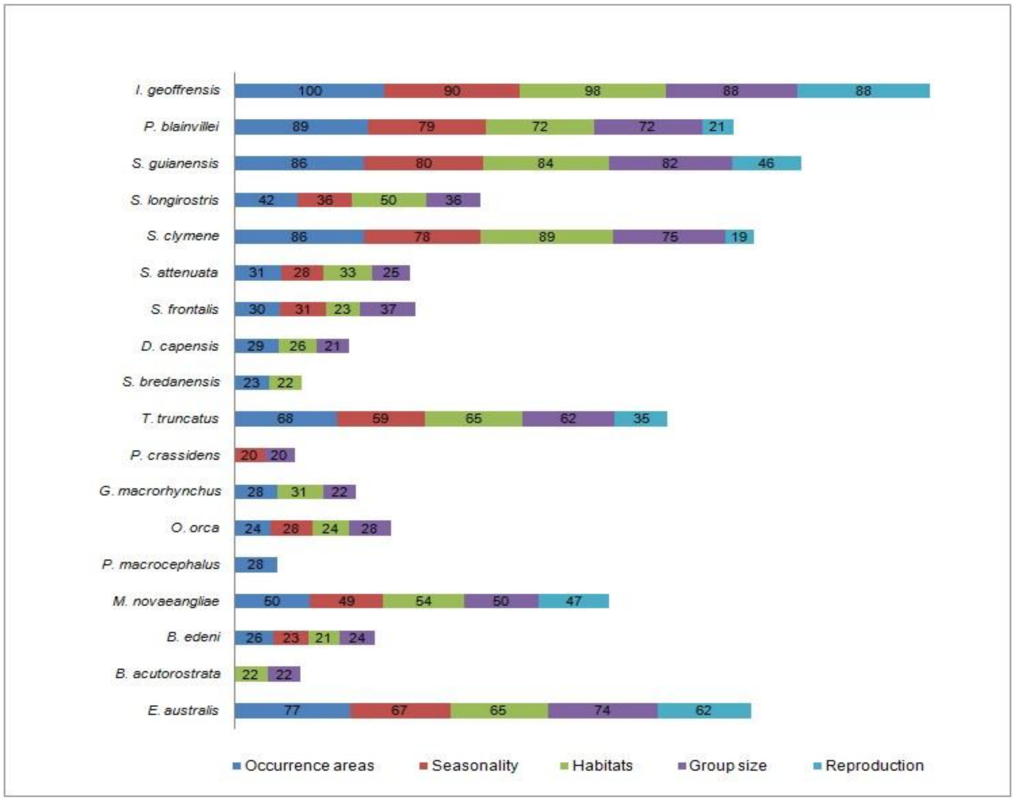


Figure 3 – Percentage of fishers' citations on each topic for cetacean species ('Do not know' answers were not represented in this figure).

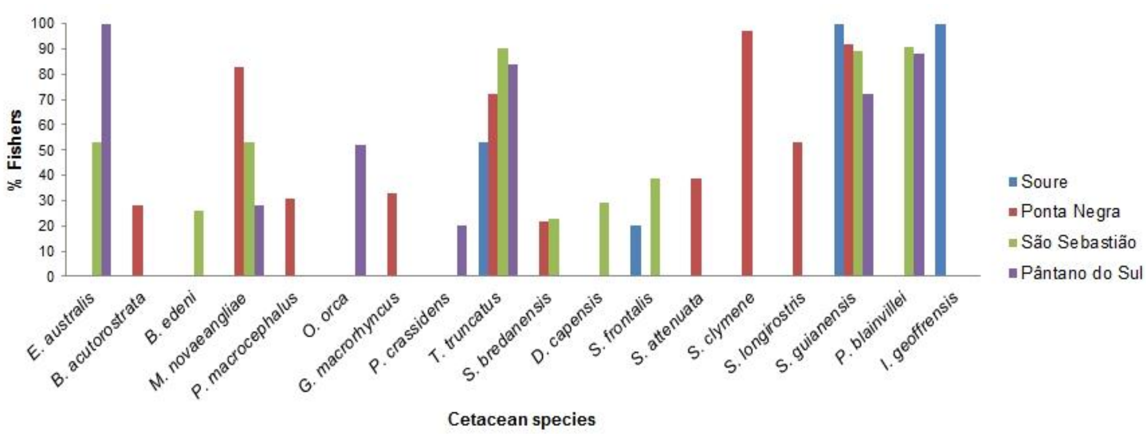


Figure 4 – Cetacean species cited by fishers (%) in each studied area (Soure: n = 40, Ponta Negra: n = 36, São Sebastião: n = 70, Pântano do Sul: n = 25).

The average of DNK answers mentioned by the fishers varied among the study areas, according to the ANOVA results ($F = 23.60$, $p < 0.0001$). Comparing the averages of DNK answers in all the areas, we found lower averages in Soure, which means that Soure's fishers know more on the surveyed topics. Among these topics, the differences in the DNK answers were not significant ($F = 2.08$, $p = 0.15$) (Fig. 5) (Appendix 4A).

We found no correlation between the time that fishers have been fishing (in years) and the 'do not know' answers (Soure: $r = -0.05$, $df = 38$, $p = 0.74$ Ponta Negra: $r = -0.22$, $df = 34$, $p = 0.18$; São Sebastião: $r = -0.05$, $df = 68$, $p = 0.66$; Pântano do Sul: $r = 0.33$, $df = 23$, $p = 0.10$). Testing the age of the fishers and 'do not know' answers, we also did not find any correlation (Soure: $r = 0.10$, $df = 38$, $p = 0.52$; Ponta Negra: $r = -0.24$, $df = 34$, $p = 0.1$; São Sebastião: $r = 0.01$, $df = 68$, $p = 0.89$; Pântano do Sul: $r = 0.19$, $df = 23$, $p = 0. 35$). The same result was found testing the correlation between fishers' schooling time (in years) and 'do not know' answers (Soure: $r = 0.24$, $df = 38$, $p = 0.12$; Ponta Negra: $r = 0.01$, $df = 34$, $p = 0.93$; São Sebastião: $r = 0.03$, $df = 68$, $p = 0.75$; Pântano do Sul: $r = -0.26$, $df = 23$, $p = 0.19$).

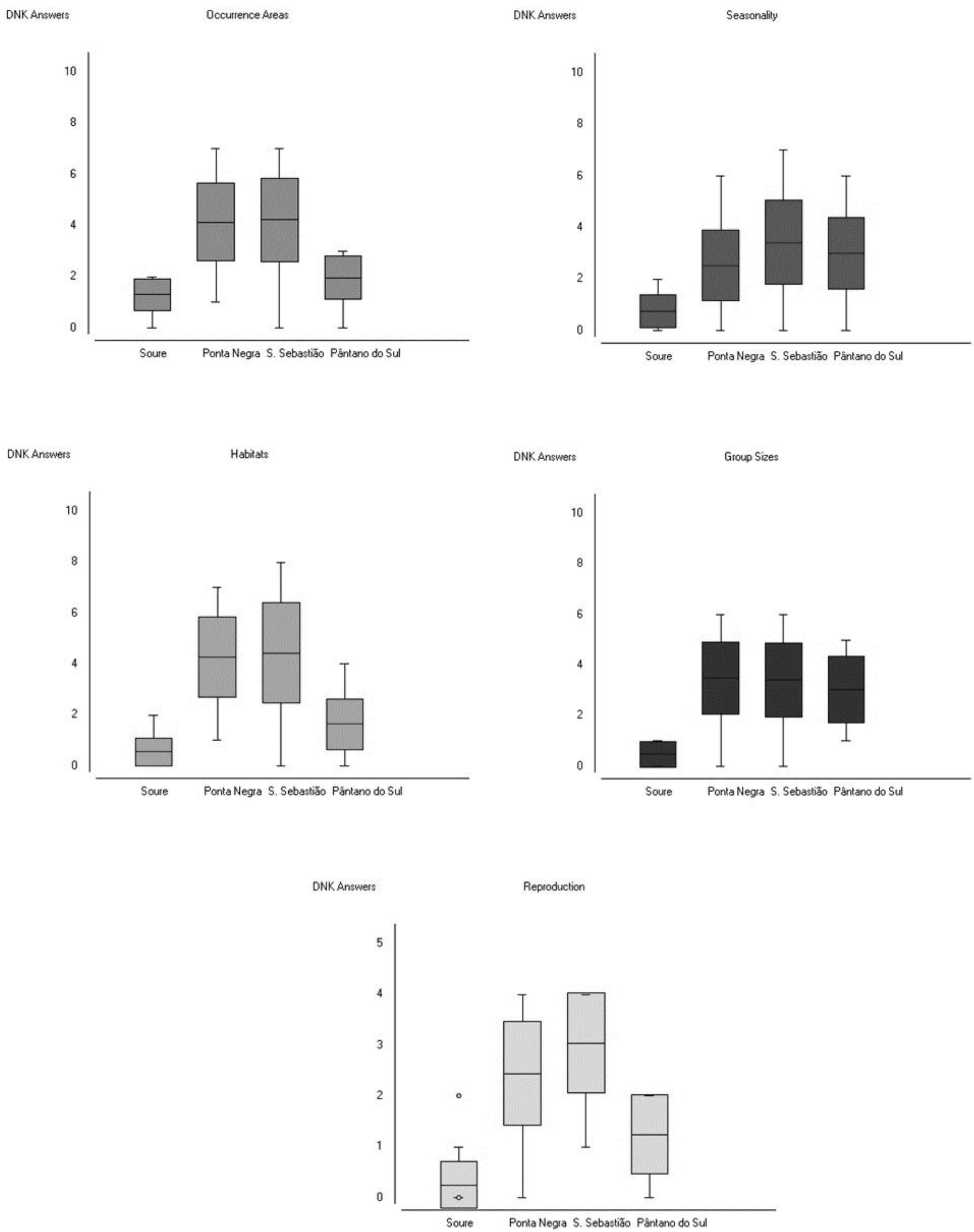


Figure 5 – Average of 'do not know' (DNK) answers for each topic in the surveyed areas.

The results of the analysis using Correlation Matrix showed that the only factor that is positively correlated to the fishers' LEK (e.g. number of recognized species by fishers) is the percentage of widely distributed species in each community ($r = 0.97$, $p = 0.02$) (Appendix 4B). Fishers recognized a higher number of species when species of wider distribution occurred in the study area.

Occurrence Areas

Regarding to cetaceans' occurrence areas, a total of 112 fishing points were mentioned for 16 species. Some of the interviewed fishers (22 %) affirmed that dolphins such as *T. truncatus, S. guianensis* and *P. blainvillei* occur where there are schools of fishes. The most cited occurrence areas were plotted in a map and are shown in the Figures 6 - A, B, C, D. These points were plotted considering the general areas cited by the fishers and their estimated depth and direction.

The number of mentioned species and occurrence areas varied in each area. We found positive correlations between the number of points/species and the number of fishers who cited these points (Soure: $r = 0.99$, $df = 2$, $p = 0.008$; Ponta Negra: $r = 0.78$, $df = 7$, $p = 0.01$; São Sebastião: $r = 0.86$, $df = 7$, $p = 0.002$; Pântano do Sul: $r = 0.96$, $df = 3$, $p = 0.006$). Fishers know more points of occurrence for those species that they know better. There was not any correlation between the number of fishing points and the number of cetaceans' occurrence areas cited by each fisher (Soure: $r_s = 0.19$, $df = 38$, $p = 0.48$; Ponta Negra: $r_s = 0.28$, $df = 34$, $p = 0.09$; São Sebastião: $r_s = 0.24$, $df = 68$, $p = 0.04$; Pântano do Sul: $r_s = 0.19$, $df = 23$, $p = 0.35$). Figures 7A, B, C, D displays the main occurrence areas and cetacean species for Soure, Ponta Negra, São Sebastião and Pântano do Sul.

According to 92% of the fishers from Soure, *I. geoffrensis* is a species 'from the river', so its occurrence area varies according to the flooding season. Despite knowing humpback and killer whales from TV, fishers did not mention the occurrence of whales in Marajó Bay.

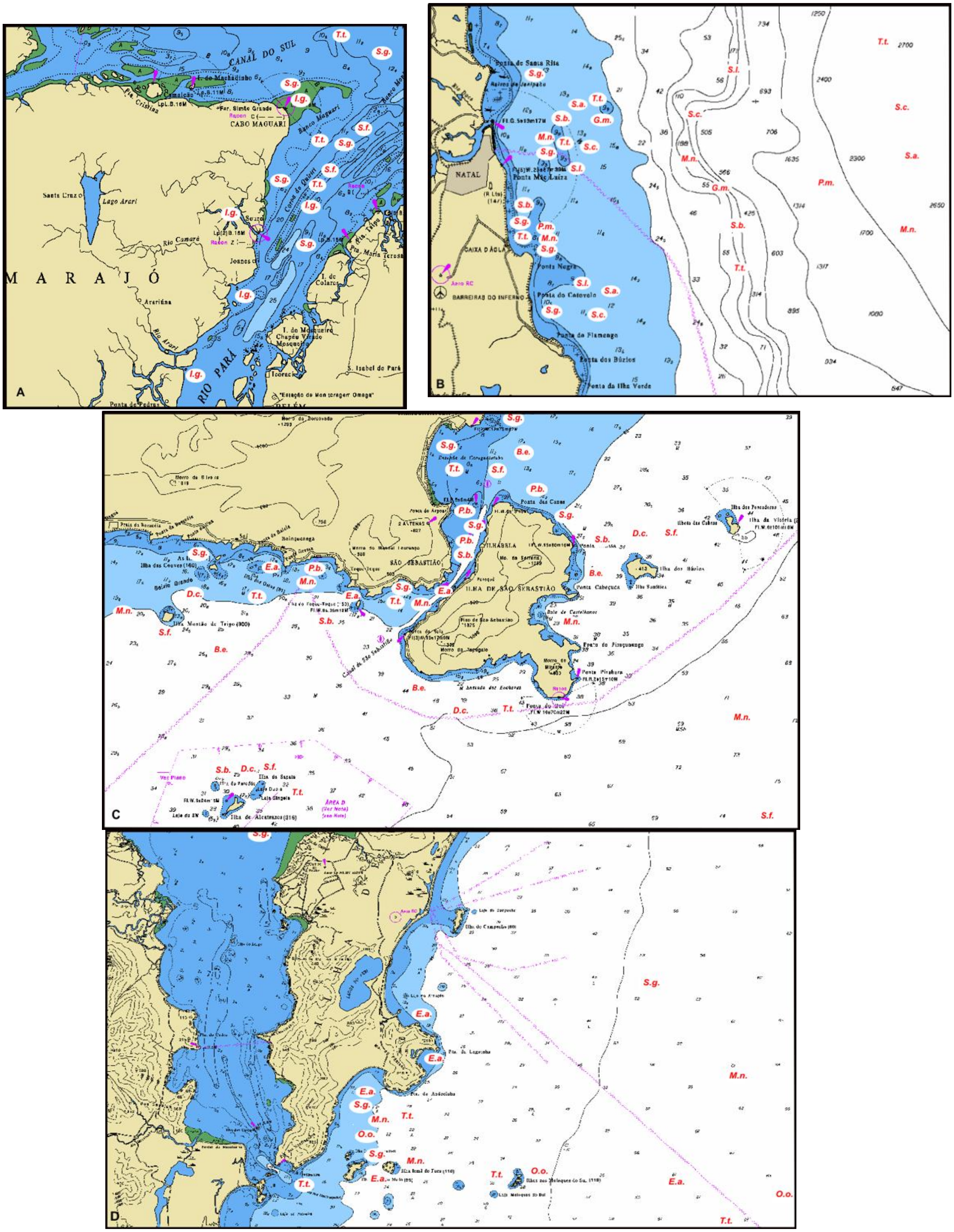


Figure 6 – Fishers' indications of the main occurrence areas of cetaceans in A – Soure, B – Ponta Negra, C – São Sebastião, D – Pântano do Sul. (Cetacean species: *E.a.= Eubalaena australis, B.e.= Balaenoptera edeni, B.a.= B. acutorostrata, M.n.= Megaptera novaeangliae,*

P.m.= Physeter macrocephalus, G.m.= Globicephala macrorhynchus, O.o.= Orcinus orca, P.C.= Pseudorca crassidens, T.t.= Tursiops truncatus, S.b.= Steno bredanensis, D.c.= Delphinus capensis, S.f.= Stenella frontalis, S.c.= S. clymene, S.a.= S. attenuata, S.l.= S. longirostris, S.g.= Sotalia guianensis, P.b.= Pontoporia blainvillei and *I.g.= Inia geoffrensis*).

Fishers from Ponta Negra mentioned the occurrence of oceanic cetacean species in their fishing points, such as *G. macrorhynchus*, *S. clymene*, and *S. longirostris*. In São Sebastião and Pântano do Sul, the fishers reported the occurrence of two migratory species of baleen whales (*E. australis* and *M. novaeangliae*) (Figs. 7A, B, C, D).

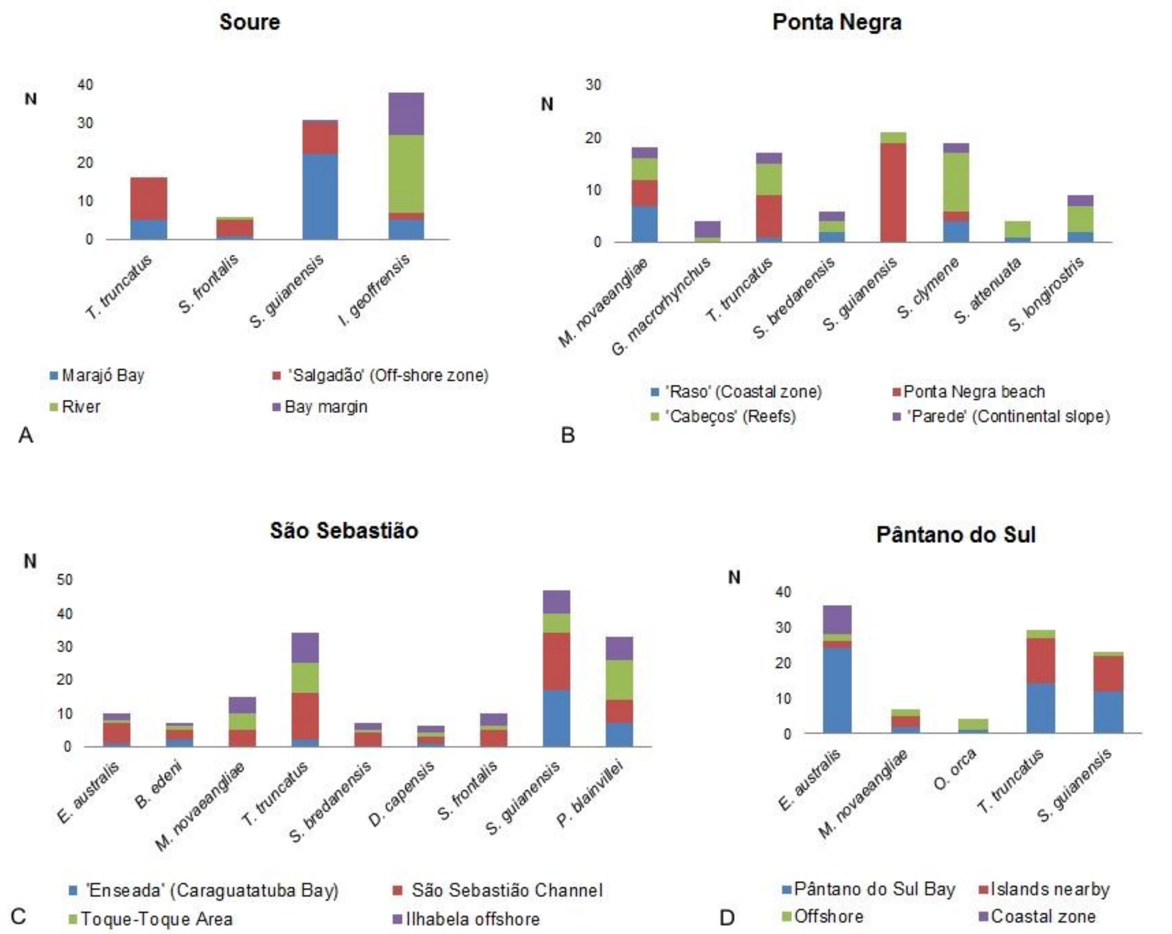


Figure 7 – Species' distribution in the main occurrence areas according to fishers' answers (N). A- Soure, B- Ponta Negra, C- São Sebastião, D- Pântano do Sul.

Seasonality

Fishers were able to distinguish the occurrence of 13 species, according to different periods of the year, mentioning the following categories: year round, summer, winter, fall, spring and some specific months that were included into their respective season. The number of recognized species and categories of seasonality varied in each area (Figs. 8A, B, C, D). For each surveyed area, we tested the number of categories mentioned by the fishers in relation to the number of the cited species and to the number of interviewed fishers and we found no correlation among them. Likewise, we also tested the number of mentioned categories and species in relation to the 'DNK' answers of each fisher, and we did not find any correlation.

In Soure, seasonal variation in the seawater salinity seems to be the main factor conditioning the occurrence and seasonality of cetaceans. According to the fishers, the riverine species *Inia geoffrensis*, expands its occurrence areas to the north of Marajó Bay during the winter (flooding season), and retracts again to the limit of freshwater when the summer arrives. In that occasion, the higher salinity water of the Atlantic Ocean enters the Bay bringing together marine species, such as *T. truncatus* and *S. frontalis*.

Some species that occurred in more than one studied area, such as *S. guianensis*, *T. truncatus* and *P. blainvillei*, showed concordance in their seasonality patterns in the four areas, according to fishers (Figs. 8A, B, C, D).

Fishers' answers indicate that migratory species, such as *E. australis* and *M. novaeangliae,* occur mainly during the winter and spring (the migratory period).

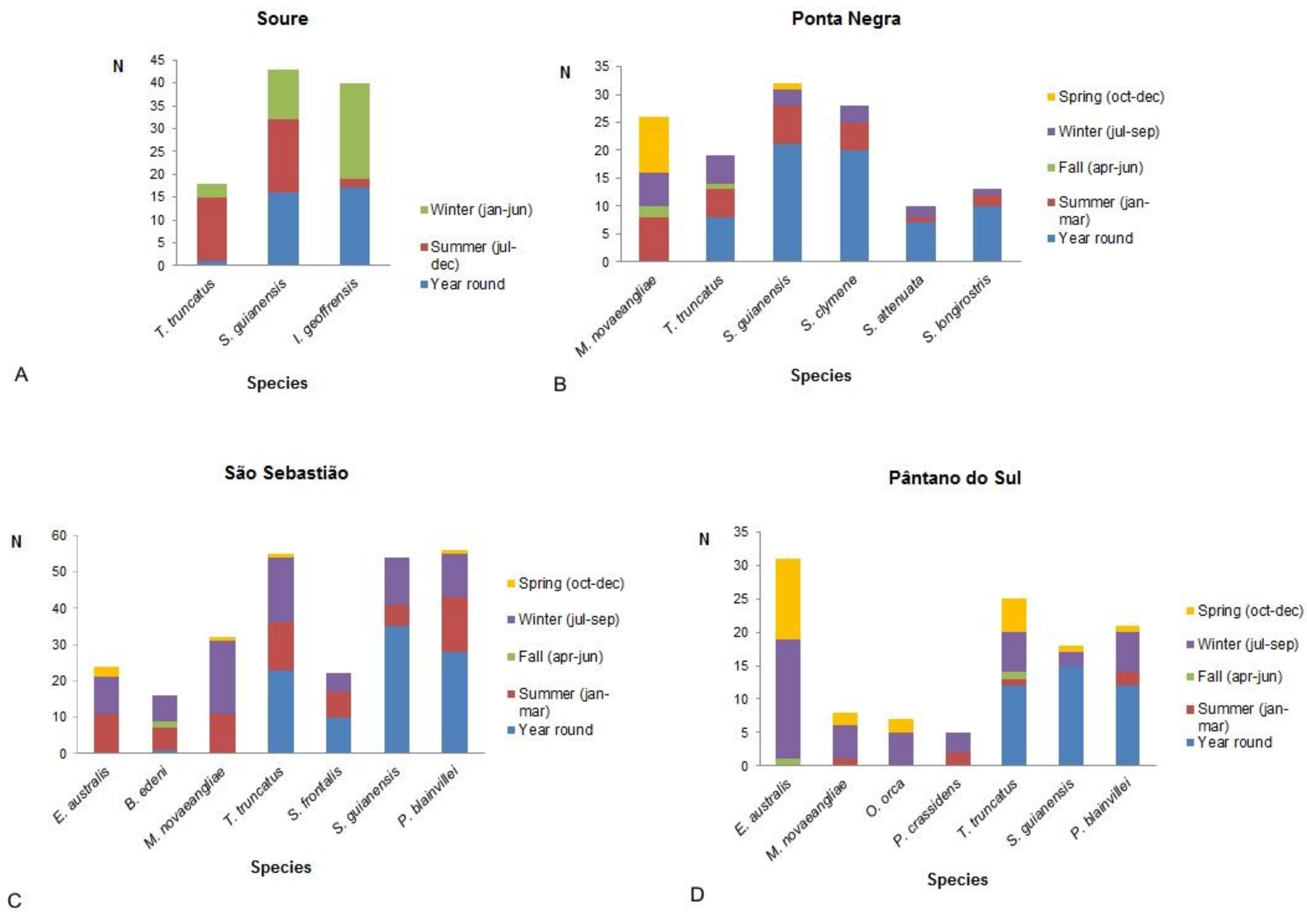


Figure 8 – Seasonality of cetaceans, according to the fishers from the studied areas (N= fishers' citation). A- Soure, B- Ponta Negra, C- São Sebastião, D- Pântano do Sul.

Preferential Habitats

Four physical characteristics were reported by the fishers to affect the preferential habitat of 16 studied cetacean species: depth, salinity, temperature and turbidity, resulting in the following categories: deep water, shallow water, deep and shallow water, seawater (sea), freshwater (rivers), estuarine water (rivers' mouth, mangroves), cold water, warm water, clear water and turbid water. The number of cited species and the habitats' categories varied in each area (Figs. 9A, B, C, D).

Only for Ponta Negra we found a positive correlation between the number of categories/species and the number of answers/species (Ponta Negra: r = 0.79, df =

7, p = 0.009), confirming that fishers attributed more categories of habitat for the most known species. Similarly to the seasonality, we found no correlation between the number of categories in relation to the number of the cited species and to the number of interviewed fishers or in relation to the 'DNK' answers.

In each area, the most cited species were included by the fishers in at least three categories of habitat (Figs. 9A, B, C, D). In Soure, fishers mentioned mainly the categories associated with water salinity such as "seawater" and "freshwater". In Ponta Negra, São Sebastião and Pântano do Sul, fishers mentioned mainly the categories associated with depth, such as "shallow water", "deep water" and "shallow or deep water". We found that fishers' citations for the two most mentioned habitats (deep water and shallow water) for each species were significantly different (Deep water: χ^2 = 106.78, df = 15, p< 0.0001; Shallow water: χ^2 = 316.63, df = 15, p< 0.0001) (Table 3).

Table 3 – Fishers' citations (n) for the two most cited habitats, for each cetacean species.

Most cited habitats / species	**E. aus tralis**	***B. ede ni***	**B. acutor ostrata**	**M. nova eang liae**	**G. macro rhyncu s**	**O. or ca**	**T. trun catu s**	**S. breda nensis**	**D. cape nsis**	**S. fron talis**	**S. cly me ne**	**S. atten uata**	**S. longi rostr is**	**S. guia nens is**	**P. blain villei**	**I. geoff rensi s**
Deep water	11	9	6	31	9	2	30	5	8	5	22	10	15	24	21	1
Shallow water	23	2	0	2	1	2	18	2	1	0	5	0	2	50	11	12

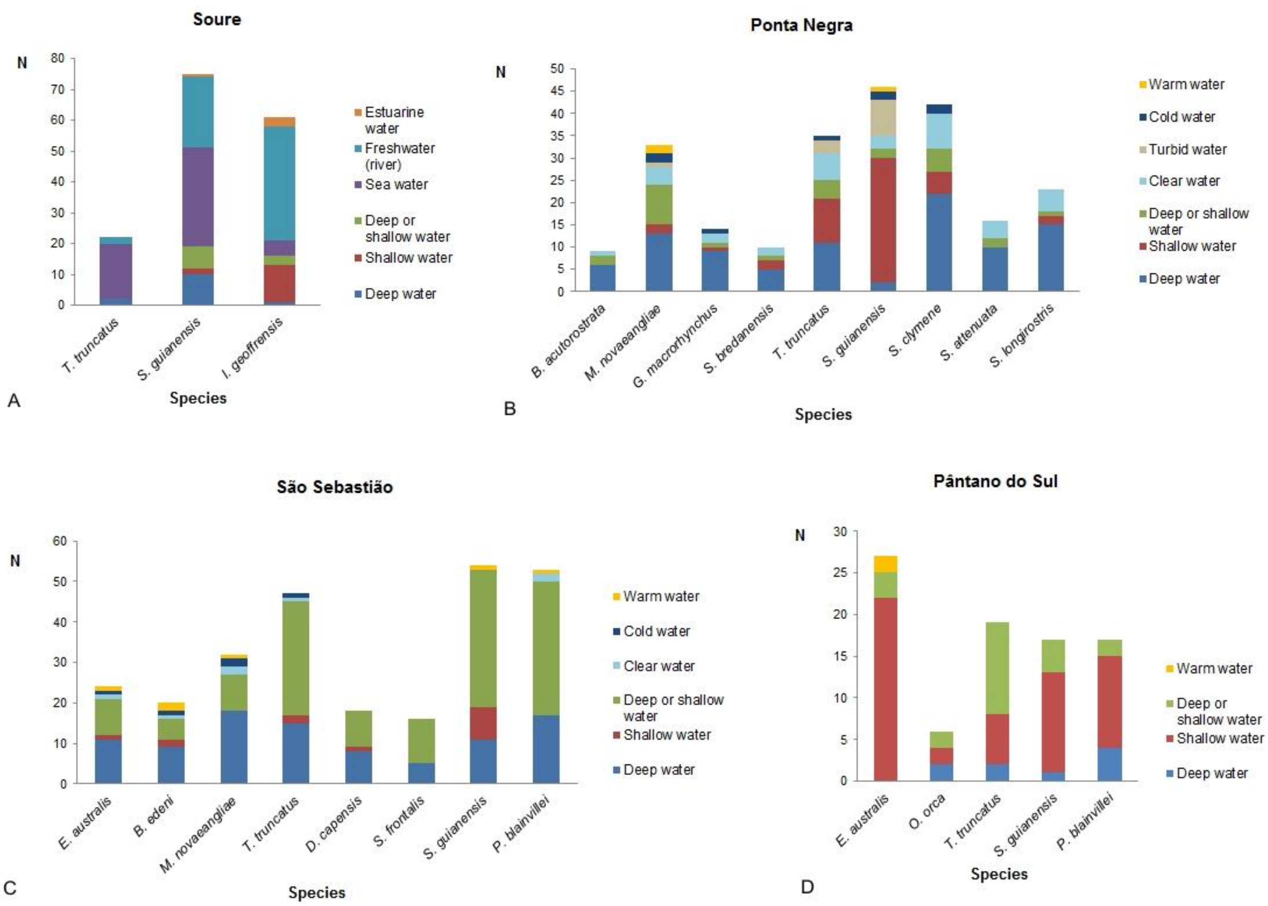


Figure 9 – Preferential habitats of cetaceans cited by the interviewed fishers (N= fishers' citation). A- Soure, B- Ponta Negra, C- São Sebastião, D- Pântano do Sul.

Group Sizes

Fishers mentioned several group sizes for the 16 cetacean species they have sighted during their fishing activities. We included this information into the following categories of group size: one, two, three to five, six to ten, 11 to 20, 21 to 50, 51 to 100 and more than 100 (Figs. 10A, B, C, D). The number of cited species varied in each area, as well as the dominant categories for some species.

For baleen whales (*E. australis*, *B. acutorostrata*, *B. edeni* and *M. novaeangliae*) and bigger delphinids (O. orca, G. macrorhynchus and P. crassidens) fishers indicated smaller group sizes than for the small cetaceans, which showed bigger group sizes, ranging from three to hundreds of individuals

(Figs. 10A, B, C, D). In fact, the mean size of each species was negatively correlated do their mean group size ($r_s = -0.76$, $p = 0.0005$).

According to fishers' answers, the group sizes for the Southern Right whale *E. australis* decrease northward (from Pântano Sul to São Sebastião) , the opposite occurring to the group sizes of *M. novaeangliae* (Figs. 10A, B, C, D).

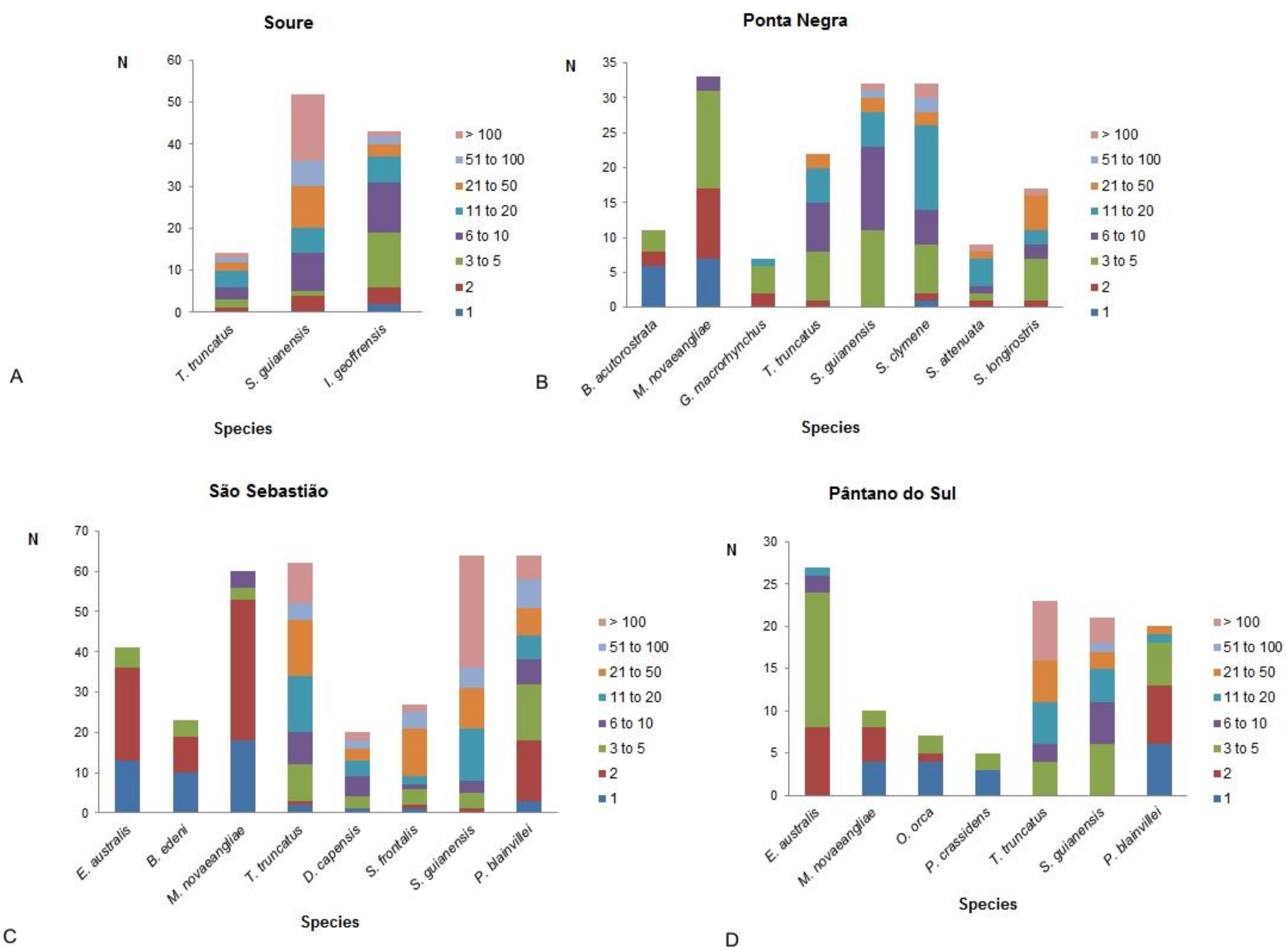


Figure 10 – Group sizes of cetaceans sighted by the fishers (N= fishers' citation). A- Soure, B- Ponta Negra, C- São Sebastião, D- Pântano do Sul.

Reproduction

The interviewed fishers did not know much about cetaceans' reproduction, only mentioning the presence or absence of calves swimming along their mothers, for the seven most common species in different seasons of the year. Some species showed a more marked seasonality (*E. australis*, *M. novaeangliae*, *S. clymene* and *I. geoffrensis*) while in other species the calves were sighted year around (Figs. 11A, B, C, D).

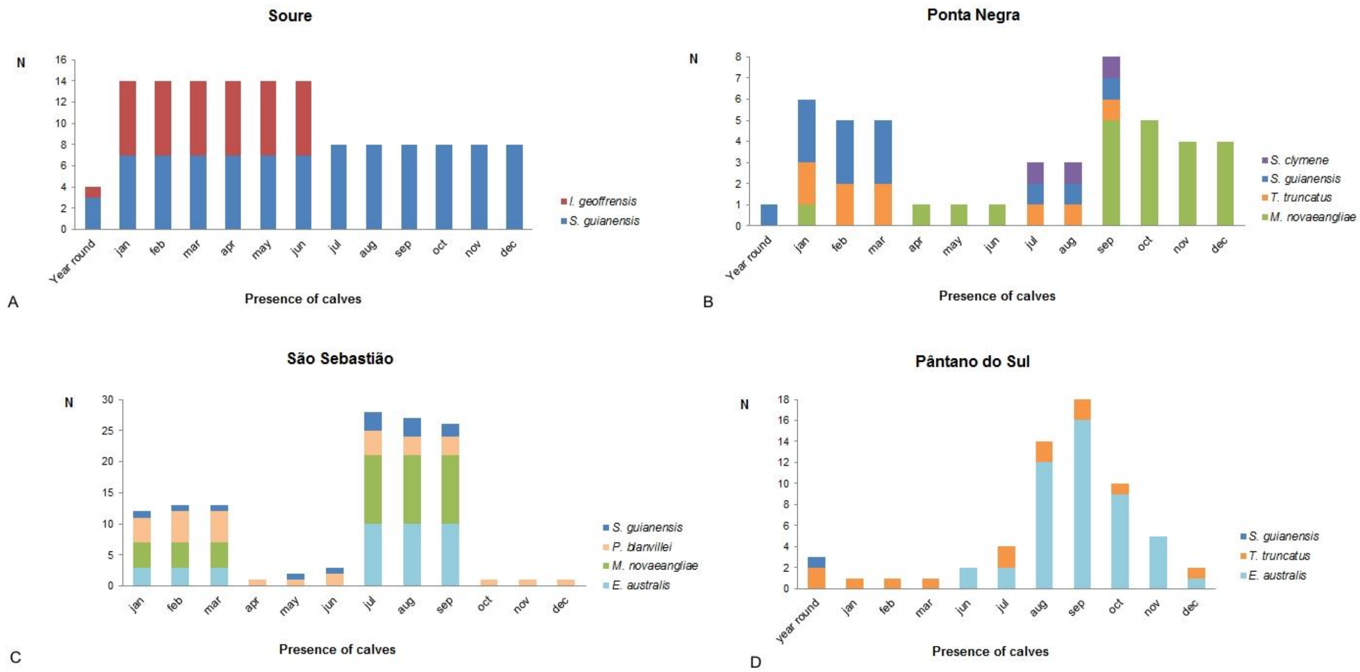


Figure 11 – Seasonal variation of the presence of calves for the most cited species (N= fishers' citation). A- Soure, B- Ponta Negra, C- São Sebastião, D- Pântano do Sul.

Table 4 displays a comparison between fishers' LEK on the seven most cited cetacean species and information obtained from the scientific literature, regarding to cetaceans' habitat, seasonality, group sizes and reproduction. Fishers' knowledge on each species was in accordance to scientific literature for at least three surveyed topics. The most cited topic for these species was 'Group size' (χ^2 = 64.49, df = 18, p<0.0001).

Table 4 – Comparison between fishers' LEK on cetacean species and the scientific literature. Fishers' information that agrees to scientific literature is in bold letters.

Species / Topics	Studied Area	Fishers' LEK	Information from the scientific literature on cetaceans' ecology	Conservation Status (IUCN 2010)
Eubalaena australis	São Sebastião and Pântano do Sul		Siciliano *et al.* (2006), Bastida *et al.* (2007), Jefferson *et al.* (2008):	Least Concern
habitat		**Shallow waters.**	Coastal waters (Southwestern Atlantic Ocean).	
seasonality		**Winter.**	Winter and spring (Southwestern Atlantic coast).	
group size		**2, 3 – 5.**	Alone, 2 - 3, groups until 12.	
presence of calves		During the **winter (July to September)** and early spring (Oct-Nov). The mother looks for warm and calm waters to give birth, and after that returns to where it came. **The calf jumps over its mother.** The mother becomes angrier when she's with a calf.	Births take place during the late fall (Jun) and winter (Jul-Sep), lactation lasts over one year. The female keeps close contact with the calf, sometimes rolling the calf over its belly.	
Megaptera novaeangliae	Ponta Negra, São Sebastião and Pântano do Sul		Clapham, P. J. (2000), Zerbini *et al.* (2004), Siciliano *et al.* (2006), Bastida *et al.* (2007), Jefferson *et al.* (2008):	Least Concern
habitat		**Deep waters.**	Coastal waters, insular coasts, deep waters (200 to 3000m).	
seasonality		**Winter and spring.**	Winter and spring (Brazilian coast).	
group size		**2, 3 - 5, alone.**	Alone, 2 - 3, groups until 20 (mating and feeding areas).	
presence of calves		During **winter** (Jul-Sep) and spring (Oct-Dec). Adults form groups to breed in warm waters. When the calf is sucking the seawater turns white.	Peak birth month is August (South Hemisphere), lactation lasts 10-11 months. Interbirth interval is around two years.	
Tursiops truncatus	Soure, Ponta Negra, São Sebastião and Pântano do Sul		Connor *et al.* (2000), Siciliano *et al.* (2006), Bastida *et al.* (2007), Bearzi *et al.* (2008), Jefferson *et al.* (2008):	Least Concern
habitat		**Seawater, shallow or deep waters.**	Coastal and continental shelf waters, oceanic islands.	
seasonality		**Year round**.	Year round or seasonal movements.	

group size		**3 - 5, 6 - 10, 11 - 20, >100.**	2 -20, 20 - 50, > 100.	
presence of calves		During the **summer** (Jan-Mar) and the winter (Jul-Sep). Large groups generally contain mother-calf pairs.	Births occur generally during spring/early summer and fall, generally with a three-years interval, and lactation lasts over two years.	
Stenella clymene	Ponta Negra		Jefferson and Curry (2003), Fertl *et al.* (2003), Moreno *et al.* (2005), Siciliano *et al.* (2006), Culik (2010), Bastida *et al.* (2007), Jefferson *et al.* (2008):	Data deficient
habitat		**Deep and clear waters.**	Warm oceanic waters, lower continental slopes to deep waters (from 100 m to 4500m).	
seasonality		**Year round.**	Year round in the Gulf of Mexico.	
group size		**11 - 20**; 3 – 5.	10 – 200.	
presence of calves		During the winter (July to September).	The species' biology and life history is poorly known. Calves observed in 45% of groups sighted in the Gulf of Mexico.	
Sotalia guianensis	Soure, Ponta Negra, São Sebastião and Pântano do Sul		Flores and Bazzalo (2004), Siciliano *et al.* (2006), Bastida *et al.* (2007), Jefferson *et al.* (2008), Santos and Rosso (2008), Flores and da Silva (2009):	Data deficient
habitat		**Seawater**, **shallow waters,** shallow or deep waters.	Shallow nearshore waters, rivers' mouth, estuaries.	
seasonality		**Year round**.	Year round.	
group size		**3 - 5, 6 -10, > 100.**	2 - 20, 10 - 15, > 100.	
presence of calves		**Year round**, during the summer and the winter. Mother and calf always swim together until the calf is weaned.	Calving occurs year round and lactation lasts almost one year.	
Pontoporia blainvillei	São Sebastião and Pântano do Sul		Di Beneditto *et al.* (2001), Siciliano *et al.* (2006), Bastida *et al.* (2007), Cremer and Simões-Lopes (2008), Jefferson *et al.* (2008):	Vulnerable
habitat		Deep or **shallow waters.**	Turbid and shallow waters, until the isobath of 30 m.	
seasonality		**Year round.**	Year round.	
group size		**2 - 5**, alone.	Singly, 2 - 5, 10 – 17.	
presence of calves		From January to March, and from July to September.	Peak calving from October to January, lactation lasts from 7 to 9 months.	
Inia geoffrensis	Soure		Best and Da Silva (1993), Bastida *et al.* (2007), Jefferson *et al.* (2008), Da Silva (2009) and Culik	Data deficient

			(2010):	
habitat		**Freshwater.**	Main rivers, small channels, lakes, flooded areas.	
seasonality		Winter; **year round.**	Year round, seasonal migrations related to the annual flooding cycle.	
group size		**3 -5; 6 – 10.**	2 - 3; loose aggregations of 12 - 15 for mating and feeding.	
presence of calves		From January **to July**, the mother goes up to land to give birth. Mother and calf swim together and the calf imitates its mother.	The link mother-calf is very strong and it is only broken when the calf is weaned after two years. Most births occur in May to July, and lactation lasts over one year.	

Discussion

We collected information on the occurrence areas, seasonality, preferential habitats, group size and reproduction for 18 cetacean species through a survey of fishers' local ecological knowledge in four geographically and culturally different areas.

Among them, two species were cited in all the surveyed topics, confirming that these species are really the most known by the fishers along the Brazilian coast: *S. guianensis* and *T. truncatus.* The first (*S. guianensis*) occurs from Honduras to Santa Catarina (Brazilian Southern coast), in shallow waters, and is commonly sighted year round (Flores and Bazzalo 2004, Siciliano *et al.* 2006, Bastida *et al.* 2007, Jefferson *et al.* 2008, Santos and Rosso 2008, Flores and Da Silva 2009). The second, *T. truncatus* is a cosmopolitan species, typical of coastal and continental shelf waters and oceanic islands, which also occurs year round but can move seasonally in some areas (Connor *et al.* 2000, Siciliano *et al.* 2006, Bastida *et al.* 2007, Bearzi *et al.* 2008, Jefferson *et al.* 2008).

Other three species are migratory (*E. australis, M. novaeangliae* and *B. acutorostrata*), occurring in some of the studied areas just for a few months, whereas the other mentioned species are distributed, year round, along some areas of the Brazilian continental shelf and slope (*B. edeni, P. macrocephalus, G. macrorhynchus*, *O. orca, P. crassidens, S. bredanensis, D. capensis, S. frontalis, S. clymene, S. attenuata, S. longirostris, P. blainvillei* and *I. geoffrensis*).

Among the studied species, *P. macrocephalus* (Sperm whale) and *P.blainvillei* (the small dolphin Franciscana) are considered vulnerable by the IUCN Red List, while *B. edeni* (Bryde's whale), *O. orca* (Killer whale), *G. macrorhynchus* (Short-finned Pilot whale), *P. crassidens* (False Killer whale), *S. guianensis* (Guiana dolphin), *S. frontalis* (Atlantic spotted dolphin), *S. longirostris* (Spinner dolphin), *S. clymene* (Clymene dolphin), *D. capensis* (Short-beaked Common dolphin) and *I. geoffrensis* (Amazon dolphins) have been considered as "data deficient" species, due to the lack of information about them (IUCN 2010). For this reason, all the information obtained from the fishers is valuable and can be considered a contribution for cetaceans' ecology, from which further detailed surveys could be done.

Bearzi and collaborators (2008) observed that "even species best known globally, such as *T. truncatus*, can be relatively unknown in local scale, in relation to their ecology and population trends". This lack of locally based information can delay the implementation of conservation actions. In this sense, fishers' LEK can complement the biological knowledge on these cetacean species, as has been suggested by many authors (Huntington 2000, Huntington *et al.* 2004, Silvano and Valbo-Jorgensen 2008, Silvano and Begossi 2010).

Fishers' LEK varied in relation to the recognized species and to the surveyed topics in each studied area. Fishers from Soure recognized 60% of the cetacean species, but demonstrated more knowledge on cetaceans' ecology (21% of DNK answers) than the fishers from the other areas.

Maybe the fact that in Soure fishers recognized a smaller number of species makes their LEK more specialized on these few species. Additionally, nearly 90% of Soure's fishers are full-time dedicated to fishing activities, live in a city distant from big cities and survive mostly from fisheries and from the extraction of forest products, in contrast to the other areas, where the fishers lead a more urban life style and are involved in other commercial activities besides fishing.

Our results show that fishers' characteristics such as 'age', 'time spent fishing', or 'schooling' did not influence their knowledge on cetaceans. However, fishers' LEK increased in areas where the number of wide-ranging species was bigger. Maybe, in face of their wide distribution, these species have more probability to be known by all the local fishers, despite the range of their fishing points.

Cetaceans' distribution is conditioned by the availability of prey species, which, in its turn, are affected by environmental factors, such as primary production of the seas, temperature and marine currents, and sea-floor depth and relief (Moreno *et al.* 2005, Bastida *et al.* 2007, Jefferson *et al.* 2008). Variations in species' density and group size in coastal areas can be linked to habitat heterogeneity, group behavior, interspecific competition, among other causes (Flores and Bazzalo 2004, Bearzi *et al.* 2008, Wedekin *et al.* 2007).

The results suggest that the patterns of cetaceans' occurrence along the studied areas can be associated to the heterogeneous width of the continental shelf and to the variation in oceanographic factors and in the bottom depth. The influence of geographic, oceanographic and seasonal factors in the results obtained in ethnobiological studies has been mentioned in other surveys around the world (Johannes *et al.* 2000; Silvano and Begossi 2005).

Oceanic species were frequently sighted by small-scale fishers from Ponta Negra in their fishing points situated at the continental slope. Three of these species (*S. clymene, S. attenuata* and *S. longirostris*) were listed by Moreno *et al.* (2005) for this area, showing overlapping distribution. As the continental shelf is extremely narrow in the northeastern Brazilian coast, fishers get to fish in areas of great depth situated beyond the continental slope, just a few hours from the coast, increasing the possibilities of contact with oceanic species.

In Soure, the seasonal variation in the water salinity seems to be the main factor conditioning the occurrence and seasonality of cetaceans. This variation defines the occurrence pattern of *I. geoffrensis* that is strongly linked to the expansion or contraction of riverine waters along the Bay of Marajó, as mentioned by the fishers and by the scientific literature (Best and Da Silva 1993, Bastida *et al.* 2007, Culik 2010). The presence of marine species cited by the fishers, such as *T. truncatus*, *S. guianensis* and *S. frontalis*, inside the estuarine Bay of Marajó is also related to the seasonal variation of water salinity. *T. truncatus* and *S. guianensis* have been previously recorded in the Amazon delta and Marajó Bay (respectively), but we did not find any references for the presence of *S. frontalis* in the Marajó surroundings (Siciliano *et al.* 2008).

On the other hand, fishers mentioned that the occurrence of whales in Ponta Negra, São Sebastião and Pântano do Sul varied seasonally, which is confirmed by many authors that have recorded the period and range of each species' migration (Bastida *et al.* 2007, Jefferson *et al.* 2008).

Except for the most known species or those locally restricted, the seasonality was more perceived by the informants in relation to the migratory species *E. australis* and *M. novaeangliae*. There was a tendency, by at least 35% of the fishers, to attribute the category 'year round' to the locally most known species (*S. guianensis*, *T. truncatus*, *I. geoffrensis*, S. *clymene* and *P. blainvillei*), and this lack of seasonality is confirmed by the scientific literature on these species (Best and Da Silva 1993, Connor *et al.* 2000, Di Beneditto *et al.* 2001, Jefferson and Curry 2003, Flores and Bazzalo 2004).

Habitat preferences are inherent to each cetacean species but are influenced by the patterns of water circulation (Jefferson *et al.* 2008). The predominance of categories related to the water salinity in Soure reflects the major driver of local environmental variation, which is the seasonal change in the local circulation. For this reason, Soure's fishers perceive cetaceans as species 'from the saltwater' or 'from the river'. In Ponta Negra, São Sebastião and Pântano do Sul, where salinity shows little variation year round, habitat categories were related to the sea depth, which is the main locally varying factor, and local fishers perceive cetaceans as species 'from shallow-water' and 'from deep-water'.

Concerning group sizes, the most mentioned cetacean species were those most common or those locally restricted and the migratory whales, which due to its huge size, always call for the fishers' attention. The latitudinal variation in the group sizes of *E. australis* and *M. novaeangliae* reported by the informants may be due to breeding aggregations, which for *E. australis* occur in the southern coast and for *M. novaeangliae* occur in the northeastern Brazilian coast (Bastida *et al.* 2007).

According to the fishers, whales' group sizes were smaller than dolphins', reaching a maximum of five animals in average. Generally, small groups are the rule for whales and larger aggregations are often observed only at the feeding areas (Clapham 2000). Dolphins' group sizes varied among the species and for the same species the most cited group sizes varied in each area. Connor (2000) suggests that the formation of stable groups among cetaceans is influenced by the predation pressure and by the feeding competition, which varies according to the size and feeding habits of each species. Besides, the fact that fishers from different areas mentioned different group sizes for the same species can be attributed to abiotic features, such as variations in local circulation, and biotic features (primary production and prey availability) in the study areas, which determine variations in the species behavior.

When speaking of reproduction, informants observed seasonality in the presence of calves of *E. australis*, *M. novaeangliae*, *S. clymene* and *I. geoffrensis*. In contrast, for other cetacean species fishers reported calves year round. According to Jefferson *et al.* (2008) seasonal breeding is common in temperate and high-latitude species, which is the case of E. *australis* and *M. novaeangliae*, where the calving peak occurs during the winter. In the case of *I. geoffrensis*, the calving peak is during the flooding season, which occurs during the Amazon winter (January to July).

Concerning to *S. clymene*, there is a possibility that fishers' information on the presence of calves during the winter could be true, because they indicated that this is the only species of small cetacean regularly sighted in fishing points located in deep waters. So, the probability of confusion between S. *clymene* and other similar species by fishers seems remote. This information deserves further investigation, since literature reports that the reproduction of *S. clymene* is poorly known (Jefferson *et al.* 2008).

The level of concordance between fishers' LEK and scientific literature can be considered as a medium to high concordance (> 50% of the topics concordant), indicating that fishers' information on cetaceans' ecology agree to real biological patterns occurring in the nature. Fishers' LEK can be an important contribution to complement the local biological information on these species, helping in their conservation.

Other researchers have studied the hunters' LEK on cetaceans (especially belugas – *Delphinapterus leucas* and bowhead whales – *Balaena mysticetus*), gathering substantial information on distribution, seasonality, habitats, group size, migration and anthropogenic impacts, and these studies have contributed to establish regulations and to improve the management of the whales' local hunt (Mymrin *et al.* 1999, Huntington 2000, Noongwook *et al.* 2007).

Our informants demonstrated a valuable knowledge on occurrence areas, preferential habitat and group size for 18 cetacean species. For this reason, fishers' LEK could be useful to indicate fishing points in Soure, Ponta Negra, São Sebastião and Pântano do Sul, where the concentration of vulnerable or "data deficient" species is greater, which should be under special management conditions to provide cetaceans' protection and where alternative fishing strategies should be developed. Fishers' LEK also should be considered in Environmental Impact Assessments concerning to the implementation of potential polluter activities situated in the geographical range of the local fisheries (Silvano *et al.* 2009).

Nevertheless, due to its local and cultural specificity, some authors have suggested that LEK should be tested and validated, as other source of information are, to confirm its credibility and to follow a standard in ethnobiological research (Huntington 2000; Gilchrist *et al.* 2005; Gilchrist and Mallory 2007; Begossi 2008; Berkes 2008).

Considering the lack of resources and time to do long term research, fishers' LEK can be considered a low cost and immediate source of data, especially useful in the cases where there are not enough data on which base the management actions. In these cases, Johannes (1998) has suggested to adopt the data-less fisheries management approach, complementing the available scientific data with fishers' local ecological knowledge, as has been done for some coastal fish species in Brazil (Begossi and Silvano 2008, Silvano and Begossi 2010, Begossi et al. 2011).

Conclusion

Studying the local ecological knowledge of 171 fishers from four coastal communities in the northern, northeastern, southeastern and southern Brazil, we gathered important information about the ecology of cetaceans. Nine of the studied species are classified under the status "data-deficient" and other two species are considered vulnerable to extinction by IUCN Red List (2010). So, the collected information can complement the scientific information necessary to efficiently manage these species' to achieve their conservation.

Socioeconomic differences and characteristics of local fisheries did not cause LEK variations among the studied areas. Soure was the only area where the direct dependence on natural resources influenced fishers' LEK. Variations in oceanographic parameters, such as width of continental shelf, bottom depth and salinity, seem to affect the occurrence of cetaceans, as well as fishers' LEK.

Among the surveyed topics, fishers reported 112 occurrence areas, and preferential habitats and group sizes for 16 species. Additionally, they described the seasonality pattern for 13 species and provided local information on the reproduction of seven species. The most known species by the fishers along the Brazilian coast are the Guiana dolphin (*S. guianensis*), the bottlenose dolphin (*T. truncatus*), followed by the migratory humpback whale (*M. novaeangliae*).

Most of the obtained information agrees to the scientific literature. However some discordant points suggest new topics to be further investigated. We suggest that fishers' LEK about cetaceans' occurrence areas and seasonality should be considered in the discussions for delimitation of marine protected areas, since fishers have detailed and reliable information on these topics.

Marine mammal conservation is a socio-ecological issue, and the integration of local and scientific knowledge can greatly contribute to the natural resources management and conservation.

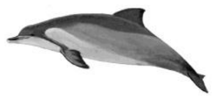
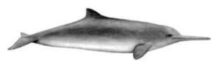
Acknowledgements

We are grateful to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a doctoral scholarship to S.P.S., and for fellowships to AB (301957/2007-0 and 151084/2009-2); to FAPESP, for the grant # 06/50435-0 to AB; to PIATAM Mar and PIATAM Oceano Projects, S. Siciliano and A. L. F. Rodrigues for all the help during the research in Marajó Island, and to the fishers from Soure, Ponta Negra, São Sebastião and Pântano do Sul, for their cooperation and participation in this research.

Appendix 1

List of cetaceans' species surveyed and the percentage of recognition by the fishers in the study areas (NS – species not surveyed; NR – species not recognized). (Figures, out of scale, by Jefferson *et al.* 1993).

Biological name **common name**		**Soure (n = 40)**	**Ponta Negra (n = 36)**	**São Sebastião (n = 70)**	**Pântano do Sul (n = 25)**
Eubalaena australis (Desmoulins, 1822) Southern Right whale		NS	NS	53	100
Megaptera novaeangliae (Borowski, 1781) Humpback whale		75	83	53	28
Balaenoptera edeni (Anderson, 1878) Bryde's whale		10	NS	26	4
Balaenoptera acutorostrata (Lacépède, 1804) Minke whale		5	28	1	NR
Balaenoptera bonaerensis (Burmeister, 1867) Antarctic Minke whale		NS	11	NS	NR
Physeter macrocephalus (Linnaeus, 1758) Sperm whale		3	31	NS	NR
Orcinus orc (Linnaeus, 1758) Killer whale		70	NS	64	52
Globicephala macrorhynchus (Gray, 1846) Short-finned pilot whale		NS	33	NS	NR
Pseudorca crassidens (Owen, 1846) False killer whale		NS	4	NS	16
Peponocephala electra (Gray, 1846) Melon-headed whale		NS	19	NS	NS
Tursiops truncatus (Montagu, 1821) Bottlenose dolphin		53	72	90	84
Steno bredanensis (Lesson, 1828) Rough-toothed dolphin		3	22	23	NR
Stenella frontalis (Cuvier, 1829) Atlantic spotted dolphin		20	NS	39	16
Stenella clymene (Gray, 1850) Clymene dolphin		NS	97	NS	NS

Stenella attenuata (Gray, 1846) Pantropical spotted dolphin		NS	39	NS	NS
Stenella longirostris (Gray, 1828) Spinner dolphin		NS	53	NS	NS
Delphinus delphis (Linnaeus, 1758) Short-beaked Common dolphin		NS	NS	NS	4
Delphinus capensis (Gray, 1828) Long-beaked Common dolphin		NS	NS	29	NS
Sotalia guianensis (van Bénéden, 1864) Guiana dolphin		100	92	89	72
Pontoporia blainvillei (Gervais e d'Orbigny, 1844) Franciscana		NS	NS	91	88
Inia geoffrensis (de Blainville, 1817) Amazon river dolphin		100	NS	NS	NS
Total of surveyed species		10	13	11	15
% of species recognized by more than 20% of fishers/area		50	77	81	47

Appendix 2

Main target species cited by the fisheries from Soure, Ponta Negra, São Sebastião and Pântano do Sul (percentages of fishers who cited each species).

Main target species	Biological name	Soure (n = 40)	Ponta Negra (n = 36)	São Sebastião (n = 70)	Pântano do Sul (n = 25)
Bagre, bandeirado	*Bagre bagre (Linnaeus, 1766)*	33	---	---	---
Dourada	*Brachyplatystoma flavicans* (Castelnau, 1855)	65	---	---	---
Piramutaba	*Brachyplatystoma vaillantii* (Valenciennes, 1840)	28	---	---	---
Filhote	*Brachyplatystoma filamentosum* (Lichtenstein, 1819)[a]	30	---	---	---
Tainha	*Mugil* sp., *Mugil platanus* (Günther, 1880)[a]	50	11	25	80
Pratiqueira, parati	*Mugil curema* (Valenciennes, 1836)[a]	35	11	16	---

Pescada-amarela	*Cynoscion acoupa* (Lacépède, 1802)	30	---	---	---
Pescada-branca	*Cynoscion leiarchus* (Cuvier, 1830)	28	58	---	---
Pescadas em geral	(Scianidae)	20	---	41	---
Corvina	*Micropogonias furnieri* (Desmarest, 1823)[a]	---	---	32	92
Garajuba	*Caranx latus* (Agassiz, 1831)	---	19	---	---
Xaréu, xarelete	*Caranx crysos* (Mitchill, 1815), *Caranx* sp.	28	11	24	---
Robalo	*Centropomus undecimalis* (Bloch, 1792)[a]	---	17	---	---
Serra	*Scomberomorus brasiliensis* (Collete *et al*., 1978)	10	53	---	---
Cioba	*Lutjanus analis* (Cuvier, 1828)	---	28	---	---
Enchova	*Pomatomus saltatrix* (Linnaeus, 1766)[a]	---	---	32	92
Sardinha	*Sardinella brasiliensis* (Steindachner, 1879)	---	---	45	
Espada	*Trichiuris lepturus* (Linnaeus, 1758)[a]	---	---	30	---
Abrótea	*Urophycis brasiliensis* (Kaup, 1858)	---	---	---	52
Cação	*Carcharhinus* sp.	---	---	---	16
Camarão-sete-barbas	*Xiphopenaus kroyeri* (Heller, 1862)	---	---	34	---

([a] Fishes' biological names that were obtained through consulting Begossi *et al.* 2008. Other fishes' names according to FishBase 2010 (Froese and Pauly 2011)).

Appendix 3

Main fishing gear and the percentage of fishers from Soure, Ponta Negra, São Sebastião and Pântano do Sul who cited them.

Fishing Gear	Soure	Ponta Negra	São Sebastião	Pântano do Sul
Gillnets (general)	29	---**	35	43
Bottom gillnets	---	61	---	---
Caçoeira* (gillnet made of thicker thread)	32	---	---	---
Rabiola* (gillnet typical from Soure)	10	---	---	---
Drift gillnets	---	---	16	11
Seine (encircling)nets	---	---	19	---
Beach pull nets	---	13	---	---
Trawling nets	8	---	7	---
Fixed trap nets	---	---	17	7
Cast net	5	2	---	---

Line and hook	11	24	---	21
Long-line	5	---	---	18

Appendix 4

A. Results of the Two-way ANOVA used to test the variation of fishers' LEK on cetacean species among the surveyed areas and topics.

Sources of Variation	GL	SQ	QM
Treatments	3	28.4014	9.467
Blocks	4	3.336	0.834
Error	12	4.812	0.401
F (treatments) =	23.6073		
p (treatments) =	**< 0.0001**		
F (blocks) =	2.0797		
p (blocks) =	0.1464		
Tukey	Q	(p)	
Averages (Soure and P. Negra) =	9.4772	**< 0.01**	
Averages (Soure and S. Sebastião) =	10.7978	**< 0.01**	
Averages (Soure and P. do Sul) =	5.3742	**< 0.05**	
Averages (P. Negra and S. Sebastião) =	1.3206	ns	
Averages (P. Negra and P. do Sul) =	4.1030	ns	
Averages (S. Sebastião and P. do Sul) =	5.4236	**< 0.05**	

B. Correlation matrix among the degree of fishers' LEK (% of recognized species) and different factors (% of informants/study areas, % of widely distributed species, % of restrictedly distributed or migratory species, isolation degree of each area).

	% Species recognized	% of informants	% species widely distributed	% species of migratory or restrictly distributed	Isolation (distance from big cities in hours)

Soure	60	23	40	20	100
Ponta Negra	77	21	62	15	50
São Sebastião	91	41	64	27	8
Pântano do Sul	40	15	20	20	17

	Columns 1 and 2	**Columns 1 and 3**	**Columns 1 and 4**	**Columns 1 and 5**	**Columns 2 and 3**	**Columns 2 and 4**	**Columns 2 and 5**	**Columns 3 and 4**	**Columns 3 and 5**	**Columns 4 and 5**
n (pairs) =	4	4	4	4	4	4	4	4	4	4
r (Pearson) =	0,8493	**0,9751**	0,3622	-0,1699	0,7119	0,7967	-0,3162	0,1466	-0,0716	-0,457
IC 95% =	-0.61 a 1.00	0.22 a 1.00	-0.92 a 0.98	-0.97 a 0.95	-0.79 a 0.99	-0.70 a 1.00	-0.98 a 0.93	-0.95 a 0.97	-0.97 a 0.96	-0.99 a 0.90
IC 99% =	-0.87 a 1.00	-0.37 a 1.00	-0.98 a 0.99	-0.99 a 0.98	-0.93 a 1.00	-0.90 a 1.00	-0.99 a 0.98	-0.98 a 0.99	-0.99 a 0.99	-1.00 a 0.97
R2 =	0,7214	0,9509	0,1312	0,0289	0,5068	0,6348	0,1	0,0215	0,0051	0,2089
t =	2,2756	6,2218	0,5495	-0,2438	1,4336	1,8645	-0,4714	0,2096	-0,1015	-0,7267
DF =	2	2	2	2	2	2	2	2	2	2
(p) =	0,1506	**0,0249**	0,6378	0,8301	0,288	0,2032	0,6838	0,8534	0,9284	0,5429
	0,3478	0,7062	0,0998	0,013	0,2252	0,2892	0,0106	0,0598	0,0273	0,0402
Correlation Matrix	0,1405	0,4448	0,0065	0,1438	0,0698	0,1055	0,2219	0,0485	0,1069	0,3467
	Coluna 1	Coluna 2	Coluna 3	Coluna 4	Coluna 5					
Column 1	1	---	---	---	---					
Column 2	0,8493	1	---	---	---					
Column 3	0,9751	0,7119	1	---	---					
Column 4	0,3622	0,7967	0,1466	1	---					
Column 5	-0,1699	-0,3162	-0,0716	-0,457	1					

Capítulo 4

Fisheries and Cetaceans interactions along the Brazilian coast: an ethnoecological approach

Fotos: Shirley P. Souza

Botos-cinza nadando próximo a rede de espera em São Sebastião, maio de 2006.

Perfumes feitos de pedaços da genitália do boto, Mercado Ver-o-Peso, Belém, em maio de 2007.

Capítulo 4

Fisheries and Cetaceans interactions along the Brazilian coast: an ethnoecological approach.

Shirley P. Souza[1,2,3] and Alpina Begossi[2,3,4]
1 – PPG Ecologia – UNICAMP
2- CAPESCA/PREAC and CMU - UNICAMP
3 – FIFO
4- UNISANTA

[1,2]UNICAMP (PPG Ecologia, CAPESCA/PREAC, CMU), CP 6023, 13.083-970, Campinas, SP, Brazil
[3]FIFO - Fisheries and Food Institute
[4]ECOMAR, UNISANTA, SANTOS, SP, Brazil
(shirleypacheco@yahoo.com)

Abstract

Fishers' local ecological knowledge has been studied around the world, especially regarding fishing strategies and resources use. We surveyed fishers' knowledge on cetaceans, concerning to their interactions with fisheries, in a regional scale along the Brazilian coast: Marajó (north), Natal (northeast), São Sebastião (southeast) and Florianópolis (South). We interviewed 171 fishers from 20 small communities in these four areas, gathering information on interactions between 12 cetacean species and fisheries. We found that these interactions occurs in multiple ways: competition (with local fish and fishers), cooperation (with the fishers), and predation (on the target species of the local fisheries or as prey for other top predators). The most common species in each area (*Sotalia guianensis, Tursiops truncatus*, *Inia geoffrensis, Stenella clymene, Pontoporia blainvillei* and *Eubalaena australis*) are the most known by the fishers, and those mentioned as the main cooperators or competitors. As a result of these interactions some cetaceans are accidentally caught by fishers, especially in gillnets used near the coast. Fishers know details about the feeding habits of some of the studied cetaceans, describing 28 different feeding behaviors and listing 48 species of fishes, mollusks and crustaceans as preferential prey. Fishers' knowledge on the way that cetaceans interact with fisheries can minimize the impact of bycatches on vulnerable species and the constant damage of the fishing gear, contributing to the fisheries management and to the conservation of cetaceans.

Keywords: fishers, local ecological knowledge, bycatch, cooperation, predation, competition, cetaceans' ecology, conservation.

Introduction

Ethnoecology studies the local ecological knowledge (LEK) of a people that is composed by their knowledge, practices and beliefs developed through the interactions with nature (Toledo 1992; Berkes 2008).

In this context, fishing communities have been intensively surveyed concerning their LEK on the aquatic ecosystems and their interactions with the species they use (Ruddle 2000; Marques 2001; Johannes 2003a; Silvano *et al.* 2008, 2009; Begossi *et al.* 2010). Recent studies on the LEK of several fishing communities in Brazil have provided valuable information on fishing strategies and territories, resources use (including fish, game and plants), conflicts between fishing activities and conservation units, decision making process and local fisheries management (Begossi 1995, 1998, 2004 and 2008; Begossi *et al.* 2010).

Multiple interactions involving cetaceans and fisheries occur through the contact between cetaceans and fishers or their fishing gear, such as: competition between cetaceans and fishers for feeding resource (e.g. fish or squids), bycatch of cetaceans by fishing gear, cooperation between cetaceans and fishers during the capture of fish schools or through giving-care behavior in relation to entangled partners (epimeletic behavior), predation on target fishes by cetaceans and use of cetaceans by fishers for several purposes. In Brazil and all over the world, these interactions have been studied for the last three decades (Busnel 1973; Best and Da Silva 1993; Richard and Pike 1993; Perrin *et al.* 1994; Siciliano 1994; Secchi *et al.* 1997; Simões-Lopes *et al.* 1998; Huntington *et al.* 1999; Di Beneditto *et al.* 2001a; Ott *et al.* 2002; Noongwook *et al.* 2007; Bearzi *et al.* 2008; Hovelsrud *et al.* 2008; Moore *et al.* 2009).

Bycatch, or the accidental capture of non-target species in fishing gear, is one of the major impacts on cetacean populations, causing the mortality of over than 300.000 cetaceans annually (WWF 2004; Reeves *et al.* 2005). Cetaceans and marine mammals in general, are quite vulnerable to mortality from bycatch and other anthropogenic causes due to their slow maturity and low reproductive rates. Both the industrial and small-scale fisheries cause high levels of bycatches, involving not only marine mammals but also sea turtles and seabirds (Moore *et al.* 2009). Generally, fisheries that are not under on-board observers' programs underreport bycatch (Spencer *et al.* 2000; Kemper *et al.* 2005; Soykan *et al.* 2008). Some authors question if bycatch information provided by fishers can be considered totally reliable, because fishers not always remember non-target species captured (Moore *et al.* 2010).

Different solutions have proven their utility in reducing bycatch, such as acoustic deterrent devices or pingers, modifications in gillnets, and seasonal or area closures for fishery (Spencer *et al.* 2000). However, the application of these solutions in some situations can cause losses to the fishers, in terms of fishing production. Besides, Soykan *et al.* (2008) and Moore *et al.* (2010) argue that there is a gap in the knowledge about bycatches due to the lack of: enough on-boarder observers programs, reliable estimates on population size of the captured species, reliable information on the bycatch numbers for each kind of fishery and on the efficacy of the mitigation measures, among other data. These authors also suggest that bycatch management should adopt a multi-specific and multi-gear approach. Considering the limited resources and time to carry out extensive studies, Moore *et al.* (2010) and Silvano and Begossi (2010) have suggested collaborative studies involving researchers and fishers, in order to better understand the interactions between small-scale fisheries and the coastal environment, including target species or bycatch.

In Brazil, fisheries bycatch have impacted especially the cetacean species *Pontoporia blainvillei* (Franciscana dolphin) and *Sotalia guianensis* (Guiana dolphin) (Di Beneditto *et al.* 2001a, 2010; Ott *et al.* 2002; Secchi *et al.* 2004; Da Silva and Martin 2010).

In order to contribute with information on interactions involving fishers and cetaceans, we carried out an ethnoecological survey in fishing communities along the Brazilian coast. Our objective is to record fishers' LEK on interactions between cetaceans and fisheries, in four distinct geographic areas and analyze how they affect fishing activities and cetaceans' conservation.

Methods

Study Areas

We studied the fishers' LEK in four areas of the Brazilian coast (North, Northeast, Southeast and South) (Fig. 1):

- Soure (00° 43' 00"S - 48° 31' 24"W), a city at the Marajó Island, where we interviewed 40 fishers of the communities of Matinha, São Pedro, Pesqueiro and Araruna in May 2007. Marajó Island is situated in the estuaries of the Amazon River and Pará-Tocantins Rivers and is characterized by mangroves and savannas.
- Ponta Negra (05° 47' 42" S - 35° 12' 34" W), a famous beach in Natal, where 36 fishers were interviewed in January 2007. Natal is a very touristic coastal city, characterized by the Atlantic Forest, mangroves and sand dunes.
- São Sebastião (23° 45' 36" S - 45° 24' 35" W), a small coastal city situated at the slopes of Atlantic Forest, where 70 fishers from 14 communities (Enseada, Cigarras, São Francisco, Pontal da Cruz, Barequeçaba, Toque-Toque Grande, Toque-Toque Pequeno, Paúba, Maresias, Boiçucanga, Barra do Sahy, Juqueí, Barra do Una and Boracéia) were interviewed in 2006.
- Pântano do Sul (27° 35' 48" S - 48° 32' 57" W), a traditional fishing community in the touristic city of Florianópolis, where we interviewed 25 fishers in February 2008.

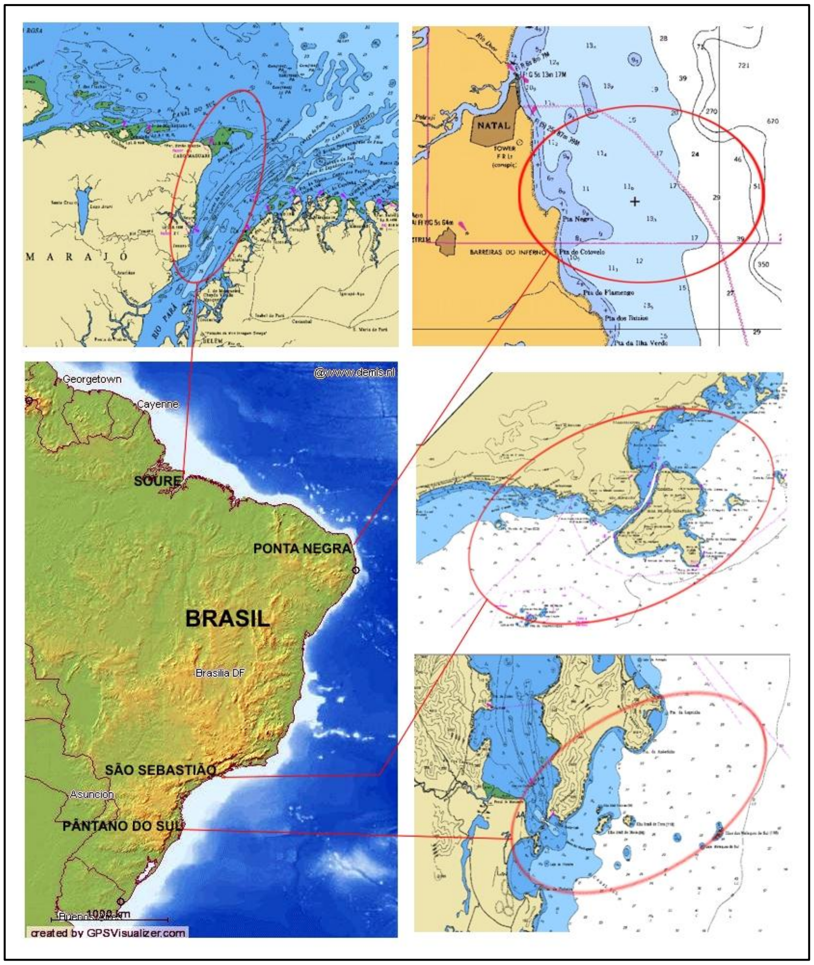


Figure 1 – Fishing communities studied along the Brazilian coast.

In face of their geographical localization, these areas are characterized by different climatic, oceanographic and socioeconomic parameters (Figs. 2 and 3).

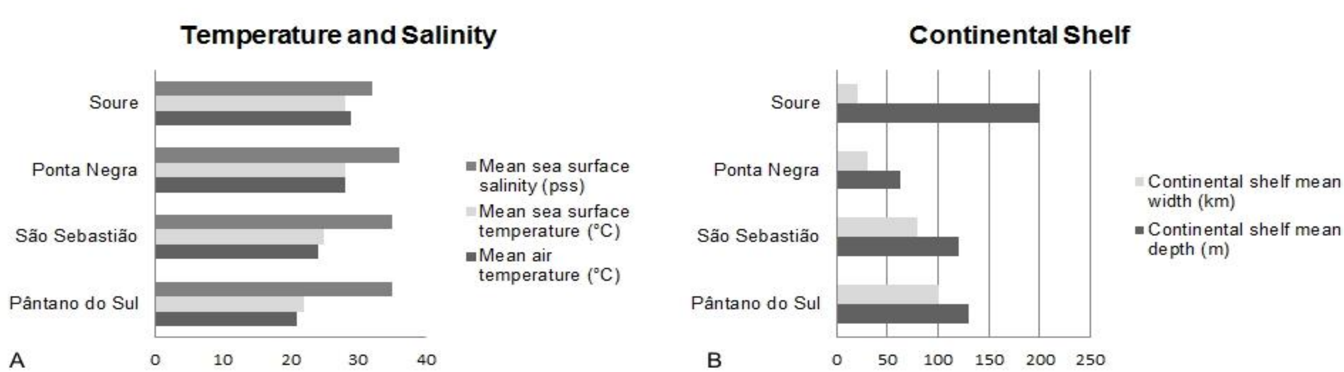


Figure 2 – A. Temperature of the air and of the sea and sea salinity. B. Continental shelf characteristics of the study areas (Tabosa and Vital 2002; Souza-Filho 2005; NOAA 2005; Rossi-Wongtschowski and Madureira 2006; DHN 2010).

Interviews with fishers

We interviewed fishers from 20 small communities along the four selected areas, older than 35 years old, and that have been fishing for more than 15 years. The interviews lasted 40 minutes on average and occurred only after each fisher gave his personal consent to be interviewed.

Unlabelled pictures and photos of 21 cetacean species previously selected in face of their occurrence in the study areas were used in the semi-structured interviews. We asked about the local fisheries, the interactions between cetaceans and fisheries, such as predation of cetaceans on target fishes, cooperation and competition between cetaceans and fishers during fishing activities, bycatch of cetaceans by fishing gear, intentional use of cetaceans by fishers for baiting, medicinal purposes and other uses and the presence of cetaceans' predators.

Data analysis

We quantify numerically the answers obtained for each question in order to allow comparisons among species, topics and informants. More than one citation (answer) was obtained per fisher for many questions. We analyzed the level of fishers' knowledge through the "do not know" answers (DNK) for each species on each topic, considering that the number of DNK answers is positively related to lack of knowledge, as proposed before by Silvano and Begossi (2002). We only considered the species cited by more than 20% of the fishers interviewed per area in the statistical analysis, since our focus was the dominant perception of the community. Additionally, we compared the dominant perceptions of fishers on cetaceans among the studied communities. For statistical tests (correlations and chi-squares), we tested the normality of the data.

We used Two-way ANOVA to check the variation in fishers' knowledge on the species, in relation to the surveyed topics and areas, comparing the average of DNK answers cited by fishers (Appendix 2). We also used Two-way ANOVA to check the variation in fishers' knowledge on the different kinds of interactions between cetaceans and fisheries, such as 'Competition', 'Cooperation', 'Predation', ‘Accidental capture’, ‘Intentional use’ and ‘Social interactions’ in the four areas, comparing the average of DNK answers cited by fishers. We use Pearson correlation coefficient (r) (Appendix 2) to test the relation between:

3. The fishers’ age, the time spent fishing, the schooling (in years) of each fisher and the ‘do not know’ answers to check if these factors affect their knowledge on cetaceans.
4. The number of species cited in each area per topic (interactions, feeding behavior and predators) and the average number of ‘do not know’ answers (DNK), to check if number of species cited is related to the lack of knowledge of the fishers. Our expectation was that the greater the fishers’ knowledge, the more species fishers would cite per topic.
5. The total numbers of prey items and of feeding behaviors cited for each area, to check if these numbers are correlated.
6. The frequency of entanglement of *T. truncatus, S. guianensis, S. clymene, P. blainvillei* and *I. geoffrensis*, and their frequency for the feeding behavior ‘dolphins steal and eat fish from the net’.

A Correlation Matrix was used to analyze the correlation among different factors (number of citations on: recognized species, informants, total interactions, incidental catch, intentional use, prey items, feeding behaviors and predators) for each area (Appendix 2).

We compared the information obtained for the most common species in the study areas (*S. guianensis, T. truncatus*, *I. geoffrensis, S. clymene, P. blainvillei, E. australis and M. novaeangliae*) with the information in the scientific literature, to check possible contributions of fishers’ LEK to the cetaceans’ ecology.

The scientific nomenclature of cetacean species and its English common names followed Bastida *et al.* (2007) and Jefferson *et al.* (2008). All statistical tests were performed using the software Biostat 5.0 (Ayres *et al.* 2007).

Results

The interviews with 171 fishers in Soure, Ponta Negra, São Sebastião and Pântano do Sul provided information to characterize the local ecological knowledge on the interactions involving cetaceans and fishers.

Twelve species were recognized in the four areas: *Eubalaena australis* (Southern Right whale), *Balaenoptera edeni* (Bryde's whale), *Megaptera novaeangliae* (Humpback whale), *Pseudorca crassidens* (False Killer whale), *Tursiops truncatus* (Bottlenose dolphin), *Stenella frontalis* (Atlantic spotted dolphin), *Stenella clymene* (Clymene dolphin), *Stenella attenuata* (Pantropical spotted dolphin), *Stenella longirostris* (Spinner dolphin), *Sotalia guianensis* (Guiana dolphin), *Pontoporia blainvillei* (Franciscana) and *Inia geoffrensis* (Amazon river dolphin) (Appendix 1).

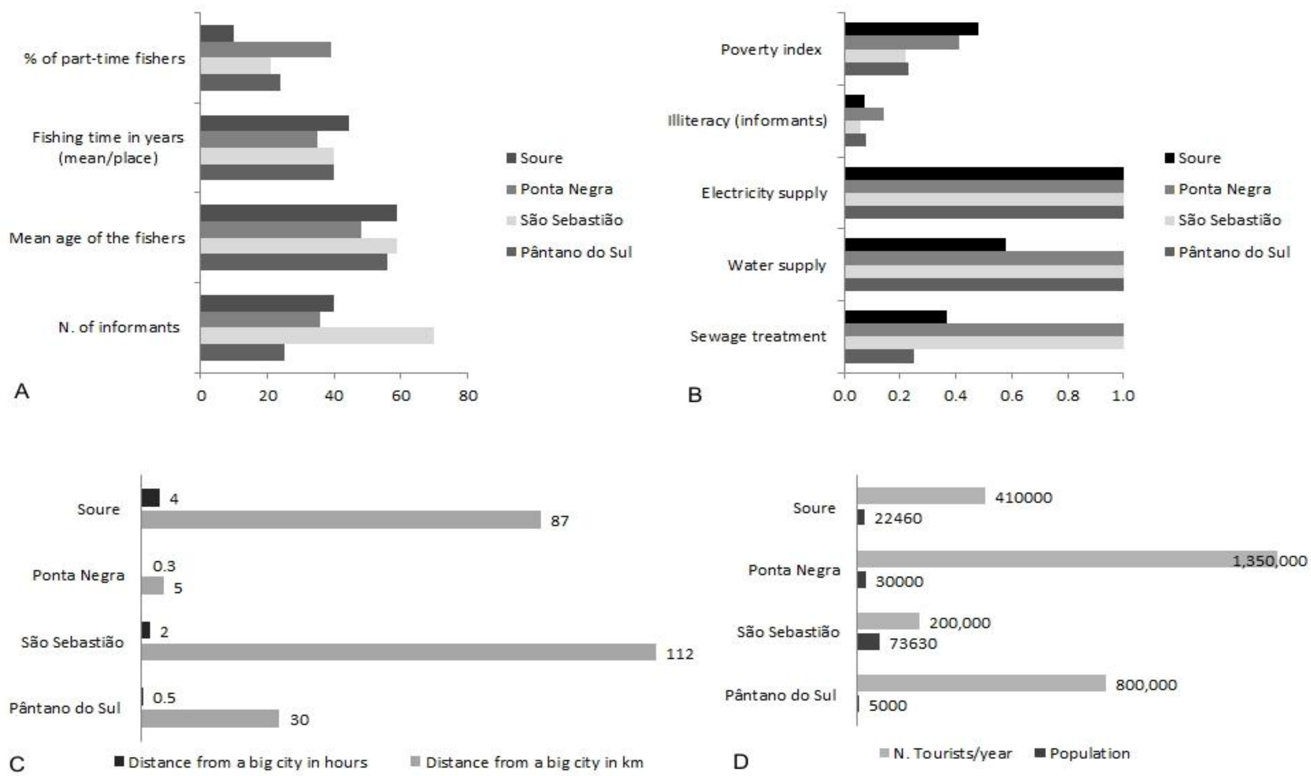


Figure 3 – A. Fishers' personal information obtained in this survey; B. Development indexes (%) (IBGE 2010); C. Isolation level (in hours and in kilometers); D. Tourism and Demography in the study areas (Governo do Pará 2001; Hafermann 2004; Ministério do Turismo 2010).

Socioeconomic information was also collected, showing that fishers from the most touristic areas are more involved in other commercial activities than only in fisheries (Figure 3A). Despite that, the indexes of poverty and illiteracy of the touristic areas are not lower (Fig. 3C), as should be expected.

The latitudinal variation among the study areas is reflected mainly in the local climate, which shows four well marked seasons in São Sebastião and Pântano do Sul and only two defined seasons (summer and winter) in Soure and Ponta Negra. This climatic variation influences the seasonality of the local fisheries, which is also influenced by the variation found in the width and depth of the continental shelf, which is wider in Soure and narrower in Ponta Negra (Fig. 2B).

Comparing the DNK answers with fishers' age, the time they have spent fishing along their lives and their schooling, we did not find correlation (Appendix 2).

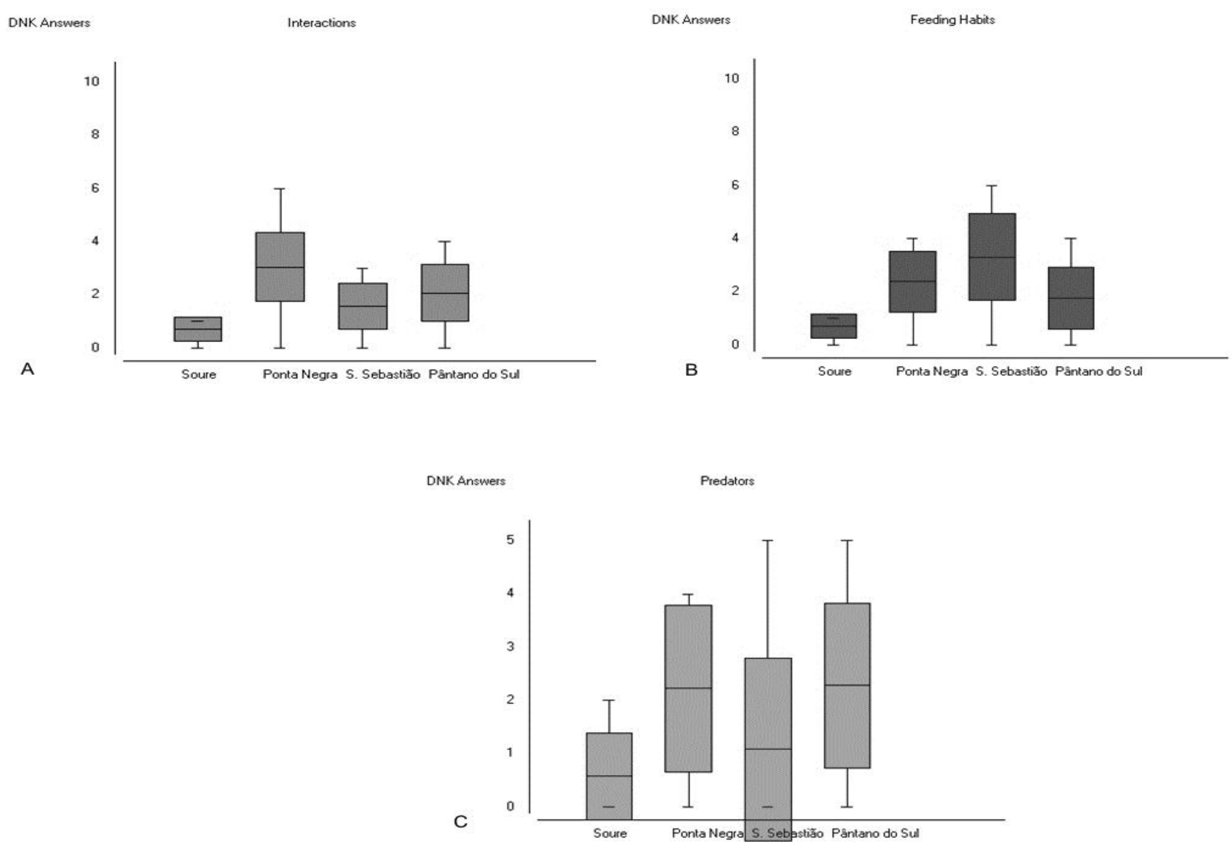


Figure 4 – Fishers' knowledge on cetaceans. A: Interactions, B: Feeding Habits and C: Predators, in each study area.

The topics asked to fishers were ‘Interactions cetaceans x fisheries’, ‘Cetaceans’ feeding habits’, and ‘Cetaceans’ predators’ (Figure 4). Testing the averages of DNK answers given by the fishers (ANOVA), we did not find differences in fishers’ knowledge about these topics ($F = 1.62$, $p = 0.27$) and in each area ($F = 0.03$, $p = 0.96$). We found a positive correlation between the number of species cited by the fishers for the topic ‘Feeding habits’ and the average number of DNK answers ($r = 0.98$, $p = 0,01$), which means that higher numbers of DNK answers resulted in more species cited. For the topics ‘Interactions’ and ‘Predators’ we did not find correlation (Appendix 2).

The most known species by the fishers (higher % citation) were those mentioned as the main competitors or those usually most caught by gillnets. They were: in Soure, *S. guianensis* (94%) and *I. geoffrensis* (88%), in Ponta Negra, *S. guianensis* (71%) and *S. clymene* (68%), in São Sebastião, *P. blainvillei* (78%) and *S. guianensis* (68%), and in Pântano do Sul, *E. australis* (80%) and *P. blainvillei* (71%) (Fig. 5).

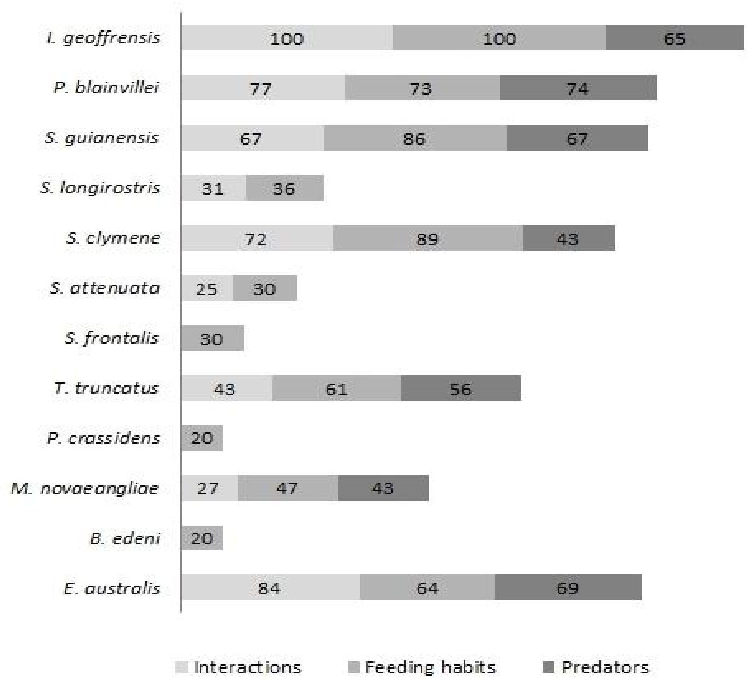


Figure 5 – Fishers’ knowledge (% of citations) on cetaceans’ interactions, feeding habits and predators for each surveyed species.

According to the informants, cetaceans interact with fisheries in several ways: competition (with fishers or local fishes), cooperation (with the fishers), and predation (on the target species of the local fisheries or as prey for other top predators). As a result from these interactions, bycatches of cetaceans in fishing nets and intentional use of captured cetaceans can occur. Fishers also described the behavior of some cetacean species, which we included in the category of 'social interactions' (Fig. 6). ANOVA tests confirmed that the topics 'Bycatch' and 'Competition' were the most known in all the areas ($F = 16.46$, $p < 0.0001$) (Appendix 2). In Soure, 'Intentional use' of dolphins for baiting was mentioned by 19% of the fishers against 3% in Ponta Negra and Pântano do Sul (Fig.6).

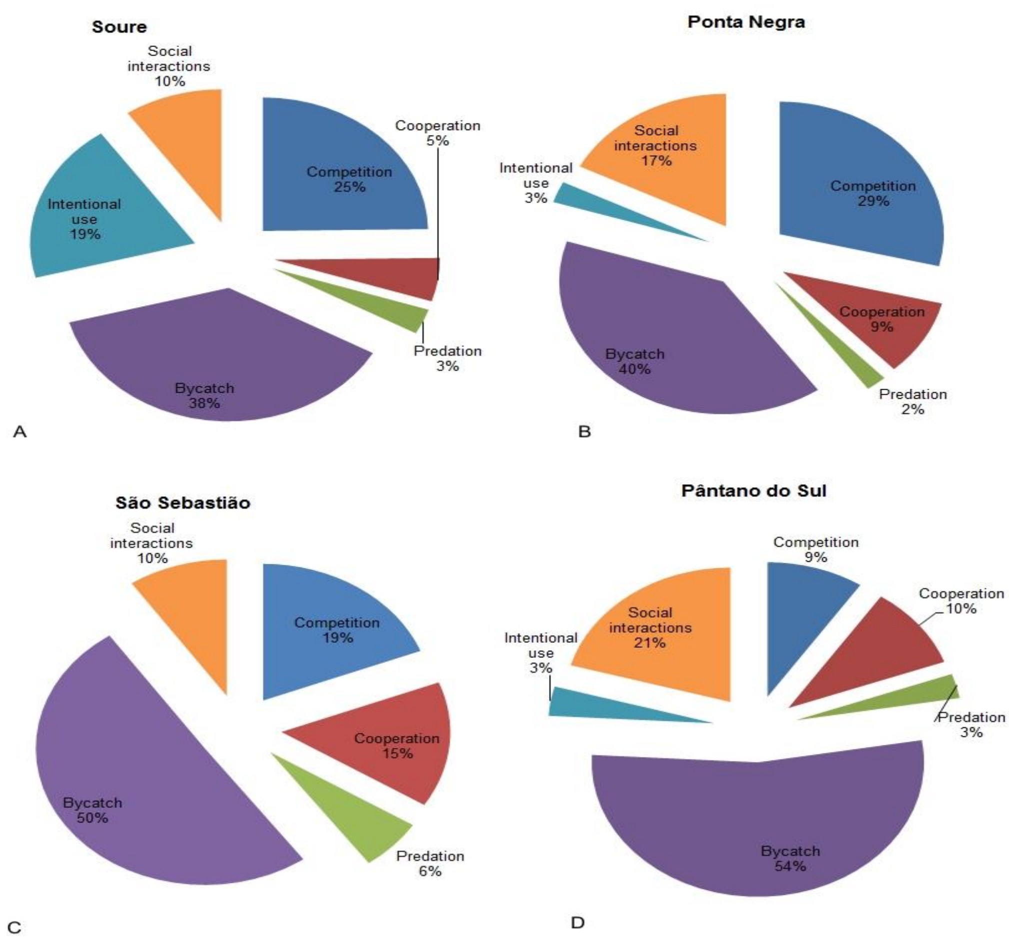


Figure 6 – Comparison among the categories of interaction (%) between cetaceans and fisheries reported by the informants in: A. Soure; B. Ponta Negra; C. São

Sebastião; Pântano do Sul.

In all the areas, bycatch was the main interaction reported by the fishers. Analyzing fishers' citations for seven species, we can infer which of them have more probability to be entangled. Other information was available for some species, such as the kind of nets involved in accidental capture. In some cases, fishers suggested a hypothesis for the cause of entanglement (Table 1). We did not find correlation between the entanglement frequency of the dolphin species: *T. truncatus, S. guianensis, S. clymene, P. blainvillei* and *I. geoffrensis*, and their frequency for the feeding behavior 'dolphins steal and eat fish from the net' (r = -0.49, df = 3, p = 0.39).

Table 1 – Cetaceans accidental capture in the study areas, fishing nets involved and fishers' hypothesis related to these events.

	Percentage of fishers' citation for each cetacean species						
	E. australis	*T. truncatus*	*S. guianensis*	*S. clymene*	*S. attenuata*	*P. blainvillei*	*I. geoffrensis*
Soure			80				12
Ponta Negra		19	61	39	4		
São Sebastião		8	21			70	
Pântano do Sul	8	12	20			48	
Gillnets		3.6	20			35	2
Pull nets			3				
Encircling nets			1			8	
Fixed trap nets	8					2	
Hypothesis 1: the cetacean get entangled because it eats fish from the net			1	39	5	3	84
Hypothesis 2: the Franciscana (P. blainvillei) ´beak´get entangled due to its bigger length						6.5	
Hypothesis 3: the dolphins get entangled by their flukes			5				

Two species are the most impacted by bycatches, according to fishers: the Guiana dolphin (*S. guianensis*) and the Franciscana dolphin (*P. blainvillei*). According to 80% of the fishers from Soure, the Guiana dolphin is the species most captured by fishing nets, especially the gillnet “caçoeira”, a thicker gillnet (Nylon filaments: 60 – 100mm and mesh sizes: 14 to 24 cm), and most catches involve an average of 3 animals (± 1). In Ponta Negra, the same species (*S. guianensis*) was mentioned by 61% of the fishers and are mainly caught also by thicker gillnets (for capture of fishes from the families Centropomidae and Carangidae). In São Sebastião, the Franciscana dolphin and Guiana dolphin were mentioned by, respectively, 71% and 21 % of the informants as the species most caught, especially by surface and bottom gillnets. In Pântano do Sul, Franciscana dolphins were cited by 48% of the fishers as the main species caught by surface and bottom gillnets. In this area, fishers (64%) also mentioned that the adults of Southern right whale (*E. australis*) can be entangled in fixed trap nets, carrying that net for kilometers before it frees itself, causing great economic losses to the fishers. Part of southern Brazilian coast is the breeding area for right whales during the winter and spring, and has been defined as ‘APA Baleia Franca’ (Right whale Protection Area). However, entanglements are common in Pântano do Sul during the breeding season. According to fishers, only whale’s calves can be entangled and killed by the nets.

The second most cited interaction was competition and the behaviors that best describe this interaction between fishers and cetaceans in each area were: cetaceans cause damages to the fishing nets and drive off the fishes or steal fishes directly from the net, disturbing the fisheries. Fishers from Soure (30%) mentioned the competition between the Guiana dolphin and the fish ‘piramutaba’ (*Brachyplatystoma vaillantii*) for the same prey, the ‘amoré’ (*Gobioides grahmae*). According to them, the Guiana dolphin nose the muddy bottom, digging up the ‘amorés’, which attracts the ‘piramutabas’. The informants consider that Guiana dolphin and piramutaba are competing for the same prey, but eventually, Guiana dolphin can eat ‘piramutaba’. In Natal, fishers (3%) mentioned that the Clymene dolphins (*S. clymene*) sometimes fight among them for fish.

Regarding cooperation, in the four areas fishers reported that some dolphins, especially the Guiana dolphin and the bottlenose dolphin (*T. truncatus*), help the fisheries indicating the location of fish schools or driving the fishes to the shore. In Soure and São Sebastião, fishers (4%) also mentioned that these dolphins help shipwrecked people, taking them to the beach.

Predation was mentioned by an average of 22% of the informants that provided details about the feeding habits of 12 cetacean species, describing 28 different feeding behaviors and listing 43 species of fishes, in addition to 3 three species of mollusks, two of crustaceans, and unidentified species of jellyfish, algae and plankton, as their preferential prey (Appendix 3). A comparison of the feeding habits and prey items of the cetaceans, among the four areas, is shown in Figures 7 and 8. We did not find correlation between the number of prey items and the number of feeding behaviors cited for each area (r= 0.81, p= 0.18).

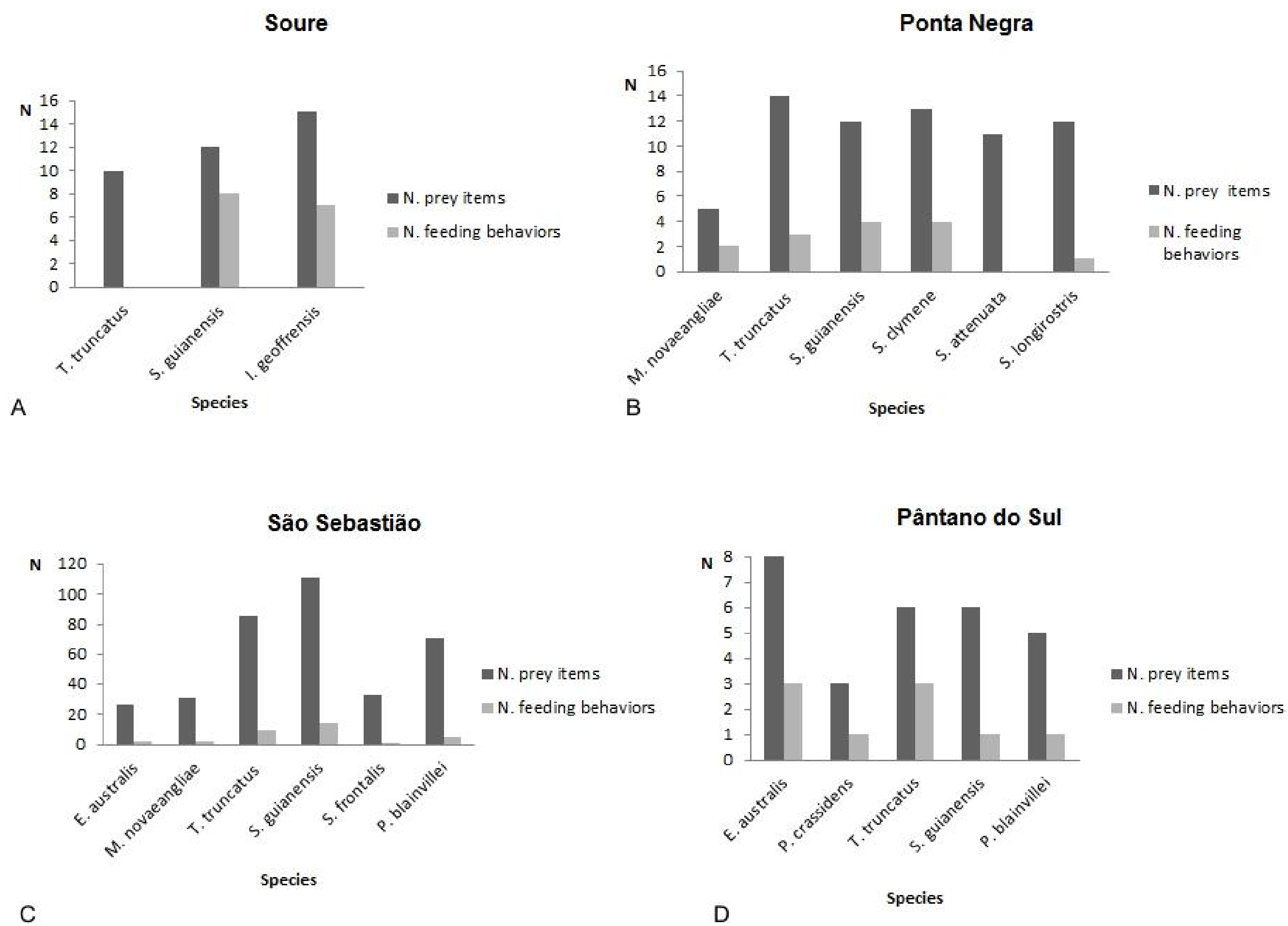
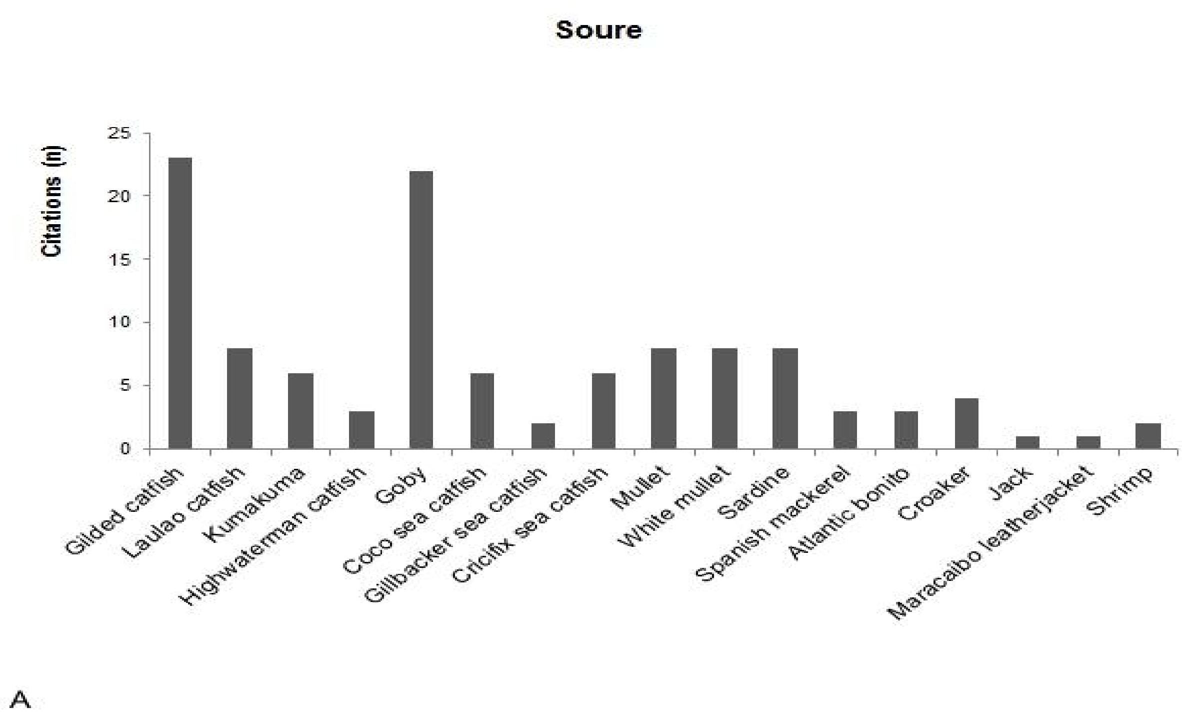
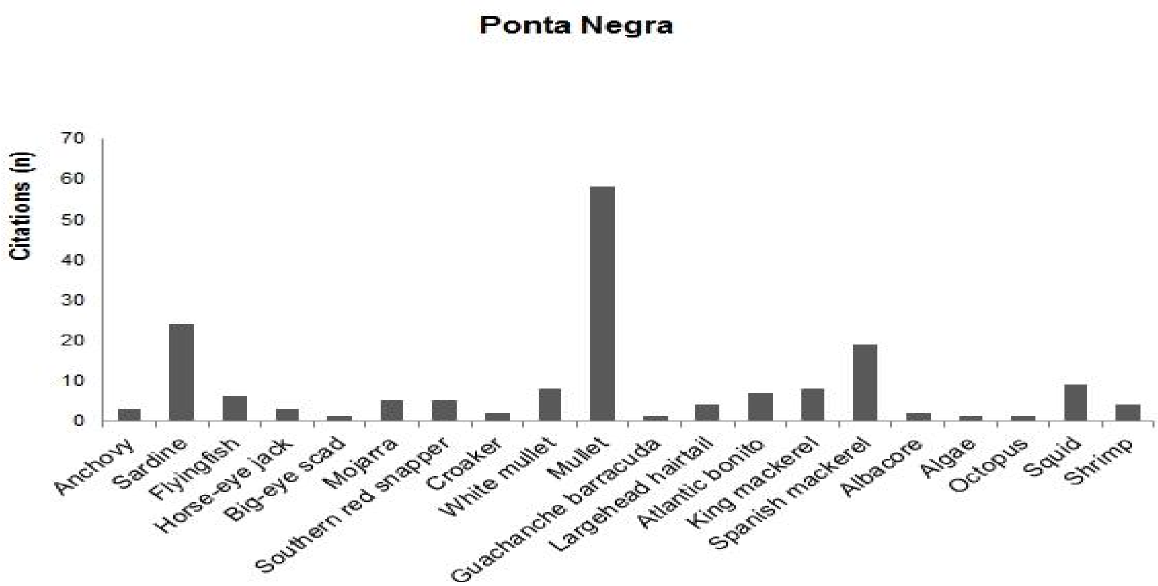


Figure 7 – Cetaceans' feeding habits, including the number of prey items and the number of feeding behaviors cited for each species in: A. Soure; B. Ponta Negra; C. São Sebastião; D. Pântano do Sul.

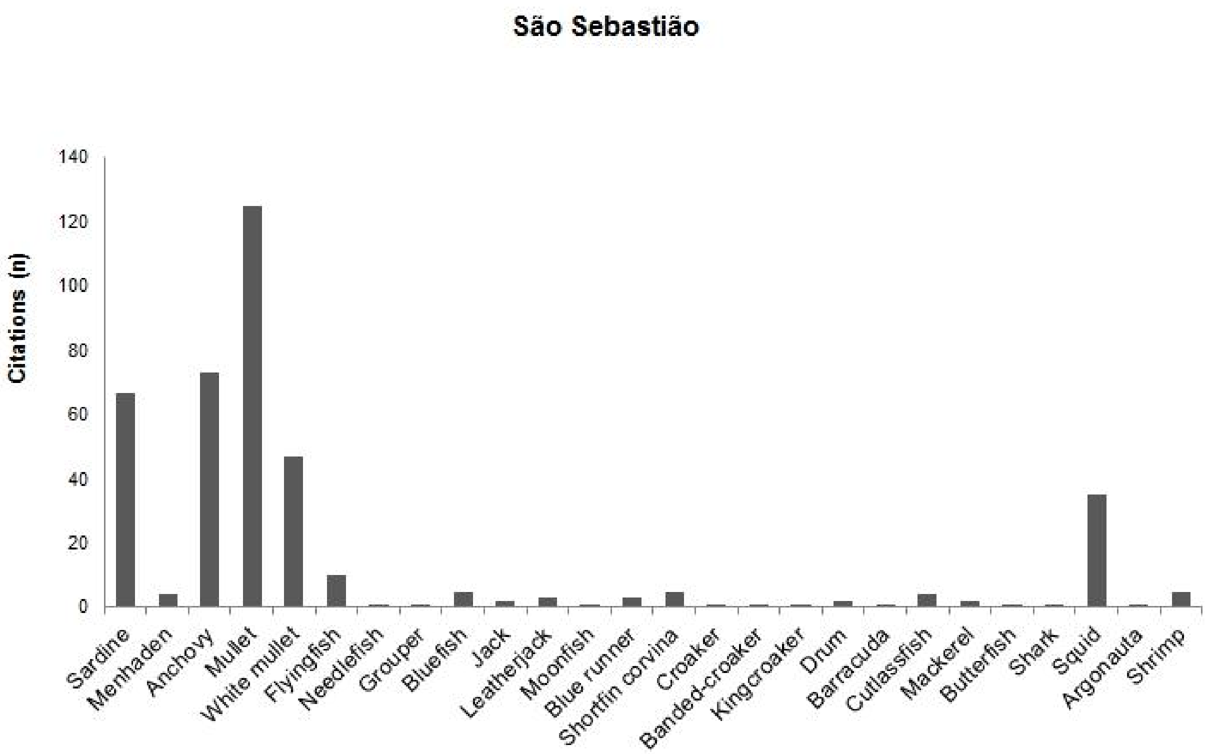
Grouping the feeding behaviors mentioned by fishers of the four study areas, the most cited (%) were:

- dolphins (*I. geoffrensis* (40%)) eat only the posterior part of the fish, leaving its head on the net;
- Dolphins (*S. guianensis* (30%)) join each other to dig the muddy bottom to find and eat the 'amoré' (Gobiidae);
- dolphins (*S. guianensis* (10%), *T. truncatus* (6%), *S. clymene* (5%)) throw up the fish to take away its scales, then catch it with their jaws;
- dolphins (*S. guianensis* (4%), *T. truncatus* (13%)) drive the fish to the shore, grouping the fish;
- whales (*E. australis* (15%), *M. novaeangliae* (3%)) they engulf a great volume of water containing small fish schools and eat only small fishes, one fish by time, because their throat is narrow.




Ponta Negra
Citations (n)
70
60
50
40
30
20
10
0
Anchovy
Sardine
Flyingfish
Horse-eye jack
Big-eye scad
Mojarra
Southern red snapper
Croaker
White mullet
Mullet
Guachanche barracuda
Largehead hairtail
Atlantic bonito
King mackerel
Spanish mackerel
Albacore
Algae
Octopus
Squid
Shrimp

B


São Sebastião
Citations (n)
140
120
100
80
60
40
20
0
Sardine
Menhaden
Anchovy
Mullet
White mullet
Flyingfish
Needlefish
Grouper
Bluefish
Jack
Leatherjack
Moonfish
Blue runner
Shortfin corvina
Croaker
Banded-croaker
Kingcroaker
Drum
Barracuda
Cutlassfish
Mackerel
Butterfish
Shark
Squid
Argonauta
Shrimp

C

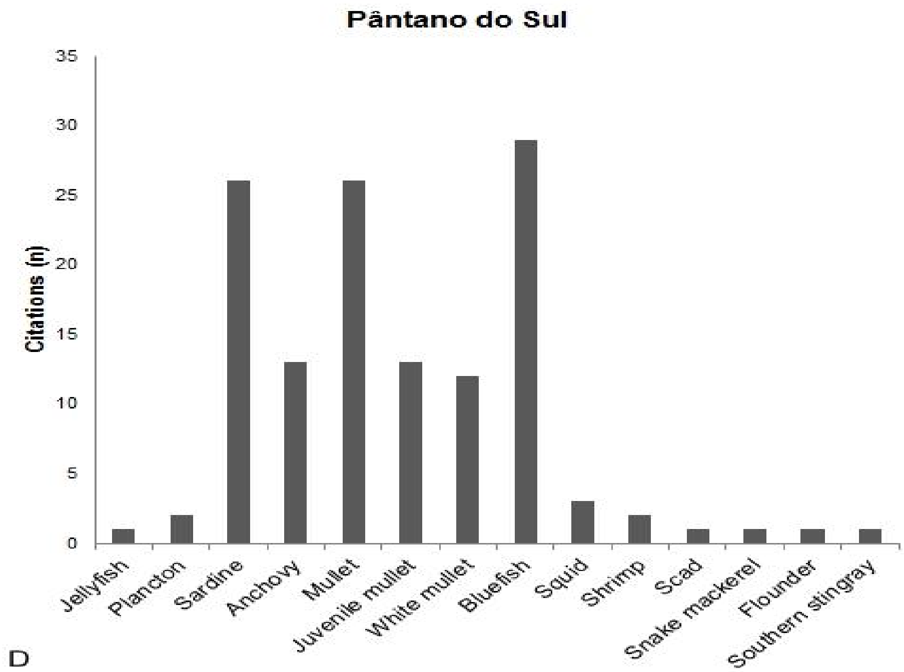


Figure 8 – Prey items cited as components of cetaceans' diet in each study area in: A. Soure; B. Ponta Negra; C. São Sebastião; D. Pântano do Sul.

A complete list of the cetaceans' prey items cited by the fishers is provided in Appendix 3. The most cited fishes are from the families:

- In Soure: Pimelodidae, Gobiidae, Mugilidae, Ariidae;
- In Ponta Negra: Mugilidae, Scombridae, Clupeidae;
- In São Sebastião: Mugilidae, Engraulidae, Clupeidae;
- In Pântano do Sul: Mugilidae, Pomatomidae, Clupeidae;

In Appendix 4 we compare the cetaceans' prey items cited by the fishers to the items recorded in specialized literature and we found concordant and also discordant information.

According to 55% of the informants, cetaceans do not have predators. They mentioned the intelligence, strength and speed as characteristics that protect cetaceans from predators. On the other hand, 45% of the informants mentioned that cetaceans are prey for other animals. Sharks, killer whales, swordfishes and humans were considered by the fishers as the main predators of cetaceans, due to evidences of bites in the flukes or fins of entangled or dead dolphins reperted by the fishers (Figure 9).

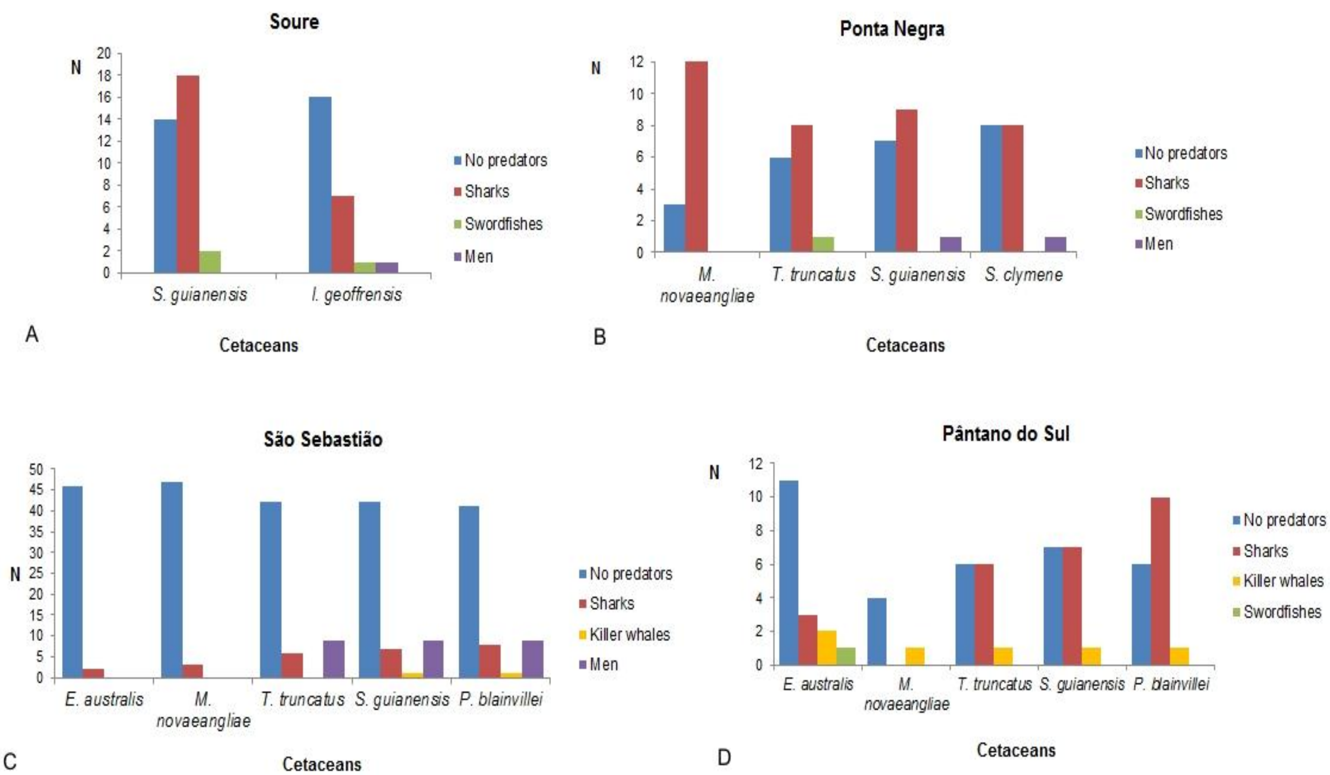


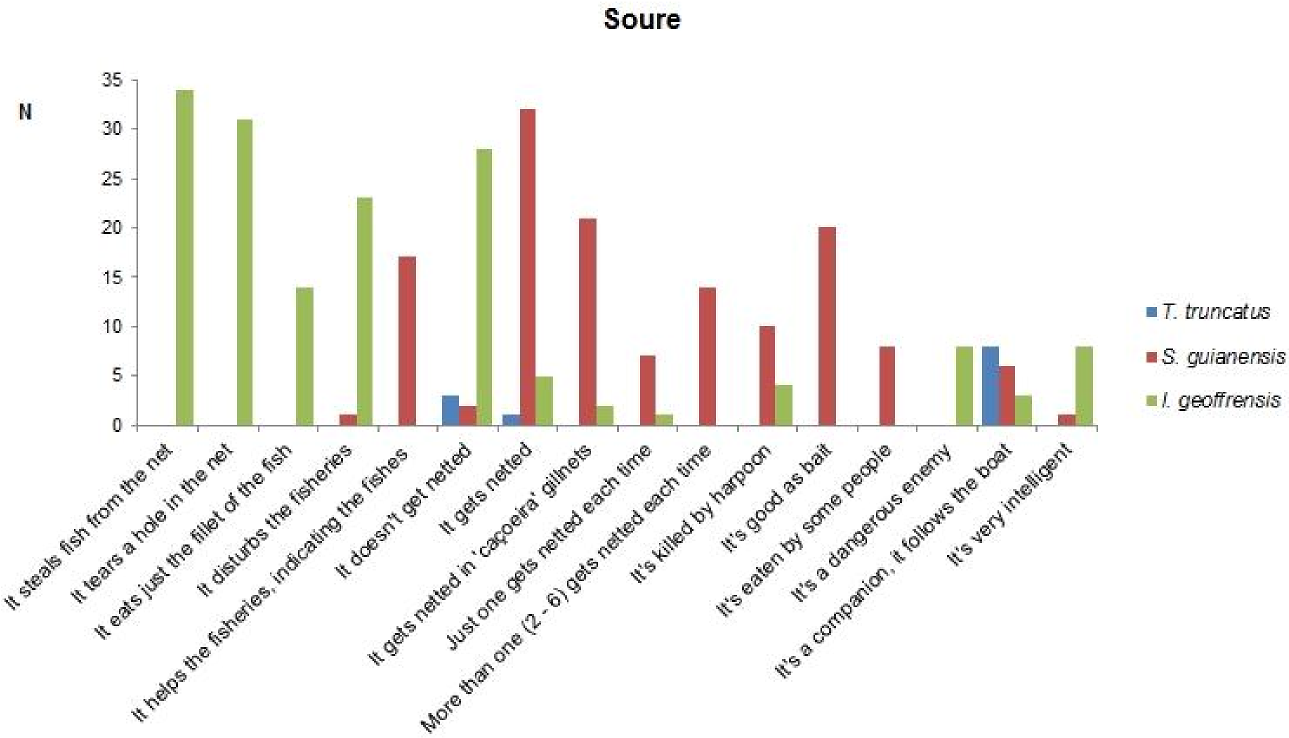
Figure 9 – Predators of cetaceans, according to the interviewed fishers. A: Soure, B: Ponta Negra, C: São Sebastião, D: Pântano do Sul.

Intentional use of cetaceans was most reported in Soure, where 50% of the informants mentioned that the meat and fat of Guiana dolphin (*S. guianensis*) can be used as bait (especially for piramutaba and shark fisheries) when they get netted or when they are harpooned by the fishers. Other uses, such as meat consumption of entangled dolphins or the use of the cetacean's sexual organs and eyes as loving charms and the fat for medicinal purposes, were mentioned by less than 20% of the fishers in Soure. In Ponta Negra and Pântano do Sul less than 4% of the fishers reported occasionally using entangled dolphins as bait in shark fisheries.

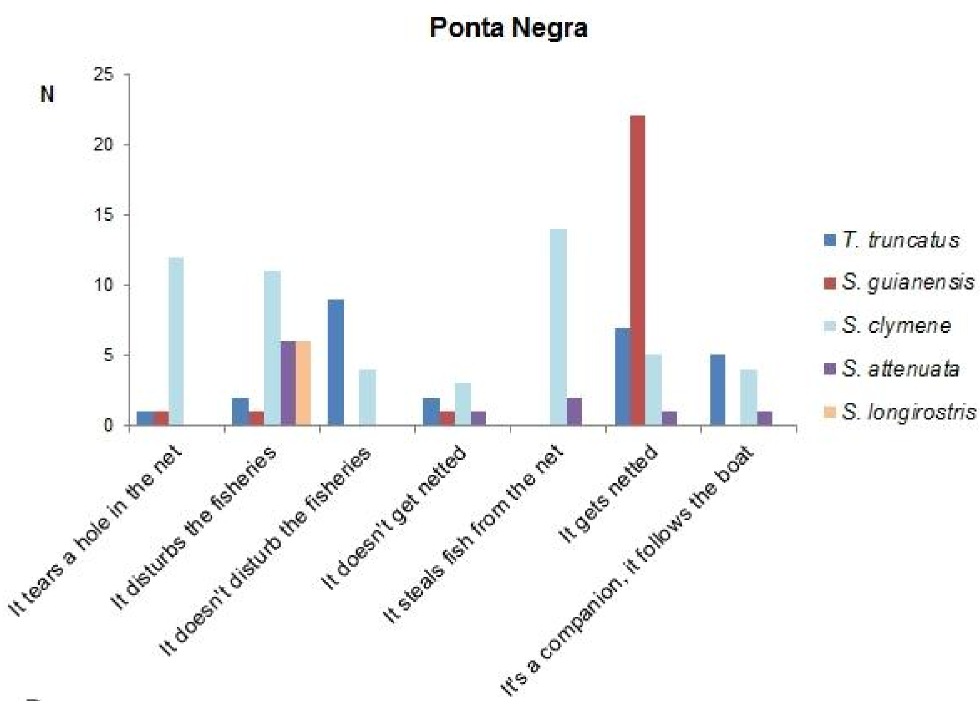
Testing the relation between fishers' citations for the topics 'Interactions', 'Feeding habits' and 'Predators' and the level of fishers' knowledge (DNK answers), we did not find any correlation among them (Appendix 2). Using a correlation matrix to analyze the relation among the number of citations on recognized species, informants, total interactions, bycatch, intentional use, prey items, feeding behaviors, and predators, for each area, we only found a positive correlation between the number of informants and the number of citations for prey items ($r= 0.98$, $p= 0.013$).

The informants reported several social behaviors of cetaceans in relation to the fishers or among themselves. The most mentioned by the fishers in the four study areas were positive behaviors such as: 'dolphins follow the boats and are good companions (39%)', 'they are very intelligent and fast swimmers' (16%), 'they jump and spin in the air' (11%), 'they appear when the fishers whistle to them' (7%), 'they take care of their calves or partners when one of them entangles in a net' (6%), 'they save people in the sea' (5%). In Soure we found the most negative perception about the dolphins, where 18% of the fishers mentioned that the Amazon dolphin (*I. geoffrensis*) is "an enemy, very dangerous and evil".

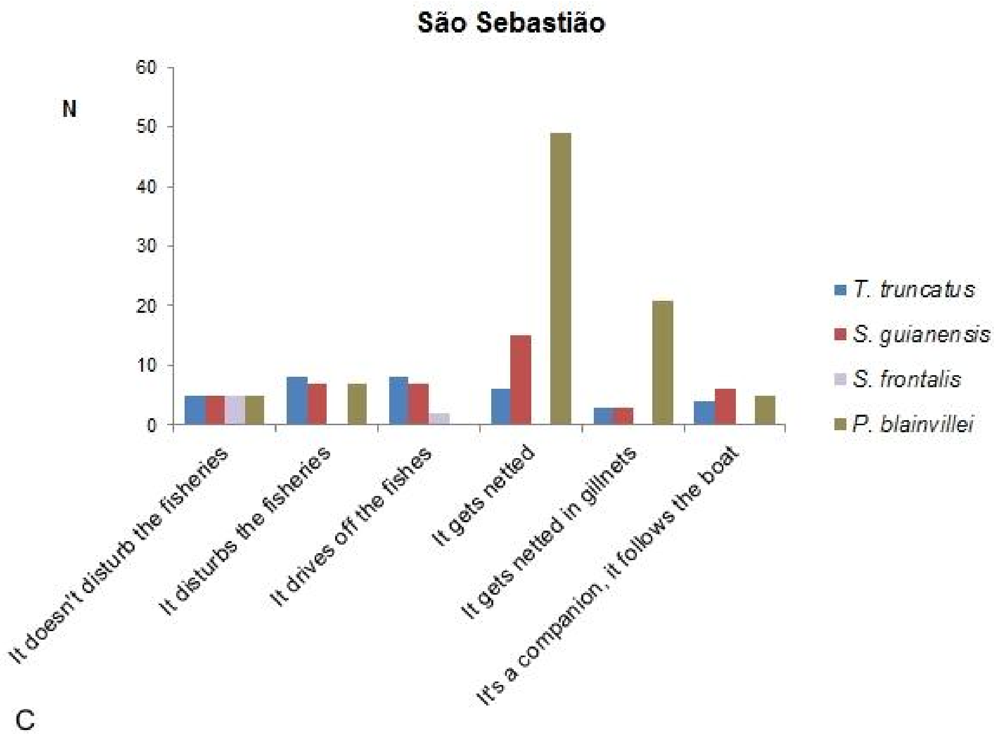
Based in fishers' answers, we quantified all the behaviors mentioned for each category of interaction. The most cited cetaceans' behaviors in each area are shown in Figure 10.


Soure
N
35
30
25
20
15
10
5
0
It steals fish from the net
It tears a hole in the net
It eats just the fillet of the fish
It disturbs the fisheries
It helps the fisheries, indicating the fishes
It doesn't get netted
It gets netted
It gets netted in 'caçoeira' gillnets
Just one gets netted each time
More than one (2 - 6) gets netted each time
It's killed by harpoon
It's good as bait
It's eaten by some people
It's a dangerous enemy
It's a companion, it follows the boat
It's very intelligent
T. truncatus
S. guianensis
I. geoffrensis

A


Ponta Negra
N
25
20
15
10
5
0
It tears a hole in the net
It disturbs the fisheries
It doesn't disturb the fisheries
It doesn't get netted
It steals fish from the net
It gets netted
It's a companion, it follows the boat
T. truncatus
S. guianensis
S. clymene
S. attenuata
S. longirostris

B



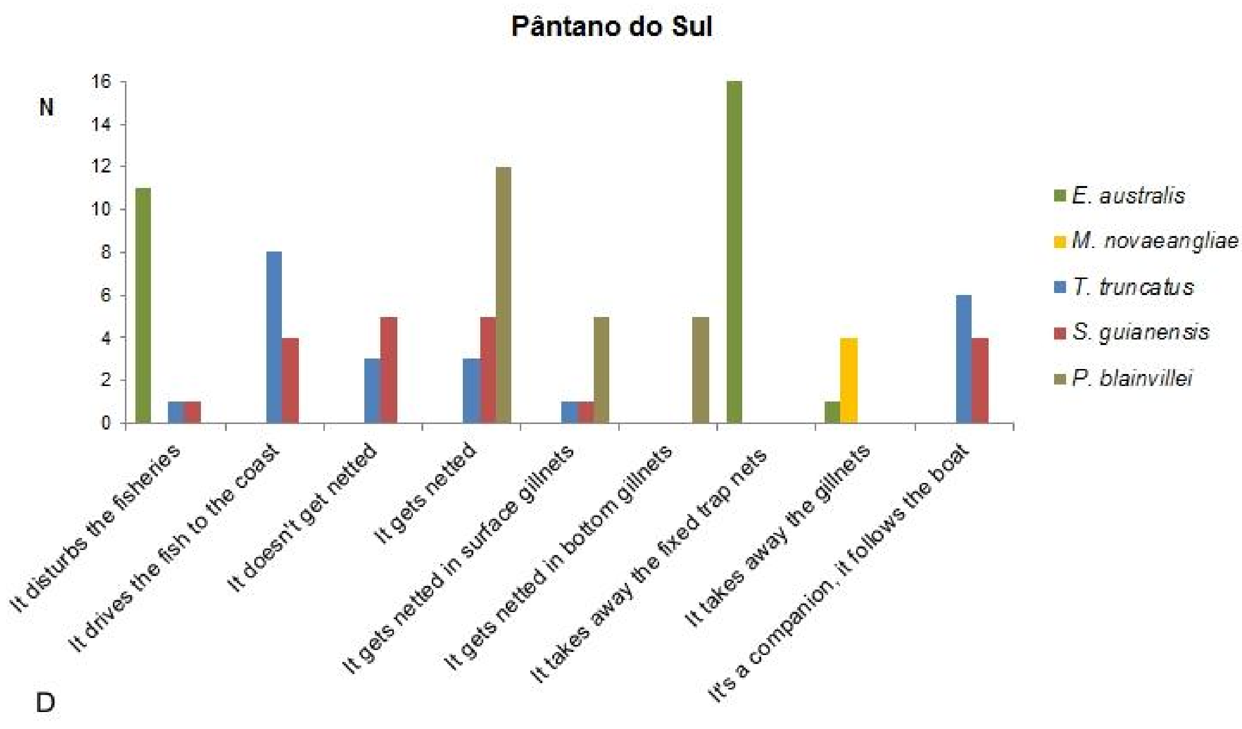


Figure 10 – Interactions between cetaceans and fishers. A. Soure; B. Ponta Negra; C. São Sebastião; D. Pântano do Sul.

Discussion

The socioeconomic differences do not seem to cause significant differences in LEK in the four areas, maybe due to the fact that the informants were selected in the same age interval (> 35 years old), with a reasonable period of time dedicated to fishing activities (> 15 years) and using similar fishing gear (gillnets) and strategies, common to the Brazilian small-scale fisheries (Begossi 2010).

Bycatch was the most mentioned interaction, probably because it calls a lot of fishers' attention, despite dolphins not being target species to the local fisheries in Brazil. Every event of bycatch may represent an economic loss to the fishers, due to the damage in the fishing net. Besides that, two fishers from Soure and one from Pântano do Sul said to be impressed by the fact that entangled dolphins (Guiana dolphin and franciscana) cry as babies when they are found still alive. The emotional impact of the cetaceans' entanglement on the fishers deserves further and more detailed investigation to quantify which percentage of fishers is affected in this manner and if it could have any implication in local fisheries management. Campbell and Cornwell (2008) mentioned that people's reaction to charismatic species can vary according to the group considered. They argued that marine mammals (including cetaceans) may not be valued by fishers in the same way as the public in general do, which could affect fishers compliance to bycatch reduction management.

The species most impacted by bycatch, the Guiana dolphin and the franciscana dolphin, are mainly distributed in coastal areas, overlapping with the areas of gillnetting and consequently increasing the chances of entanglement. The prevalence of gillnets in cetaceans' bycatch was reported by the fishers and also by the specialized literature (Siciliano 1994, Di Beneditto and Ramos 2001, Secchi *et al.* 2004, Danilewicz *et al.* 2009). Fishers know details on the variety of gillnets involved in those bycatches, as mentioned before.

Bycatch in gillnets has affected populations of franciscana and of Guiana dolphins in the northeastern, southeastern and southern Brazilian coast in shallow waters (< 30 m) (Siciliano 1994, Di Beneditto and Ramos 2001, Alarcon *et al.*

2009, Danilewicz *et al.* 2009), confirming the information given by the studied fishers.

It is not by chance that fishers from Soure showed more knowledge on bycatch, intentional use and competition involving cetaceans and humans. Accidental and intentional captures of *S. guianensis*, and occasionally of *I. geoffrensis*, have been reported in the Amazon estuaries for decades, and the carcasses of these dolphins have had several uses, such as bait for catfishes and sharks fisheries; dried genitalia and eyes are sold as love charms, and teeth and bones are used by handcrafters (Siciliano 1994, Alves and Rosa 2008, Sholl *et al.* 2008, Siciliano *et al.* 2008, Da Silva and Martin 2010). It is interesting to note that fishers refer to the intentional use of dolphins always using third person plural, not defining the subject of the action. Probably they were afraid of talking about intentional use, since it is forbidden by law in Brazil. In this situation, it is difficult to define if this activity has been currently carried out or not.

The intentional use of *I. geoffrensis* was reported by only 16% of the informants in comparison to 84% for Guiana dolphin's use. It seems that fishers associated this species to the protagonist of the 'Boto's legend', a local myth, which transforms itself in an attractive and powerful man who seduces young women leaving them pregnant (Cascudo 2001, Fraxe, 2004, Alves and Rosa 2008). This legend associated to the more aggressive behavior of the 'boto malhado' is somehow protecting it from the intentional capture. The same did not happen to the Guiana dolphin, which despite their cooperative behavior to the fishers, is still intentionally captured in the Brazilian northern coast.

According to the fishers, intentional capture of dolphins does not currently occur in the studied areas in the northeastern, southeastern and southern Brazilian coast. Siciliano (1994), in a comprehensive review on small cetaceans' interactions with fisheries along the Brazilian coast, recorded the intentional capture of Guiana dolphins along the northern coast. However, for the other areas Siciliano (1994) reported the occasional use of dolphins accidentally caught in gillnets for meat consumption or for baits. Our results confirm this trend.

The competition between fishers and the Amazon boto (*I. geoffrensis*) was insistently reported by fishers from Soure, with more than 70% of them complaining that *I. geoffrensis* steals fishes from the gillnets, damaging the nets and causing economic losses to them. This interaction is opposed to the cooperation offered by the Guiana dolphins, reported by 42% of the fishers, which said that these dolphins indicate the presence of the fish schools, helping the fisheries. *Inia geoffrensis* was perceived by 20% of the fishers as a 'dangerous enemy', which not only disturbs their fishing activities but also can attack the fishers and is associated with misfortune and bad luck.

Cooperation between dolphins and fishers is well known by the informants, despite the lower number of citations of this topic in relation to the other topics. Bottlenose and Guiana dolphins are the most cooperative species in the fishers' opinion. The most cited behavior, in which dolphins group the fishes and drive them to the coast, then fishers can easily catch them in surround and gillnets, have been described by other authors for both dolphins' species (Busnel 1973; Simões-Lopes *et al.* 1998; Peterson *et al.* 2008; Freitas-Netto and Di Beneditto 2008; Zappes *et al*. 2011).

Fishers' knowledge on cetaceans' feeding habits provided a list of prey items for each study area, which not only show items recorded before for the most common species, but also add new items to the diet of these species. The concordance between fishers' information and the scientific literature can be considered high, with more than 50% of the items cited by fishers concordant to the items reported in the literature, as shown in Appendix 4. However, the contrasting information given by fishers in relation to some prey items should be analyzed carefully, species by species, to check if these contrasts reflect lack of fishers' knowledge on the diet of the studied cetaceans or if they could be considered as new information on this subject, as suggested by Silvano and Valbo-Jorgensen (2008) regarding fishers' LEK about fish.

The feeding behavior described for the whales ('engulfing a fish school) is also reported in the literature for Humpback whales and is called "gulp feeding" (Clapham 2000). The detailed description given by the fishers from Soure about the feeding behavior of the Guiana dolphin (*S. guianensis*), competing with the catfish 'piramutaba' (*Brachyplatystoma vaillantii*) for the same prey, the 'amoré' (*Gobioides grahmae*), was rich in details. Barthem (1990) studying the feeding habits of *B. vaillantii*, found that the 'amoré' is one of the main items in the diet of this fish, with a frequency of occurrence of 40% in the stomachs collected, confirming the information given by the fishers on 'piramutabas' diet. Beltrán-Pedreros and Pantoja (2006) studied the feeding habits of *S. guianensis* in the Marajó Bay and listed 13 species of fish, but the 'amoré' (*G. grahmae*) or any member of the family Gobiidae was not included. However, Gurjão *et al.* (2003) found, among other demersal species, fishes from the family Gobiidae in 4% of the Guiana dolphins' stomachs studied in Ceará, northeastern Brazilian coast. Further studies on feeding behavior of Guiana dolphin should be conducted to confirm the information given by the fishers. In fact, fishers could contribute to collect information on the feeding behavior of dolphins. This kind of joint study could help to reduce the impact of bycatches, since many dolphins are entangled when they are feeding from fishes in the nets.

Information given by most of the fishers on cetaceans' predation suggested that these animals do not have natural predators. In fact, their size, strength and intelligence are mentioned by the informants as qualities that protect them from predation. However another part of the informants mentioned sharks and killer whales as the main predators of cetaceans. This information is confirmed by the specialized literature that reports killer whale attacks to blue and sperm whales, as well as smaller dolphin species. Additionally, tiger sharks, great white sharks, dusky sharks and bull sharks (*Galeocerdo curvieri*, *Carcharodon carcharias*, *Carcarhinus obscurus* and *Carcharhinus leucas*, respectively) were also reported predating on small porpoises, dolphins and beaked whales (Connor 2000). According to this author, the predation risk is the factor responsible for group formation in cetaceans (Connor 2000). In Brazil, attacks from killer whale and sharks have been reported to the small Franciscana and Guiana dolphins (Praderi 1985; Ott and Danilewicz 1998; Di Beneditto 2004; Santos and Netto 2005;

Danilewicz *et al*. 2009). In fact, 25% and 3% of the fishers, respectively, mentioned attacks from sharks and killer whales on Guiana dolphins and Franciscana.

Among the social behaviors, fishers also highlighted the behavior of care-giving between individuals of *E. australis*, *S. guianensis* and *P. blaivillei*, in São Sebastião and Pântano do Sul. According to the fishers a right whale mother stayed beside their entangled calf, taking care of them, until it was released from the net. In other example, fishers said that the whale mother saved the entangled calf. Fishers also observed that when a dolphin is entangled, another dolphin ('a friend') stays beside it, even when the dolphin is dead. This behavior, also called epimeletic behavior, has been reported in Brazilian waters and around the world for several cetacean species, including those mentioned by the fishers (Connor and Norris 1982; Lodi 1992; Cremer *et al*. 2006; Moura *et al.* 2008). Connor and Norris (1982) discussed this behavior, which can also be interespecific, suggesting the evolution of reciprocal altruism into the complexes cetacean societies, as a consequence of the high mutual dependence observed in these social systems.

Concerning wildlife conservation the most important, as many authors have argued, is to find and to apply all reliable information, including LEK, in order to better contribute to management decisions (Johannes 1998; Gilchrist and Mallory 2007; Silvano and Begossi 2010). With this in mind, we suggest that fishers' knowledge, especially on cetaceans' feeding habits and interactions with fisheries, should be considered in fisheries management plans, helping to minimize the impact of bycatch on vulnerable species and the constant damage of the fishing gear. Spencer *et al.* (2000) attribute the success in the design of effective mitigation measures to address the by-catch in the Pacific driftnet tuna fishery, to the fishers' cooperation and valuable knowledge.

Specifically to each area we suggest:

- Soure: educational campaigns at schools and other community forums, integrating the cultural aspects (myths) of the 'boto' to its ecological importance in the local ecosystems in order to start a change in peoples' reactions in relation to *I. geoffrensis*. Besides that, environmental managers should devise strategies to involve interested fishers in monitoring programs on the intentional use of local dolphins. Participating in these programs, fishers could collect local data on the areas and frequency of dolphins' intentional catches, which would increase their awareness of the problem and would provide a better baseline to support educational and regulatory measures in relation to these illegal captures. As a compensation for the time and energy spent in these programs, fishers could receive a "payment for environmental services" (PES), as an economic incentive to their participation.

- Ponta Negra and São Sebastião: to tackle the impact of small dolphins' bycatch we suggest, besides educational campaigns, to start working groups integrating local managers, researchers and fishers, in order to define critical bycatch areas and species (as shown in this study) and to develop alternatives to the use, design and size of the most impacting gillnets (also evidenced by our results), as suggested by Spencer *et al.* (2000). It is important that these groups be local and opened to the participation of any interested fisher.
- Pântano do Sul: the problem of dolphins' bycatch can be addressed by the same initiatives suggested above. However, the seasonal economic losses caused to the fishers by the "protected right whales" need to be quantified by the authorities and fishers have to be economically compensated. Educational workshops specifically addressing the right whale's protection area and its superposition on the fishing spots should be implemented in Pântano do Sul to discuss strategies to minimize potential conflicts.

Conclusion

The interviews with 171 fishers from distinct geographical areas characterized the local ecological knowledge on the interactions between cetaceans and fisheries. Variations in socioeconomic and oceanographic conditions among the study areas did not influence fishers' knowledge.

Fishers were asked on interactions, feeding habits and predators of cetaceans. The species most cited by the fishers were those most common in each area. Guiana and bottlenose dolphins (*S. guianensis* and *T. truncatus*) were common in the four areas.

Among the cited interactions, bycatch of cetaceans in fishing gear was the most mentioned by the fishers, probably due to the negative impacts it has on the fishing activities. Several feeding behaviors and a list of prey items were provided by the fishers for 12 cetacean species.

The comparison between fishers' LEK and scientific literature pointed out many concordances, especially in relation to cetaceans' prey items. Nevertheless, fishers' information on the feeding habits of Amazon and Clymene dolphins (*I. geoffrensis* and *S. clymene*) were not consistent with available scientific information, which in its turn lack details on some of the surveyed topics. Further research should be conducted to check if fishers' LEK on these species is accurate enough to fill these gaps.

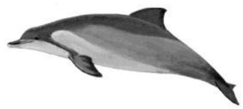
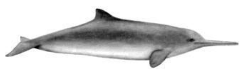
Fishers' LEK obtained in this survey is consistent and comparable among the study areas. It has provided important details to better understand the interactions involving cetaceans and fishers, contributing to minimize the gap in the knowledge on bycatches and to support alternative management actions.

Acknowledgements

We are grateful to Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for a doctoral scholarship to S.P.S., and for fellowships to AB (301957/2007-0 and 151084/2009-2); to FAPESP, for the grant # 06/50435-0 to AB; to PIATAM Mar and PIATAM Oceano Projects, S. Siciliano and A. L. F. Rodrigues for all the help during the research in Marajó Island, and to the fishers from Soure, Ponta Negra, São Sebastião and Pântano do Sul, for their cooperation and participation in this research.

Appendix 1

Cetacean species surveyed in relation to Interactions with fisheries, Feeding habits and Predators, from the most to the least cited species (%) in the four study areas (S = Soure, PN = Ponta Negra, SS = São Sebastião, PS = Pântano do Sul). (Figures from Jefferson, Leatherwood, and Webber 1993).

 ***Sotalia guianensis*** **(S = 94%, PN = 71%, SS = 68%, PS = 57%)**	 ***Tursiops truncatus*** **(S = 26%, PN = 51%, SS = 61%, PS = 63%)**	 ***Megaptera novaeangliae*** **(PN = 41%, SS = 56%, PS = 20%)**	 ***Eubalaena australis*** **(SS = 54%, PS = 80%)**
 ***Pontoporia blainvillei*** **(SS = 78%, PS = 71%)**	 ***Inia geoffrensis*** **(S = 88%)**	 ***Stenella clymene*** **(PN = 68%)**	 ***Stenella longirostris*** **(PN = 33%)**
 ***Stenella frontalis*** **(SS = 30%)**	 ***Stenella attenuata*** **(PN = 27%)**	 ***Pseudorca crassidens*** **(PS = 20%)**	 ***Balaenoptera edeni*** **(SS = 20%)**

Appendix 2

A. Results of correlations tests between the variables fishers' knowledge (average number of DNK answers), fishers' social parameters and the topics 'Interactions', 'Feeding habits' and 'Predators' of cetaceans.

Correlations (Pearson coefficient) (p<0.05)	**Soure**		**Ponta Negra**		**São Sebastião**		**Pântano do Sul**		**Among the four areas**	
	r	*p*	r	*p*	r	*p*	r	*p*	r	*p*
Fishers' age x DNK answers	0.10	0.52	-0.49	0.14	0.02	0.89	0.19	0.36	-	-
Fishing time x DNK answers	-0.05	0.74	-0.22	0.18	-0.05	0.66	0.33	0.10	-	-

Fishers' schooling x DNK answers	0.24	0.12	0.013	0.94	0.04	0.75	-0.27	0.19	-	-
Interactions (n. of species) x DNK answers	-	-	-	-	-	-	-	-	0.29	0.70
Feeding habits (n. of species) x DNK answers	-	-	-	-	-	-	-	-	**0.98**	**0.01**
Predators (n. of species) x DNK answers	-	-	-	-	-	-	-	-	0.78	0.21
N. of prey x N. of feeding behavior									0.81	0.18

B. Results of ANOVA tests between:

1) the variables fishers' knowledge (average number of DNK answers) and surveyed topics ('Interactions', 'Feeding habits' and 'Predators' of cetaceans);
2) the variables fishers' knowledge (average number of citations) and different forms of Interactions (competition, cooperation, predation, accidental capture, intentional use and social interactions).

ANOVA (p = 0.05)	**F**	**p**
1) Average number of DNK answers / topic / area	1.62	0.27
2) Average number of citations / topics/area	**16.46**	**< 0.0001**

C. Results of the Correlation Matrix among the variable fishers' knowledge (% of recognized species) and the variables: informants, total interactions, accidental catch, intentional use, prey items, feeding behaviors, predators.

	% Species recognized	**% of informants**	**% of Total interactions**	**% of accidental catch**	**% intentional use**	**% of prey items**	**% of feeding behaviors**	**% of predators**
Soure	60	23	42	36	9	22	29	13
Ponta Negra	77	21	18	16	5	24	21	14
São Sebastião	91	41	24	28	0	38	33	59
Pântano do Sul	40	15	16	19	6	17	17	14

	Columns 1 and 2	Columns 1 and 3	Columns 1 and 4	Columns 1 and 5	Columns 1 and 6	Columns 1 and 7	Columns 1 and 8	Columns 2 and 3	Columns 2 and 4	Columns 2 and 5	**Columns 2 and 6**	Columns 2 and 7	Columns 2 and 8	Columns 3 and 4
n (pares) =	4	4	4	4	4	4	4	4	4	4	4	4	4	4
r (Pearson) =	0.8493	0.0384	0.1119	-0.7082	0.9072	0.7049	0.7259	0.1711	0.4005	-0.7798	**0.9864**	0.8806	0.9482	0.935
IC 95% =	-0.61 a 1.00	-0.96 a 0.96	-0.95 a 0.97	-0.99 a 0.79	-0.42 a 1.00	-0.79 a 0.99	-0.78 a 0.99	-0.95 a 0.97	-0.91 a 0.98	-1.00 a 0.72	0.49 a 1.00	-0.52 a 1.00	-0.15 a 1.00	-0.26 a 1.00
IC 99% =	-0.87 a 1.00	-0.99 a 0.99	-0.99 a 0.99	-1.00 a 0.93	-0.79 a 1.00	-0.94 a 1.00	-0.93 a 1.00	-0.98 a 0.99	-0.97 a 1.00	-1.00 a 0.91	-0.09 a 1.00	-0.83 a 1.00	-0.64 a 1.00	-0.71 a 1.00
R2 =	0.7214	0.0015	0.0125	0.5015	0.8231	0.4969	0.527	0.0293	0.1604	0.6082	**0.9729**	0.7755	0.8991	0.8742
t =	2.2756	0.0543	0.1592	-1.4184	3.0506	1.4055	1.4928	0.2456	0.6182	-1.7618	8.4797	2.6287	4.2213	3.7286
DF =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
(p) =	0.1506	0.9616	0.8881	0.2918	0.0927	0.295	0.274	0.8289	0.5995	0.2201	**0.0136**	0.1193	0.0518	0.065
	0.3478	0.0433	0.0543	0.1571	0.447	0.221	0.234	0.0638	0.1086	0.245	0.8013	0.395	0.567	0.5206
Correlation Matrix	0.1405	0.0744	0.0563	1.0303	0.2074	0.0675	0.0746	0.0432	0.0005	1.7268	0.5656	0.171	0.3042	0.2645

	Columns 3 and 5	Columns 3 and 6	Columns 3 and 7	Columns 3 and 8	Columns 4 and 5	Columns 4 and 6	Columns 4 and 7	Columns 4 and 8	Columns 5 and 6	Columns 5 and 7	Columns 5 and 8	Columns 6 and 7	Columns 6 and 8	Columns 7 and 8
n (pares) =	4	4	4	4	4	4	4	4	4	4	4	4	4	4
r (Pearson) =	0.4819	0.047	0.6172	-0.077	0.2259	0.2584	0.765	0.2189	-0.8418	-0.3904	-0.8998	0.8119	0.9431	0.7167
IC 95% =	-0.89 a 0.99	-0.96 a 0.96	-0.85 a 0.99	-0.97 a 0.95	-0.94 a 0.98	-0.93 a 0.98	-0.74 a 0.99	-0.94 a 0.97	-1.00 a 0.62	-0.98 a 0.91	-1.00 a 0.45	-0.68 a 1.00	-0.19 a 1.00	-0.79 a 0.99
IC 99% =	-0.97 a 1.00	-0.99 a 0.99	-0.95 a 1.00	-0.99 a 0.99	-0.98 a 0.99	-0.98 a 0.99	-0.92 a 1.00	-0.98 a 0.99	-1.00 a 0.87	-0.99 a 0.97	-1.00 a 0.80	-0.90 a 1.00	-0.67 a 1.00	-0.93 a 1.00
R2 =	0.2322	0.0022	0.381	0.0059	0.051	0.0668	0.5852	0.0479	0.7086	0.1524	0.8097	0.6591	0.8894	0.5137
t =	0.7777	0.0665	1.1094	-0.1093	0.328	0.3783	1.6798	0.3172	-2.2056	-0.5996	-2.9174	1.9665	4.0108	1.4535
DF =	2	2	2	2	2	2	2	2	2	2	2	2	2	2
(p) =	0.5181	0.953	0.3827	0.923	0.7741	0.7416	0.235	0.7811	0.1581	0.6096	0.1001	0.1881	0.0569	0.2832
	0.1298	0.0445	0.177	0.0266	0.0731	0.0789	0.262	0.0719	0.3994	0.0249	0.7835	0.3041	0.5479	0.2281
Correlation Matrix	0.0153	0.0722	0.0434	0.1087	0.032	0.0257	0.09	0.0334	3.4338	0.2789	12.2637	0.1141	0.2874	0.0714

	Column 1	**Column 2**	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
Column 1	1	---	---	---	---	---	---	---
Column 2	0.8493	1	---	---	---	---	---	---
Column 3	0.0384	0.1711	1	---	---	---	---	---
Column 4	0.1119	0.4005	0.935	1	---	---	---	---
Column 5	-0.7082	-0.7798	0.4819	0.2259	1	---	---	---
Column 6	0.9072	**0.9864**	0.047	0.2584	-0.8418	1	---	---
Column 7	0.7049	0.8806	0.6172	0.765	-0.3904	0.8119	1	---
Column 8	0.7259	0.9482	-0.077	0.2189	-0.8998	0.9431	0.7167	1

Appendix 3

List of prey items of cetaceans, according to fishers' citations (in %) (Fishes' biological names from Froese and Pauly 2011).

Biological family or Group	Biological species	English common names	Folk names	Predators (cetaceans) cited by fishers (%).											
				E. australis	*M. novaeangliae*	*B. edeni*	*P. crassidens*	*T. truncatus*	*S. guianensis*	*S. frontalis*	*S. clymene*	*S. attenuata*	*S. longirostris*	*P. blainvillei*	*I. geoffrensis*
Argonautidae	*Argonauta sp.*	Argonauta	Argonauta							1					
Ariidae	*Bagre bagre*	Coco sea catfish	Bagre, Bandeirado					2.5							12.5
	Hexanematichthys parkeri	Gillbacker sea catfish	Gurijuba												5
	Hexanematichthys proops	Crucifix sea catfish	Uritinga						12.5						2.5
Belonidae	*Tylosurus acus*	Needlefish	Timbale							1					
Bothidae	*Paralichthys brasiliensis*	Flounder	Linguado	4											
Carangidae	*Caranx crysos*	Jack	Xaréu					2.5	1	1					
	Oligoplites palometa	Maracaibo leatherjacket	Timbiro, Guaivira					2.5	1	1					
	Caranx latus	Horse-eye jack	Garajuba								8.3				
	Decapterus sp.	Scad	Xixarro	4											
	Selar crumenophthalmus	Big-eye scad	Garapau					2.8	1						
Carcharhinidae	*Carcharhinus sp.*	Shark	Cação						1						
Clupeidae	*Sardinella brasiliensis*	Sardine	Sardinha	25.8	14.3	10	8	18.4	17.7	5.7				15.2	2.5

	Opisthonema oglinum				33.3				7.7		8.3	2.8	5.5		
	Brevoortia pectinata	Menhaden	Savelha					1	1					2.8	
Dasyatidae	*Dasyatis americana*	Southern stingray	Arraia				4								
Engraulidae	*Anchoa sp.*	Anchovy	Manjuba	19.2	8.5	5.7		8.6	14.3	2.8		2.8	2.8	28	
Exocoetidae	*Exocoetus volitans*	Flyingfish	Voador					1.9	2.8	2.8	5.5	2.8	2.8		
	Hyporhamphus sp.	Flyingfish	Panaguaiú					2.8		1			1		
Gempylidae	*Gempylus serpens*	Snake mackerel	Lanceta	4											
Gerreidae	*Eucinostomus sp.*	Mojarra	Carapeba					5.5	5.5		2.8				
Gobiidae	*Gobioides grahmae*	Goby	Amoré					2.5	52.5						
Loliginidae	*Loligo sp.*	Squid	Lula	2.8	2.8	1		5	4	11.4	16.7	2.8	7.7		
Lutjanidae	*L. purpureus*	Southern red snapper	Pargo					2.8			2.8	5.5	2.8		
Mugilidae	*Mugil sp., Mugil platanus*	Mullet	Tainha					44.7	60.5	14.2	22.2	2.8	5.5	13.2	7
	Mugil curema	White mullet	Pratiqueira					12.5	18.8	2.8			2.8	10	12.5
Octopoda	*Octopus insularis*	Octopus	Polvo								2.8				
Penaeidae	*Xiphopenaeus kroyeri, Litopenaeus schimitti*	Shrimp	Camarão	4.5	8.3	1		2.8	3.3				2.8		2.5
Pimelodidae	*Brachyplatystoma flavicans*	Gilded catfish	Dourada						10						47
	Brachyplatystoma vaillantii	Laulao catfish	Piramutaba, Piaba						12.5						7.5
	Brachyplatystoma filamentosum	Kumakuma	Filhote, Cadete												15

	Hypophtalmus sp.	Highwater man catfish	Mapará										7.5	
Pomatomidae	*Pomatomus saltatrix*	Bluefish	Enchova			4	31.4	21.4				6.5		
Sciaenidae	*Cynoscion leiarchus*	Croaker	Pescada					2.8	2.8			2.8		10
	Micropogonias furnieri	Croaker	Corvina									1		
	Paralonchurus brasiliensis	Banded-croaker	Maria-Luíza									1		
	Menticirrhus sp.	Kingcroaker	Betara					1						
	Pogonias cromis	Black drum	Piraúna							2.8				
	Larimus breviceps	Drum	Oveva									2.8		
Scombridae	*Sarda sarda*	Atlantic bonito	Bonito				2.8	2.6	2.8	5.5	5.5			5
	Scomberomorus cavalla	King mackerel	Cavala				5.5		8.3	2.8	5.5			
	Scomberomorus brasiliensis	Spanish mackerel	Serra, Sororoca				6.2	5.5	22.2	8.3	8.3			
	Thunnus alalunga	Albacore	Albacora				2.8				2.8			
Serranidae	*Epinephelus marginatus*	Grouper	Garoupa					1						
Sphyraenidae	*Sphyraena guachancho*	Barracuda,	Bicuda				1	2.8						
Stromateidae	*Peprilus paru*	Butterfish	Gordinho					1						
Trichiuridae	*Trichiurus lepturus*	Largehead hairtail	Espada		2.8		1.9	5.6				1		
Scyphozoa (classe)		Jellyfish	Água viva	4										
Algae		Algae	Algas		2.8									
Plancton			Plâncton	4.5										

Appendix 4

Comparison between fishers' LEK on cetaceans (feeding habits, predators and bycatch) and the scientific literature. Fishers' concordant information to scientific literature is highlighted.

Species / Topics	Fishers' LEK	Information found in the scientific literature on cetaceans' ecology
Eubalaena australis		Bastida *et al*. (2007), Jefferson *et al.* (2008):
Prey items (most cited)	*Sardinella brasiliensis / Pellona harroweri, Anchoa* sp., *Loligo* sp., small shrimps, plankton.	Planktonic diet (small crustaceans, Ctenophora)
Feeding behavior	They engulf a great volume of water containing small fish schools and eat only small fishes, one fish by time, because their throat is narrow.	Filter feeders, they swim with their mouth wide open to filter the plankton.
Bycatch	They can carry the fixed trap nets and gillnets for kilometers. The calfs can be entangled in fixed trap nets.	The calves can be entangled in gillnets.
Megaptera novaeangliae		Clapham, P. J. (2000), Bastida *et al.* (2007), Jefferson *et al.* (2008):
Prey items (most cited)	*Sardinella brasiliensis / Pellona harroweri, Anchoa* sp., small shrimps	krill, small schooling fishes (sardines, anchovies)
Feeding behavior	They engulf a great volume of water containing small fish schools and eat only small fishes, one fish by time, because their throat is narrow.	Lunge feeders, they can encircle fish schools with bubble nets, using cooperating feeding techniques.
Bycatch	They carry the gillnets for kilometers.	They can entangle in gillnets.
Tursiops truncatus		Siciliano *et al.* (1994), Santos *et al.* (2002), Culik (2004), Bastida *et al.* (2007), Bearzi *et al.* (2008), Jefferson *et al.* (2008), Simões-Lopes *et al.* (2008):
Prey items (most cited)	*Mugil platanus*, *M. curema*, *Sardinella brasiliensis / Pellona harroweri, Anchoa* sp., *Scomberomorus brasiliensis*, *Pomatomus saltatrix, Loligo* sp.	*Trichiurus lepturus, Mugil* sp., *Octopus vulgaris, Loligo plei, Loligo sanpaulensis,* Scombridae

Feeding behavior	They throw up the fish, scale it and then catch it with their mouths. They drive the fish to the shore, grouping the fish.	They can show cooperative feeding association with humans. Cooperative herding of fish schools is reported in many areas.
Bycatch	They can entangle in thicker surface gillnets ('caçoeira').	They can be caught by gillnets, drift nets and trawl fisheries.
Stenella clymene		Jefferson and Curry (2003), Culik (2004), Bastida *et al.* (2007), Jefferson *et al.* (2008):
Prey items (most cited)	*Mugil platanus, Scomberomorus brasiliensis, S. cavalla, Opisthonema oglinum, Caranx latus, Loligo* sp.	No concordant prey species. (Authors report fishes from the families Myctophidae, Argentinidae, Bregmacerotidae)
Feeding behavior	They throw up the fish, scale it and then catch it with their mouths. They steal fish from the net.	They can feed in groups, using cooperative techniques.
Bycatch	They sometimes entangle in gillnets when they are stealing fish from the nets.	They can be caught by gillnets and purse seine.
Sotalia guianensis		Siciliano *et al.* (1994), Di Beneditto *et al.* 2001, Santos *et al.* (2002), Beltrán-Pedreros e Pantoja (2006), Bastida *et al.* (2007), Alves e Rosa (2008), Freitas-Netto and Di Beneditto (2008), Jefferson *et al.* (2008), Sholl *et al.* (2008), Flores and Da Silva (2009), Da Silva and Martin (2010):
Prey items (most cited)	*Mugil platanus, M. curema, Sardinella brasiliensis / Pellona harroweri, Opisthonema oglinum, Anchoa* sp., *Pomatomus saltatrix, Trichiurus lepturus, Scomberomorus brasiliensis, Eucinostomus* sp., *Brachyplatystoma vaillantii, B. flavicans, Hexanematichthys proops,* Gobiidae, *Loligo* sp.	*Trichiurus lepturus, Anchoa filifera, Mugil* sp., *Sardinella brasiliensis, Brachyplatystoma vaillantii, Loligo plei, Eucinostomus* sp., Gobiidae
Feeding behavior	They throw up the fish, scale it and then catch it with their mouths. They drive the fish to the shore, grouping the fish. They steal fish from the net and eat only the posterior part of the fish, leaving its head in the net. In Soure, they dig the muddy bottom to eat 'amoré' (Gobiidae).	Feed in groups, using cooperative techniques. They can surround or push a shoal toward the beach or the fishing gear.
Bycatch	They entangle in thicker ('caçoeira') or usual surface gillnets, or in drifting or surrounding nets. Usually from one to six animals can be netted each time.	They can be caught by gillnets, fixed trap nets, trawlers and longlines.
Pontoporia blainvillei		Siciliano *et al.* (1994), Di Beneditto *et al.* (2001), Secchi *et al.* (2004), Bassoi (2005), Santos e Netto (2005), Cremer *et al.* (2006), Bastida *et al.* (2007), Jefferson *et al.* (2008):

Prey items (most cited)	*Mugil platanus, Sardinella brasiliensis / Pellona harroweri*, *Anchoa* sp., *Pomatomus saltatrix, Loligo* sp.	*Anchoa fillifera, Pellona harroweri, Sardinella brasiliensis,Isopisthus parvipinnis, Loligo sanpaulensis*
Feeding behavior	They are used to eat fishes that are entangled in the net. They do not eat fishes that form schools.	Feed near the bottom, they can forage cooperatively.
Bycatch	They entangle in surface and bottom gillnets, fixed trap nets and longlines.	They can be caught by gillnets, fixed trap nets, trawlers and longlines.
Inia geoffrensis		Best and da Silva (1993), Bastida *et al.* (2007), Jefferson *et al.* (2008), Da Silva (2009) and Da Silva and Martin (2010):
Prey items (most cited)	*Brachyplatystoma flavicans, B. filamentosum, B. vaillantii, Bagre bagre, Mugil curema, M. platanus, Cynoscion* sp., *Hypophtalmus* sp.	large variety of fishes, crabs and river turtles
Feeding behavior	They eat only the posterior part of the fish, leaving its head in the net. They steal fish from the nets and longlines.	Feed near the bottom, in shallow waters.
Bycatch	They entangle in thicker gillnets ('caçoeira')	They can be caught by seine, fixed and drifiting gillnets.

CONCLUSÕES GERAIS

O estudo sobre o conhecimento ecológico local de 171 pescadores distribuídos ao longo da costa brasileira nos possibilitou reunir informações importantes sobre a ecologia de 18 espécies de cetáceos e suas interações com as atividades de pesca, além entender como os pescadores categorizam os cetáceos em uma hierarquia taxonômica.

Entre as 17 espécies de cetáceos nomeadas e classificadas pelos pescadores, duas são consideradas vulneráveis à extinção (*Physeter macrocephalus* e *Pontoporia blainvillei*) e outras nove estão categorizadas como espécies com dados insuficientes (*Balaenoptera edeni, Orcinus orca, Globicephala macrorhynchus, Sotalia guianensis, Stenella longirostris, Stenella frontalis, Stenella clymene, Delphinus capensis* e *Inia geoffrensis*) (IUCN 2010). Neste contexto, as informações fornecidas pelos pescadores sobre estas espécies contribuem para preencher lacunas importantes sobre a biologia, a ecologia e outros aspectos relacionados à conservação destes cetáceos.

Diferenças socioeconômicas e características locais da pesca não causaram variações no conhecimento ecológico local (LEK) dos pescadores entre as áreas estudadas. Entretanto, variações em parâmetros oceanográficos, como a largura da plataforma continental, a profundidade e a salinidade do mar, parecem afetar a ocorrência de cetáceos, causando variações no LEK em cada área. Soure foi a única área onde a dependência direta sobre recursos naturais influenciou no conhecimento dos pescadores.

Comparando as etnotaxonomias de cetáceos obtidas em cada área de estudo, percebe-se que:

- Os principais fatores que influenciaram no reconhecimento das espécies de cetáceos pelos pescadores foram as distribuições temporais e espaciais de cada. Desta forma, as espécies mais abundantes foram as mais reconhecidas.
- A mídia também interferiu no reconhecimento dos cetáceos, já que alguns pescadores reconheceram espécies que haviam visto somente pela televisão;

- As espécies mais citadas foram as mais salientes culturalmente e ecologicamente, incluindo as duas espécies que foram comuns às quatro áreas de estudo (*Sotalia guianensis* e *Tursiops truncatus*);
- As características morfológicas e comportamentais dos cetáceos foram os principais fatores que influenciaram na sua classificação em formas de vida e em grupos;
- A alta porcentagem de binomiais encontrados para as 37 etno-espécies de cetáceos pode ser explicada pela necessidade de diferenciar entre espécies morfologicamente muito similares.

Estes resultados demonstram que, em relação às nove espécies de cetáceos menos conhecidas, os pescadores discordaram sobre seus nomes, provavelmente devido a um menor conhecimento sobre estas espécies. Em relação às outras oito espécies, de 35 a 100% dos pescadores (dependendo da espécie) forneceram os mesmos nomes específicos para cada uma. O grau de concordância sobre um nome específico foi maior para as espécies mais conhecidas pelos pescadores.

Os estudos em Etnotaxonomia podem ser um método eficiente para pesquisar sobre as interações entre a pesca local e os cetáceos, já que a maioria dos pescadores reconheceram as espécies mais comuns e que mais interagem com eles. Estes estudos também podem ser utilizados para aumentar as oportunidades de diálogo entre gestores, pesquisadores e pescadores, introduzindo tópicos relacionados à conservação dos cetáceos, além de levar em conta o conhecimento dos pescadores em futuras ações de manejo.

Em relação ao conhecimento dos pescadores sobre a ecologia dos cetáceos (Etnoecologia), podemos concluir que os pescadores de Soure, Ponta Negra, São Sebastião e Pântano do Sul:

- Conhecem as áreas de ocorrência, os hábitats preferenciais e os tamanhos de grupo de 16 espécies de cetáceos, tendo relatado 112 pontos de ocorrência;
- Conhecem os padrões de sazonalidade para 13 espécies;
- Conhecem pouco sobre a reprodução de sete espécies.

A maioria das informações obtidas dos pescadores sobre a ecologia dos cetáceos concorda com a literatura científica. Alguns pontos discordantes sobre a reprodução do golfinho-de-Clymene (*Stenella clymene*), do boto-rosa (*Inia geoffrensis*) e da toninha (*P. blainvillei*) merecem ser investigados posteriormente.

Em relação às interações envolvendo cetáceos, obtidos dados sobre 12 espécies e verificamos que:

- A captura acidental (bycatch) de cetáceos em equipamentos de pesca é a interação mais mencionada, provavelmente devido aos impactos negativos que ela causa à pesca;
- Os comportamentos alimentares de nove espécies de cetáceos foram descritos pelos pescadores;
- As presas preferenciais de 12 espécies de cetáceos também são conhecidas pelos pescadores.

No que diz respeito ao hábito alimentar dos cetáceos, a comparação entre o LEK e a literatura científica apontou muitas concordâncias, especialmente em relação às presas utilizadas. Contudo, algumas informações relativas ao comportamento alimentar e presas preferenciais do boto-rosa (*I. geoffrensis*) e do golfinho-de-Clymene (*S. clymene*) não foram totalmente concordantes. Uma vez que a literatura não é detalhada sobre alguns dos tópicos abordados, sugerimos que pesquisas posteriores sejam feitas para confirmar se o conhecimento ecológico dos pescadores é correto e poderia suprir essas lacunas.

De uma maneira geral, o conhecimento dos pescadores obtido nesse estudo foi consistente e comparável entre as áreas estudadas. Ele forneceu detalhes importantes que podem complementar o conhecimento científico sobre as espécies estudadas e revelou alguns pontos importantes relacionados ao manejo pesqueiro e a conservação dos cetáceos, que precisam ser considerados. Nesse contexto, nossas sugestões para cada área de estudo são as seguintes:

- Soure: realização de campanhas educativas em escolas e nas comunidades, integrando os aspectos culturais (lendas) do 'boto' (*I.*

geoffrensis) à sua importância ecológica nos ecossistemas locais, a fim de iniciar uma mudança de atitude das pessoas em relação a esta espécie. Além disso, os gestores ambientais locais deveriam formular estratégias para envolver os pescadores interessados em programas para o monitoramento do uso intencional de golfinhos. Ao participar destes programas, os pescadores coletariam dados sobre as áreas e a freqüência das capturas intencionais, aumentando sua percepção sobre este problema e contribuindo para alimentar um banco de dados que poderia apoiar as iniciativas educacionais e as medidas regulatórias aplicadas a essas capturas ilegais. Como compensação pelo tempo e energia investidos nesses programas, os pescadores receberiam um "pagamento por serviços ambientais" (PSA), como um incentivo econômico à sua participação.

- Ponta Negra e São Sebastião: para abordar o problema das capturas acidentais de pequenos cetáceos sugerimos, além de campanhas educativas, a criação de grupos de trabalho integrando gestores, pesquisadores e pescadores, com o intuito de definir as areas críticas de capturas e espécies mais afetadas, como mostrado neste estudo. Outro tópico a ser abordado por estes grupos de trabalho seria o desenvolvimento de alternativas quanto ao uso, ao "design" e ao tamanho das redes de espera mais impactantes, como sugerido por Spencer *et al.* (2000). É fundamental que estes grupos sejam pequenos e estejam abertos a participação de qualquer pescador interessado.
- Pântano do Sul: as sugestões para abordar o problema das capturas acidentais são as mesmas indicadas para as áreas acima. Contudo, as perdas econômicas causadas aos pescadores pelas baleias francas localmente protegidas necessitam ser quantificadas pelas autoridades e compensadas economicamente aos pescadores. Sugerimos também a realização de oficinas educativas abordando a superposição entre a APA Baleia Franca e os pontos de pesca

tradicionalmente usados pelos pescadores da região, no sentido de discutir estratégias para minimizar potenciais conflitos.

- Em relação a todas as áreas estudadas propomos que o conhecimento dos pescadores sobre as áreas de ocorrência, sazonalidade e capturas acidentais de cetáceos seja considerado nas discussões para delimitação de áreas marinhas protegidas, uma vez que os pescadores provaram possuir conhecimento detalhado e confiável sobre estes aspectos ecológicos.

A conservação dos mamíferos marinhos é uma questão sócio-ecológica, e a integração do conhecimento local ao científico possibilita uma nova abordagem ao manejo e conservação dos recursos naturais.

LITERATURA CITADA

Alarcon, D. T., R. C. S. Costa, A. Schiavetti. 2009. Abordagem etnoecológica da pesca e captura de espécies não-alvo em Itacaré, Bahia (Brasil). *Boletim do Instituto de Pesca* 35(4): 675 – 686.

Alves, R. R. N. and I. L. Rosa. 2008. Use of Tucuxi Dolphin Sotalia fluviatilis for Medicinal and Magic/Religious Purposes in North of Brazil. *Human Ecology* 36:443-447.

Anderson Jr., E. N. 1969. Sacred fish. *Man, New Series* 4(3):443-449.

Araújo, J.P.D., J.Z.D.O. Passavante, and A.D.S. Souto. 2001. Behavior of the estuarine dolphins, *Sotalia guianensis*, at Dolphin Bay - Pipa - Rio Grande do Norte - Brasil. *Tropical Oceanography* 31(2):101–112.

Aristotle. 350 B.C. *The history of animals*.

[online] http://classics.mit.edu//Aristotle/history_anim.html

Atran, S. 1990. Cognitive foundations of Natural History – Towards an anthropology of Science. Cambridge: Cambridge University Press.

Atran, S. 1999. Itzaj Maya folkbiological taxonomy: cognitive universal and cultural particulars. In *Folkbiology*. D. L. Medin and S. Atran, eds. Pp. 119-204. Cambridge: MIT Press.

Atran S., D. Medin, and N. Ross. 2004. Evolution and devolution of knowledge: a tale of two biologies. *Journal of the Royal Anthropological Institute* 10:395-420.

Ayres, M., M. Ayres Jr., D. L. Ayres, and A. A. S. Santos. 2007. Biostat Software.

Baird, R. W. 2000. The killer whale: foraginf specializations and group hunting. In *Cetacean Societies – Field studies of dolphins and whales.* Mann, J., Connor, R. C., Tyack, P. L. and Whitehead, H. (eds.), p. 127-153. Chicago: The University of Chicago Press.

Barthem, R. B. 1990. Ecologia e pesca da piramutaba (Brachyplatystoma vaillantii). PhD Thesis, Universidade Estadual de Campinas, 286p.

Bastida, R., D. Rodríguez, E. Secchi, and V. da Silva. 2007. *Mamíferos Acuáticos de Sudamérica y Antártida.* Buenos Aires: Vázquez Mazzini Editores.

Bearzi, G., C. M. Fortuna, R. R. Reeves. 2008. Ecology and conservations of common bottlenose dolphins Tursiops truncatus in the Mediterranean Sea. *Mammal Review* 39(20):92-123.

Begossi, A. 1993. Ecologia humana: um enfoque das relações homem-ambiente. *Interciência* 18(3):121-132.

Begossi, A. 1995. Fishing spots and sea tenure: incipient forms of local management in Atlantic Forest coastal communities. *Human Ecology* 23(3):387-406.

Begossi, A. 1998. Property rights for fisheries at different scales: applications for conservation in Brazil. *Fisheries Research* 34:269-278.

Begossi, A. 2004. *Ecologia de pescadores da Mata Atlântica e da Amazônia.* Ed. Hucitec, São Paulo.

Begossi, A. 2008. Local knowledge and training towards management. *Environment, Development and Sustainability* 10:591-603.

Begossi, A. 2010. Small-scale fisheries in Latin America: Management Models and Challenges. *MAST* 9(2): 7-31.

Begossi A. and J. C. Garavello. 1990. Notes on ethnoichthyology of fisherman from Tocantis River. *Acta Amazônica* 20:341-352.

Begossi A. and J. L. Figueiredo. 1995. Ethnoichthyology of southern coastal fishermen: cases from Búzios Island and Sepetiba Bay (Brazil). *Bulletin of Marine Science* 56(2):710-717.

Begossi, A., N. Hanazaki, J. Y. Tamashiro. 2002. Medicinal plants and the Atlantic Forest (Brazil): knowledge, use and conservation. Human Ecology 30(3):281-299.

Begossi, A. and R. A. M. Silvano. 2008. Ecology and ethnoecology of dusky grouper [garoupa, *Epinephelus marginatus* (Lowe, 1834)] along the coast of Brazil. *Journal of Ethnobiology and Ethnomedicine* 2008, 4:20 doi:10.1186/1746-4269-4-20

Begossi, A., M. Clauzet, J. L. Figueiredo, L. Garuana, R. V. Lima, P. F. Lopes, M. Ramires, A. L. Silva, and R. A. M. Silvano. 2008. Are Biological Species and Higher-Ranking Categories Real? Fish Folk Taxonomy on Brazil's Atlantic Forest Coast and in the Amazon. *Current Anthropology* 49(2):291-306.

Begossi, A., P. F. M. Lopes, L. E. C. Oliveira, and H. Nakano. 2010. Ecologia de pescadores artesanais da Baía da Ilha Grande. Ed. RIMA, FAPESP, São Carlos.

Begossi, A., S. V. Salivonchyk, L. G. Araújo, T. B. Andreoli, M. Clauzet, C. M. Martinelli, A. G. L. Ferreira, L. E. C. Oliveira, R. A. M. Silvano. 2011. Ethnobiology of snappers (Lutjanidae): target species and suggestions for management. *Journal of Ethnobiology and Ethnomedicine* 7:11.

Beltrán-Pedreros, S., and T. M. A. Pantoja. 2006. Feeding habits of Sotalia fluviatilis in the Amazonian estuary. *Acta Scientiarum - Biological Sciencies* 28(4):389-393.

Berkes, F. 2008. *Sacred Ecology*. 2nd edition. New York: Routledge.

Berkes, F. 2009. Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management* 90:1692–1702.

Berkes, F., J. Colding, C. Folke. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10(5), 1251-1262.

Berkes, F., R. Mahon, P. McConney, R. Pollnac, R. Pomeroy. 2001. *Managing Small-Scale Fisheries: Alternative Directions and Methods*. Ottawa: Int. Dev. Res. Cent. 250 pp.

Berlin, B. 1973. Folk systematics in relation to biological classification and nomenclature. *Annual Review of Ecology and Systematics* 4:250-271.

Berlin, B: 1992. Ethnobiological classification – Principles of categorization of plants and animals in traditional societies. New Jersey: Princeton University Press.

Best, R. C. and V. M. F. da Silva. 1993. Inia geoffrensis. *Mammalian Species* 426:1-8.

Boyd, R. and P. J. Richerson. 1985. *Culture and the evolutionary process.* Chicago: The University of Chicago Press.

Brown, C. H. 1984. *Language and living things.* New Jersey: Rutgers University Press.

Brown, C. H. 1985. Mode of subsistence and folk biological taxonomy. *Current Anthropology* 26(1):43-62.

Bruhn, J. G. 1974. Human ecology: a unifying science? *Human Ecology* 2(2):105-125.

Busnel, R. G. (1973). Symbiotic relationship between man and dolphins. *Transactions of the New York Academy of Science, 35,* 112–131.

Campbel, L. M. and M. L. Cornwell. 2008. Human dimensions of bycatch reduction technology: current assumptions and directions for future research. *Endangered Species Research* 5: 325–334.

Carter, B. T. G. and E. A. Nielsen. 2011. Exploring ecological changes in Cook Inlet beluga whale habitat though traditional and local ecological knowledge of contributing factors for population decline. *Marine Policy* 35:299–308.

Cascudo, L. C. 2001. Dicionário do Folclore Brasileiro – 11a. Edição. São Paulo: Editora Global.

Castro, F. From myths to rules: The evolution of the local management in the Lower Amazonian floodplain. Environment and History 8(2): 197-216.

Clapham, P. J. 2000. The humpback whale. In *Cetacean Societies – Field studies of dolphins and whales.* Mann, J., Connor, R. C., Tyack, P. L. and Whitehead, H. (eds.), p. 173-196. Chicago: The University of Chicago Press.

Clement, D. 1995. Why is taxonomy utilitarian? *Journal of Ethnobiology* 15(1):1-*44.*

Connor, R. C. 2000. Group living in whales and dolphins. In *Cetacean Societies – Field studies of dolphins and whales.* Mann, J., Connor, R. C., Tyack, P. L. and Whitehead, H. (eds.), p. 199-218. Chicago: The University of Chicago Press.

Connor, R. C., K. S. Norris. 1982. Are dolphins reciprocal altruists? *The American Naturalist* 119(3):358-374.

Connor, R. C., R. R. Wells, J. Mann, A. J. Read. 2000. The bottlenose dolphin: social relationship in a fission-fusion society. In *Cetacean Societies – Field studies of dolphins and whales.* Mann, J., Connor, R. C., Tyack, P. L. and Whitehead, H. (eds.), p. 91-126. Chicago: The University of Chicago Press.

Cremer, M.J., F.A.S. Hardt, A.J.T. Junior. 2006. Evidence of epimeletic behavior involving a *Pontoporia blainvillei* calf (Cetacea, Pontoporidae). *Biotemas*, **19**, 83–86.

Cremer, M. J. and P. C. Simóes-Lopes. 2008. Distribution, abundance and density of franciscanas (Pontoporia blainvillei) (Cetacea: Pontoporiidae), in Babitonga bay, Southern Brazil. *Revista Brasileira de Zoologia* 25(3): 397-402.

Crowder, L. B., E. L. Hazen, N. Avissar, R. Bjorkland, C. Latanich, and M. B. Ogburn. 2008.The impacts of fisheries on marine ecosystems and the transition to ecosystem-based management. *Annual Review of Ecology, Evolution and Systematics* 39:259–78.

Cruz, M. E. M. 1999. *Soure – Pérola do Arquipélago do Marajó.* Belém: Empresa Jornalística e Editora Gráfica M. M. Lima Ltda.

Culik, B. 2004. *Review of Small Cetaceans. Distribution, Behaviour, Migration and Threats.* Marine Mammal Action Plan / **Regional Seas Reports and Studies no. 177.** UNEP / CMS Secretariat, Bonn, Germany. 343 pages.

Culik, B. 2010. Odontocetes. The toothed whales: "Inia geoffrensis". "Stenella clymene". Report of UNEP/CMS Secretariat, Bonn, Germany.

Danilewicz, D., E. R. Secchi, P. H. Ott, I. B. Moreno, M. Bassoi, M. Borges-Martins. 2009. Habitat use patterns of franciscana dolphins (Pontoporia blainvillei) off southern Brazil in relation to water depth. *Journal of the Marine Biological Association of the United Kingdom* 89(5), 943–949.

Da Silva, V. 2009. Amazon River Dolphin – *Inia geoffrensis*. In: *Encyclopedia of marine mammals*, 2nd Ed. Perrin, W. F., Würsig, B., Thewissen, J. G. M. (eds.). p. 26-28. Amsterdam: Academic Press.

Da Silva, V. and A. R. Martin. 2010. Status, threats, conservation initiatives and possible solutions for *Inia geoffrensis* and *Sotalia fluviatilis* in Brazil. In: Trujillo, F., Crespo, E., Van Damme, P.A. & J.S. Usma (Editors). The Action Plan for South American River Dolphins 2010 – 2020. WWF, Fundación Omacha, WDS, WDCS, Solamac. Bogotá, D.C., Colombia. 249 pp.

De Boer, W. F., A. M. P. van Schie, D. F. Jocene, A. B. P. Mabote, A. Guissamulo. 2001. The impact of artisanal fishery on a tropical intertidal benthic fish community. Environmental Biology of Fishes 61:213-229.

DHN (Diretoria de Hidrografia e Navegação) - Marinha do Brasil. 2010. *Cartas náuticas digitais*. [online] http://www.mar.mil.br/dhn/chm/cartas/download/cartasbsb/cartas_eletronicas_Internet.htm

Diamond, J. 1966. Zoological classification of a primitive people. Science 151:1102-1104.

Diamond, J. and K. D. Bishop. 1999**.** Ethno-ornithology of the Ketengban people, Indonesian New Guinea. In *Folkbiology*. D. L. Medin and S. Atran, eds. Pp. 18-25. Cambridge: MIT Press.

Di Beneditto, A. P. M. 2004. Presence of Franciscana Dolphin (*Pontoporia blainvillei*) Remains in the Stomach of a Tiger Shark (*Galeocerdo cuvieri*) Captured in Southeastern Brazil. *Aquatic Mammals* 2004, *30*(2), 311-314, DOI 10.1578/AM.30.2.2004.311

Di Beneditto, A. P. M., R. M. A. Ramos. 2001. Biology and Conservation of the Franciscana (Pontoporia blainvillei) in the North of Rio de Janeiro State, Brazil. *Journal of Cetacean Research and Management* 3(2):185–192.

Di Beneditto, A. P., R. M. A. Ramos, and N. R. W. Lima. 2001a. Os golfinhos: origem, classificação, captura acidental, hábito alimentar. Editora Cinco Continentes, Porto Alegre.

Di Beneditto, A. P. M., R. M. A. Ramos, and N. R. W. Lima. 2001b. Sightings of *Pontoporia blainvillei* (Gervais & D'Orbigny, 1844) and *Sotalia fluviatilis* (Gervais, 1853) (Cetacea) in South-eastern Brazil. *Brazilian Archives of Biology and Technology* 44(3):291-296.

Di Beneditto, A. P. M., C. C. Rocha-Campos, D. S. Danilewics, E. R. Secchi, I. B. Moreno, L. B. Hassel, M. Tavares, P. H. Ott, S. Siciliano, S. P. Souza, V. C. Alves. 2010. Plano de ação nacional para a conservação do pequeno cetáceo Toninha: *Pontoporia blainvillei*. Brasília: ICMBio.

Diegues, A. C. S. 1983. *Pescadores, camponeses e trabalhadores do mar*. São Paulo: Ática.

Dupré, J. 1999. Are whales fish? In *Folkbiology*. D. L. Medin and S. Atran, eds. Pp. 461-476. Massachusetts: MIT Press.

FAO. 2008. Fisheries and Aquaculture Statistics.

FAO. 2009. *The state of world fisheries and aquaculture – 2008*. Rome: FAO – Fisheries and Aquaculture Department.

[online] ftp://ftp.fao.org/FI/CDrom/CD_yearbook_2008/root/aquaculture/a0a.pdf

FAO. 2005-2011. Fisheries and Aquaculture topics. Types of fisheries. Topics Fact Sheets. Text by Andrew Smith. In: *FAO Fisheries and Aquaculture Department* [online]. Rome. Updated 27 May 2005. [Cited 10 April 2011]. http://www.fao.org/fishery/topic/12306/en

Fertl, D., T. A. Jefferson, I. B. Moreno, A. N. Zerbini, K. D. Mullin. 2003. Distribution of the Clymene dolphin *Stenella clymene*. *Mammal Review* 33(3):253–271.

Flores, P. A. C and M. Bazzalo. 2004. Home Ranges and movement patterns of the marine tucuxi, Sotalia fluviatilis, in Baía Norte, Southern Brazil. The *Latin American Journal of Aquatic Mammals* 3(1): 37-52.

Flores, P. A. C. and V. M. F. Da Silva. 2009. Tucuxi and Guiana dolphin. In *Encyclopedia of Marine Mammals.* Perrin, W. F., Wursig, B., Thewissen, J. G. M. (eds.), p. 1188-1192. Burlington, MA: Academic Press.

Fraxe, T. J. P. 2004. Cultura cabocla-ribeirinha – Mitos, lendas e transculturalidade. São Paulo: Annablume. 374p.

Freitas-Netto, R., A. P. M. Di Beneditto. 2008. Interactions between fisheries and cetaceans in Espírito Santo State coast, southeastern Brazil. *Revista Brasileira de Zoociências* 10(1): 55-63.

Froese, R. and D. Pauly. Editors. 2011. FishBase. World Wide Web electronic publication. [online] www.fishbase.org, version (02/2011).

Gadgil, M., P. Olsson, F. Berkes, C. Folke. 2003. Exploring the role of local ecological knowledge in ecosystem management: three case studies. In: *Navigating social-ecological systems.* Berkes F, Colding J, Folke C. (Eds.), p.189-209. Massachusetts: Cambridge University Press.

Gilchrist, G., M. Mallory, and F. Merkel. 2005. Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. *Ecology and Society* 10(1):20 [online] URL: http://www.ecologyandsociety.org/vol10/iss1/art20/

Gilchrist, G, and M. Mallory. 2007. Comparing expert-based science with local ecological knowledge: what are we afraid of? *Ecology and Society* 12(1):r1 [online] URL: http://www.ecologyandsociety.org/vol12/iss1/resp1/

Governo do Pará - PARATUR. 2001. Plano de desenvolvimento turístico do Estado do Pará.

Gurjão, L. M., M. A. A. Furtado Neto, R. A. Santos and P Cascon. 2003. Feeding habits of marine tucuxi, *Sotalia fluviatilis*, at Ceará State, northeastern Brazil. *Latin American Journal of Aquatic Mammals* 2(2): 117-122.

Hafermann, M. 2004. Sustentabilidade e desenvolvimento turístico na Ilha de Santa Catarina. PhD Thesis. Universidade Federal de Santa Catarina, Santa Catarina, Brazil.

Hanazaki, N. 2004. Etnobotânica. In: *Ecologia de pescadores da Mata Atlântica e da Amazônia.* Begossi, A. (Ed.), p. 37-57. Ed. Hucitec, São Paulo.

Hanazaki, N., F. Castro, V. G. Oliveira, N. Peroni. 2007. Between the sea and the land: the livelihood of estuarine people in southeastern Brazil. *Ambiente e Sociedade* (10):1, 121-136.

Hovelsrud, G. K., M. McKenna, H. P. Huntington. 2008. Marine mammals harvests and other interactions with humans. Ecological Applications 18(2): supplement s135-s147.

Hunn, E. 1982. The utilitarian factor in folk biological classification. *American Anthropologist* 84(4):830-847.

Hunn, E. 1999. Size as limiting the recognition of biodiversity in folkbiological classifications: one of four factors governing the cultural recognition of biological factors. In *Folkbiology*. D. L. Medin and S. Atran, eds. Pp. 47-70. Massachusetts: MIT Press – Cambridge.

Huntington, H. P. 2000. Using traditional ecological knowledge in science: methods and applications. *Ecological Applications* 10(5):1270-1274.

Huntington, H. P. and the communities of Buckland, Elim, Koyuk, Point Lay and Shaktoolik. 1999. Traditional knowledge of the ecology of beluga whales (*Delphinapterus leucas*) in the Eastern Chukchi and Northern Bering Seas, Alaska. Artic 52(1):49-61.

Huntington, H. P., R. S. Suydam, D. H. Rosenberg. 2004. Traditional knowledge and satellite tracking as complementary approaches to ecological understanding. Environmental Conservation 31(3): 177-180.

Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais e Renováveis – IBAMA. 2001. Mamíferos Aquáticos do Brasil. Plano de ação. MMA/IBAMA, Brasília.

IDEMA. 2004. Caracterização da pesca artisanal do Estado do Rio Grande do Norte. Relatório Técnico. [online] www.idema.rn.gov.br/arquivo 5/produto(relatorio tecnico)/

Instituto Brasileiro de Geografia Econômica – IBGE. 2010. Estimativas das populações residentes em, segundo os municípios [on-line] http://www.ibge.gov.br/cidadesat/default.php

IUCN. 2010. IUCN Red List of Threatened Species. Version 2010.1. [on-line] www.iucnredlist.org.

Jefferson, T. A., Leatherwood, S., Webber, M. A. 1993. Marine mammals of the World. FAO Species identification guide. UNEP, Rome.

Jefferson, T. A. S., B. E. Curry. 2003. Stenella clymene. *Mammalian Species* 726:1-5.

Jefferson, T. A., M. A. Webber, and R. L. Pitman. 2008. *Marine mammals of the world – a comprehensive guide to their identification.* London: Academic Press/Elsevier.

Johannes, R. E. 1977. Traditional law of the sea in Micronesia. *Micronesica* 13:121-127.

Johannes, R. E. 1993. Integrating traditional ecological knowledge and management with environmental impact assessment. In *Traditional ecological knowledge: concepts and cases*. J. T. Inglis. ed. Pp. 33-40. Ottawa: International Program on Traditional Ecological Knowledge and International Development Research Centre.

Johannes, R. E. 1998. The case for data-less marine resource management: Examples from tropical nearshore finfisheries. *Trends in ecology and evolution* 13(6):243-246.

Johannes, R. E., M. R. Freeman, and R. J. Hamilton. 2000. Ignore fishers' knowledge and miss the boat. *Fish and Fisheries* 1:257-271.

Johannes, R. E. 2003a. Fishers' knowledge and management: differing fundamentals in artisanal and industrial fisheries. In: *Putting fishers' knowledge to work: conference proceedings*. N. Haggan, C. Brignall and L. Woods (eds.), p. 15-19. Vancouver: Fisheries Centre, University of Columbia.

Johannes, R. E. 2003b. Use and misuse of traditional ecological knowledge and management practices. In: *Values at sea: ethics for the marine environment*. D G. Dallmeyer (ed.). p. 111-126. Athens: University of Georgia Press.

Kemper, C. M., A. Flaherty, S. E. Gibbs, M. Hill, M. Long and R. W. Byard. 2005. Cetacean captures, strandings and mortalities in South Australia 1881−2000, with special reference to human interactions. *Australian Mammalogy* 27: 37-47.

Lailson-Brito Jr., J., P. R. Dorneles, V. M. F. da Silva, A. R. Martin, W. R. Bastos, C. E. Azevedo-Silva, A. F. Azevedo, J. P. M. Torres, and O. Malm. 2008. Dolphins as indicators of micropollutant trophic flow in Amazon Basin. *Oecologia Brasiliensis* 12 (3): 531-541.

Lodi, L., 1992. Epimeletic behavior of free-ranging rough-toothed dolphins, *Steno bredanensis*, from Brazil. *Marine Mammal Science*, **8**, 284–287.

Marques, J. G. W. 1995. Etnoictiologia: pescando pescadores nas águas da transdisciplinaridade. *XI Encontro Brasileiro de Ictiologia*. Campinas: PUC.

Marques, J. G. W. 2001. Pescando pescadores – Ciência e etnociência em uma perspectiva ecológica. São Paulo: NUPAUB – USP.

Martuscelli P., F. Olmos F, R. Silva e Silva, I. P. Mazzarella, F. P. Pino, and E. M. Raduan. 1996. Cetaceans of São Paulo, Southeastern Brazil. *Mammalia* 60 (1):125-139.

Medeiros, R. P. 2001. Estratégias de pesca e usos dos recursos em uma comunidade de pescadores artesanais da praia de Pântano do Sul (Florianópolis, SC). Universidade Estadual de Campinas. Dissertação de mestrado.

Ministério do Turismo – Brasil. 2010. [online]
http://www.copa2014.turismo.gov.br/dadosefatos/estatisticas_indicadores/estatisticas_indicadores_turismo_mundial/

Moore, J. E., B. P. Wallace, R. L. Lewison, R. Zydelis, T. M. Cox, and L. B. Crowder. 2009. A review of marine mammal, seaturtle and seabird bycatch in USA fisheries and the role of policy in shaping management. *Marine Policy* 33: 435–451.

Moore, J. E., T. M. Cox, R. L. Lewison, A. J. Read, R. Bjorkland, S.L. McDonald, L.B. Crowder, E. Aruna, I. Ayissi, P. Espeut, C. Joynson-Hicks, N. Pilcher, C.N.S. Poonian, B. Solarin, J. Kiszka. 2010. An interview-based approach to assess marine mammal and sea turtle captures in artisanal fisheries. *Biological Conservation* 143:795-805.

Moreno, I. B., A. N. Zerbini, D. Danilewicz, M. C. O. Santos, P. C. Simões-Lopes, J. Lailson-Brito Jr., A. F. Azevedo. 2005. Distribution and habitat characteristics of dolphins of the genus *Stenella*(Cetacea: Delphinidae) in the southwest Atlantic Ocean. *Marine Ecology Progress Series* 300:229–240.

Moura, J. F., S. Siciliano, P.N. Sarcinelli and S. Hacon. 2008. Several organochlorine pesticides in the milk of a marine tucuxi dolphin incidentally captured with its calf in Barra de São João, east coast of Rio de Janeiro State, Brazil. *Journal of Marine Biological Association 2 - Biodiversity Records.* [online] http://www.mba.ac.uk/jmba/jmba2biodiversityrecords.php?6201

Mourão, J. S., and N. Nordi. 2003. Etnoicitiologia de pescadores artesanais do estuário do Rio Mamanguape, Paraíba, Brasil. *Boletim do Instituto de Pesca* 29(1):9-17.

Mourão, J. S. and S. C. S. Montenegro. 2006. Pescadores e Peixes: o conhecimento local e o uso da taxonomia folk baseada no modelo berliniano. Recife: NUPEEA.

Mymrin, N. I., the communities of Novoe Chaplino, Sireniki, Uelen and Yanrakinnot, Huntington, H. P. 1999. Traditional Knowledge of the Ecology of Beluga Whales (*Delphinapterus leucas*) in the Northern Bering Sea, Chukotka, Russia. *Arctic* 52(1): 62-70.

Nazarea, V. D. 1999. *Ethnoecology: situated knowledge/located lives.*Tucson: The University of Arizona Press.

Newmaster, S. G., S. Ragupathy, R. F. Ivanoff, and N. C. Balasubramaniam. 2006. Mechanisms of ethnobiological classifications. *Ethnobotany* 18:4-26.

Newmaster, S. G., S. Ragupathy, N. C. Balasubramaniam, and R. F. Ivanoff. 2007. The multi-mechanistic taxonomy of the Irulas in Tamil Nadu, South India. *Journal of Ethnobiology* 27(2):233-255.

NOAA. World Ocean Atlas. 2009. [online] http://www.nodc.noaa.gov/OC5/WOA09F/pr_woa09f.html

Noongwook, G., The native village of Savoonga, The native village of Gambell, Huntington, H. P., George, J. C. 2007. Traditional Knowledge of the Bowhead

Whale (*Balaena mysticetus*) around St. Lawrence Island, Alaska. *Arctic* 60(1): 47-54.

Oliveira, V. S. 2005. Distribuição e abundância relativa de peixes e crustáceos capturados no Programa REVIZEE/SCORE-NE na Plataforma Continental e Talude da costa do nordeste do Brasil. In: PhD Thesis, Universidade Federal de Pernambuco, Brasil.

Oliveira, F., E. L. A. Monteiro-Filho. 2006. Relação entre pescadores e botos de Cananéia – Olhar e percepção caiçara. In: Diegues, A. C. (Org.), Enciclopédia Caiçara, v.5, Festas, lendas e mitos caiçaras. Ed. Hucitec, USP/NUPAUB/CEC, São Paulo.

Ott, P. H., and D. Danilewicz. (1998). Presence of fransciscana dolphins (*Pontoporia blainvillei*) in the stomach of a killer whale (*Orcinus orca*) stranded in southern Brazil. *Mammalia 62*:605-609.

Ott, P. H., E. R. Secchi, I. B. Moreno, D. Danilewicz, E. A. Crespo, P. Bordino, R. Ramos, A. P. Di Beneditto, C. Bertozzi, R. Bastida, R. Zanelatto, J. Perez, and P. G. Kinas. 2002. Report of the working group of fishery interactions. *Latin American Journal of Aquatic Mammals* 1: 55–64.

Pauly, D. 2006. Major trends in small-scale marine fisheries, with emphasis on developing countries, and some implications for the social sciences. *MAST* 4(2):7-22.

Pauly, D. 2009. Beyond duplicity and ignorance in global fisheries. Scientia Marina 73(2):215-224.

Payne, R., V. Rowntree, J.S. Perkins, J.G. Cooke and K. Lankester,. 1990. Population size, trends and reproductive parameters of right whales (*Eubalaena australis*) off Peninsula Valdes, Argentina. *Rep. int. Whal. Commn* (special issue) 12:271-8.

Paz, V. A. and A. Begossi. 1996. Ethnoichthyology of Gamboa fishermen of Sepetiba Bay, Brazil. *Journal of Ethnobiology* 16(2):157-168.

Perrin, W. F., G. P. Donovan, and J. Barlow. (Eds.), 1994. Gillnets and cetaceans. *Report of the International Whaling Commission, Special Issue* 15: 1−629.

Peterson, D., N. Hanazaki and P. C. Simões-Lopes. 2008. Natural resource appropriation in cooperative artisanal fishing between fishermen and dolphins (Tursiops truncatus) in Laguna, Brazil. *Ocean & Coastal Management* 51:469–475.

Pinheiro, L., M. J. Cremer. 2003. Etnoecologia e captura acidental de golfinhos (Cetacea: Pontoporiidae e Delphinidae) na Baía da Babitonga, Santa Catarina. *Desenvolvimento e Meio Ambiente* 8:69-75.

Posey, D. A. 1984. Hierarchy and utility in a folk biological taxonomic system: patterns in classification of arthropods by the Kayapó Indians of Brazil. *Journal of Ethnobiology* 4(2):123-139.

Posey, D. A. 1986. Topics and issues in Ethnoentomology with some suggestions for the development of hypothesis-generation and testingnin Ethnobiology. *J. Ethnobiol.* 6(1):99-120.

Praderi, R. (1985). Relaciones entre *Pontoporia blainvillei* (Mammalia: Cetacea) y tiburones (Selachii) de aguas Uruguayas. *Comunicados Zoológicos del Museo Historia Natural de Montevideo 11*:1-19.

Pringent, M., G. Fontenele, M. Rochet, and V. M. Trenkel. 2008. Using cognitive maps to investigate fishers' ecosystem objectives and knowledge. *Ocean and Coastal Management* 51: 450-462.

Reeves, R. R., B. D. Smith, E. A. Crespo, G. Notarbartolo di Sciara. 2003. Dolphins, Whales and Porpoises: 2002 – 1020 Conservation Action Plan for the World's Cetaceans. IUCN / SSC Cetacean Specialist Group, Gland, Switzerland and Cambridge, UK.

Reeves, R. R., P. Berggren, E. A. Crespo, N. Gales, S. P. Northridge, G. N. di Sciara, W. F. Perrin, A. J. Read, E. Rogan, B. D. Smith, and K. Van Waerebeek. 2005. *Global Priorities for Reduction of Cetacean Bycatch.* WWF Report. Gland, Switzerland.

Richard, P. R. and D. G. Pike. 1993. Small Whale Co-management in the Eastern Canadian Arctic: A Case History and Analysis. *Arctic* 46(2): 138-143.

Rodrigues, A. L. F. 2008. O boto na verbalização de estudantes ribeirinhos: uma visão etnobiológica. In: Master's dissertation, Universidade Federal do Pará, Brasil.

Rosa, I. M. L., R. R. N. Alves, K. M. Bonifácio, J. S. Mourão, F. M. Osório, T. P. R. Oliveira, M. C. Nottingham. 2005. Fishers' knowledge and seahorse conservation in Brazil. *Journal of Ethnobiology and Ethnomedicine* 1:12 (DOI:10.1186/1746-4269-1-12)

Rossi-Wongtschowski, C. L. D. B. and L. S. P. Madureira. 2006. *O ambiente oceanográfico da plataforma continental e do talude na região SE-S do Brasil*. São Paulo: EDUSP.

Ruddle, K. 2000. Systems of knowledge: dialogue, relationships and process. *Environment, Development and Sustainability* 2:277-304.

Ruddle, K. 2007. Misconceptions, outright prejudice. Samudra Report 48:4-9.

Ruddle, K. and F. R. Hickey. 2008. Accounting for the mismanagement of tropical nearshore fisheries. Environmental Development and Sustainability, DOI 10.1007/s10668-008-9152-5

Ruddle, K. and A. Davis. 2011. What is "Ecological" in local ecological knowledge? Lessons from Canada and Vietnam. *Society and Natural Resources* 0:1-15.

Santos, M.C.O., S. Rosso, R. A. Santos, S. H. B. Lucato, M. Bassoi,. 2002. Insights on small cetacean feeding habits in southeastern Brazil. Aquatic Mammals 28(1): 38-45.

Santos, M.C.O. and D.F. Netto. 2005. Killer whale (Orcinus orca) predation on a franciscana dolphin (Pontoporia blainvillei) in Brazilian waters. *Latin American Journal of Aquatic Mammals* 4: 69–72.

Santos, M. C. O. and S. Rosso. 2008. Social organization of marine tucuxi dolphins, Sotalia guianensis, in the Cananéia estuary of Southeastern Brazil. *Journal of Mammalogy* 89(2):347-355.

Santos, M. C. O., S. Siciliano, A. F. C. Vicente, F. S. Alvarenga, E. Zampirolli, S. P. Souza, and A. Maranho. 2010. Cetacean records along São Paulo State coast, Southeastern Brazil. Brazilian Journal of Oceanography, 58(2):123-142.

Secchi, E.R., A. N. Zerbini, M. Bassoi, L. Dalla Rosa, L. M. Moller, C. C. Rocha-Campos. 1997. Mortality of franciscanas, *Pontoporia blain*villei, in coastal gillnets in southern Brazil: 1994-1995. *Reports of the International Whaling Commision* 47: 653-538.

Secchi, E.R., P.G. Kinas and M. Muelbert. 2004. Incidental catches of franciscana in coastal gillnet fisheries in the Franciscana Management Area III: period 1999–2000. *Latin American Journal of Aquatic Mammals* 3: 61–68.

Seixas, C. S. and A. Begossi. 2001**.** Ethnozoology of fishing communities from Ilha Grande (Atlantic Forest coast, Brazil). *Journal of Ethnobiology* 21(1):107-135.

Sholl, T. G. C., F. F. Nascimento, O. Leoncini, C. R. Bonvivino, S. Siciliano. 2008. Taxonomic identification of dolphin love charms commercialized in the Amazonian region through the analysis of cytochrome b DNA. *Journal of Marine Biological Association* 88(6): 1207-1210.

Siciliano, S. 1994. Review of small cetaceans and fishery interactions in coastal waters of Brazil. *Report International Whaling Comission* 15:241-250.

Siciliano, S., I. B. Moreno, E. D. Silva, V. C. Alves. 2006. *Baleias, botos e golfinhos na Bacia de Campos*. Rio de Janeiro: ENSP/FIOCRUZ.

Siciliano, S., N. R. Emin-Lima, A. F. Costa, A. L. F. Rodrigues, F. A. Magalhães, C. H. Tosi, R. G. Garri, C. R. Silva, and J. S. Silva Jr. 2008. Revisão do conhecimento sobre os mamíferos aquáticos da costa norte do Brasil. *Arquivos do Museu Nacional* 66(2):381-401.

Silva, L. S. 1995. Condições oceanográficas no Canal de São Sebastião: fevereiro de 1994 a março de 1995. São Paulo. In: Master's dissertation, Instituto Oceanográfico da Universidade de São Paulo.

Silvano, R. A. M. and A. Begossi. 2002. Ethnoichthyology and fish conservation in Piracicaba River, Brazil. *Journal of Ethnobiology* 22 (2):285-306.

Silvano, R. A. M. and A. Begossi. 2005. Local Knowledge on a cosmopolitan fish. Ethnoecology of *Pomatomus saltatrix* (Pomatomidae) in Brazil and Australia. *Fisheries Research* 71:43-59.

Silvano, R. A. M., P. F. L. MacCord, R. V. Lima & A. Begossi. 2006. When does this fish spawn? fishermen's local knowledge of migration and reproduction of Brazilian coastal fishes. Environmental Biology of Fishes 76: 371–386.

Silvano, R. A. M., and J. Valbo-Jorgensen. 2008. Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. *Environment, Development and Sustainability* 10:657-675.

Silvano, R. A. M., M. A. Gasalla, and S. P. Souza. 2009. Applications of fishers' local ecological knowledge to better understand and manage tropical fisheries. In: Lopes, P. F. M. and A. Begossi (eds.) Current Trends in Human Ecology. Nescastle upon Tyne, Cambridge Scholars Publishing.

Silvano, R. A. M., and A. Begossi. 2010. What can be learned from fishers? An integrated survey of fishers' local ecological knowledge and bluefish (Pomatomus saltatrix) biology on the Brazilian coast *Hydrobiologia* 637:3–18.

Simões-Lopes, P. C., M. E. Fabián, J. O. Menegheti. 1998. Dolphin interactions with the mullet artisanal fishing on southern Brazil: a qualitative and quantitative approach. Revista Brasileira de Zoologia 15(3):709-726.

Simon, M. 2010. The sounds of whales and their food: Baleen whales, their foraging behaviour, ecology and habitat use in an arctic habitat. PhD Thesis.Department of Biological Sciences, Aarhus Univeristy, Denmark. Pp. 176.

Simpson, G. G. 1961. Principals of animal taxonomy. New York: Columbia University Press.

SMA – SP (Secretaria do Meio Ambiente do Estado de São Paulo) 1996. *Macrozoneamento do litoral norte: plano de gerenciamento costeiro.* São Paulo: Secretaria do Meio Ambiente.

Souza Filho, P. W. M. 2005. Costa de manguezais de macromarés da Amazônia: cenários morfológicos, mapeamento e quantificação de áreas usando dados de sensores remotos. *Revista Brasileira de Geofísica* 23(4):427-435.

Souza, S. P., A. Begossi. 2006. Etnobiologia de *Sotalia fluviatilis* (Gervais, 1853) no litoral norte do estado de São Paulo, Brasil. *Workshop on Research and Conservation of the Genus Sotalia,* Rio de Janeiro, p.39.

Souza, S. P., A. Begossi. 2007. Whales, dolphins or fish? The Ethnotaxonomy of cetaceans in São Sebastião, Brazil. *Journal of Ethnobiology and Ethnomedicine* 3:9 (DOI:101186/1746-4269-3-9)

Soykan, C. U., J. E. Moore, R. Zydelis, L. B. Crowder, C. Safina, and R. L. Lewison. 2008. Why study bycatch? An introduction to the theme section on fisheries bycatch. *Endangered Species Research* 5: 91–102.

Spencer, N., M. B. S. Vázquez, G. J. Pierce. 2000. Evaluation of the state of knowledge concerning bycatches of cetaceans. *European Commission – Fisheries*, Final Report.

Spinelli, L. H. P., A. H. Jesus, L. F. Nascimento, and M. E. Yamamoto. 2006. Prey transfer in the marine tucuxi dolphin, *Sotalia fluviatilis*, on the Brazilian coast. Journal *of Marine Biology Association 2: Biodiversity Records*. [online] http://www.mba.ac.uk/jmba/jmba2biodiversityrecords.php?5235

Tabosa, W. F. and H. Vital. 2002. Caracterização da plataforma continental da região de São bento do Norte e Caiçara do Norte – RN/NE – Brasil: reflexos da morfologia do fundo sobre os processos costeiros atuantes na região do pólo petrolífero de Guamaré. In II Workshop de Avaliação Anual dos PRH's – ANP da UFRN, 23-25 out. 2002.

Toledo, V. M. 1992.What is Ethnoecology? Origins, scope and implications of a rising discipline. *Etnoecológica* 1(1):5-21.

Toledo, V. M. 2002. What is Ethnoecology? Origins, scope and implications of a rising discipline. Etnoecológica 1(1):5-21.

Uhen, M. D. 2007. Evolution of Marine Mammals: Back to the Sea After 300 Million Years. *The Anatomical Record* 290:514–522.

Vasconcelos, M., A. C. Diegues, R. R. Sales. 2007. Limites e possibilidades na gestão da pesca artesanal costeira. In: *Nas redes da pesca artesanal*. COSTA, A. L.(org.), p. 2-70. Brasília: IBAMA-PNUD.

Wedekin, L. L., F. G. Daura-Jorge, V. Q. Piacentini and P.C. Simões-Lopes. 2007. Seasonal variations in spatial usage by the estuarine dolphin, *Sotalia guianensis* (van Bénéden, 1864) (Cetacea; Delphinidae) at its southern limit of distribution. *Brazilian Journal of Biol*ogy 67(1):1-8.

Williams, R., S. L. Hedley, and P. S. Hammond. 2006. Modelling distribution and abundance of Antarctic baleen whales using ships of opportunity. *Ecology and Society* 11(1):1. [online] URL: http://www.ecologyandsociety.org/vol11/iss1/art1

WWF. 2004. Cetacean bycatch and the IWC. WWF Species Programme, Gland, Switzerland.

Zappes, C. A., A. Andriolo, F. Oliveira-Silva, E. L. A. Monteiro-Filho. 2009. Potential conflicts between fishermen and *Sotalia guianensis* (VAN BÉNÉDEN, 1864) (CETACEA, DELPHINIDAE) in Brazil. *Sitientibus Série Ciências Biológicas* 9(4): 208-214.

Zappes, C. A., A. Andriolo, P. C. Simões-Lopes, A. P. M. Di Beneditto. 2011. 'Human-dolphin (*Tursiops truncatus* Montagu, 1821) cooperative fishery' and its influence on cast net fishing activities in Barra de Imbé/Tramandaí, Southern Brazil. *Oceans and Coastal Management* doi:10.1016/j.ocecoaman2011.02.003

Zerbini, A. N., A. Andriolo, J. M. Rocha, P. C. Simões-Lopes, S. Siciliano, J. L. Pizzorno, J. M. Waite, D. P. DeMaster, and G. R. VanBlaricom. 2004. Winter distribution and abundance of humpback whales (*Megaptera novaeangliae*) off Northeastern Brazil. *Journal of Cetacean Resource Management* 6(1):101–107.

Zerbini, A. N., A. Andriolo, M. P. Heide-Jørgensen, J. L. Pizzorno, Y. G. Maia, G. R. VanBlaricom, D. P. DeMaster, P. C. Simões-Lopes, S. Moreira, C. Bethlem. 2006. Satellite-monitored movements of humpback whales *Megaptera novaeangliae* in the Southwest Atlantic Ocean. *Marine Ecology Progress Series* 313:295-304.