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Report of the Working Group on Major Threats and Conservation

Enrique A. Crespo[1,*], Daniela Alarcon[2], Mariana Alonso[3], Mariel Bazzalo[4], Monica Borobia[5], Marta Cremer[6], Gislaine Filla[7], Liliane Lodi[8], Fagner A. Magalhães[9], Juliana Marigo[10], Helder Lima de Queiróz[11], John E. Reynolds, III[12], Yara Schaeffer[13], Paulo R. Dorneles[14], José Lailson-Brito[15] and Dana L. Wetzel[12]

Introduction

The species of the genus *Sotalia* inhabit river and lake systems of Amazonia, the lower Orinoco River, and coastal marine waters from Nicaragua to southern Brazil (Borobia *et al.,* 1991; da Silva and Best, 1994; 1996; Carr and Bonde 2000; Flores and da Silva, 2009). Freshwater and marine animals can be differentiated based on skeletal morphology (Monteiro Filho *et al.,* 2002). Recently they were demonstrated to be separate species, with *S. fluviatilis* being the riverine species in the Amazon and *S. guianensis* being found in marine and estuarine environments (Cunha *et al.,* 2005; Caballero *et al.,* 2007). The identity of the animals found in the Orinoco system remains unclear (see Solé-Cava *et al*. 2010, this volume). Both species are believed to be locally abundant, although numbers reported for some areas (such as Guanabara Bay, Rio de Janeiro) seem to have declined (Santos *et al*., 2010, this volume; Azevedo *et al.*, 2008). Common names for the riverine species *S. fluviatilis* include '*tucuxi*' in Brazil or '*bufeo negro*' in other countries, while the marine species *S. guianensis* is called '*boto-cinza*', or simply '*boto*' or '*golfinho*' in Brazil. The proposed English common name for *S. guianensis* is 'Guiana dolphin' (Flores *et al.,* 2010 this volume).

The freshwater and near-shore marine distribution means that both *Sotalia* species are vulnerable to the effects of anthropogenic activities, including water development projects, chemical pollution, noise, as well as by-catch. The Scientific Committee of the International Whaling Commission (IWC) urged in 1994 that steps should be taken by member states to reduce incidental mortality of *Sotalia*, while at the same time establishing better systems of recording and monitoring take levels (IWC, 1995).

A particular concern has been expressed for the status of mangrove forests, which are threatened in many areas by pollution and coastal development. Several Guiana dolphin populations probably depend to a considerable extent on the productivity derived from mangrove ecosystems (Zanelatto, 2001) and may be particularly vulnerable as the species appears to occur in a series of small resident populations along the Brazilian coast (*e.g*. Geise and Borobia, 1988; Santos *et al.* 2001; Rossi-Santos *et al.,* 2007; Nery *et al.,* 2008a).

This report presents the discussions of the group tasked with covering Major Threats and Conservation at the 'Workshop on Research and Conservation of the genus *Sotalia*' held in Armação dos Búzios, Rio de Janeiro, Brazil, 19-23 June 2006. It is intended as a compilation of information supplied by workshop participants and from a literature review. This report is organized by type of threats: documented and potential. Participants also reviewed aspects of regulations and legislation in the different countries, which are included in this report.

Documented Threats

Fisheries interactions

Mortality in fishing gear is likely the most important threat to the conservation of small cetaceans worldwide (Reeves *et al.,* 2003). Fishermen and dolphins often interact, in many different ways, throughout Amazonia and Orinoquia, as well as along the coastal zone of Central and South America. Interactions include incidental mortality in different types of nets, the use of dynamite in fishing operations, direct catches for meat consumption and bait, and competition with fisheries

[1] Centro Nacional Patagónico (CONICET), Universidad Nacional de la Patagonia & IUCN Cetacean Specialist Group, 9120 Puerto Madryn, Chubut, Argentina
[2] Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil
[3] Laboratório de Química Orgânica Marinha, Instituto Oceanográfico da Universidade de São Paulo.
[4] Doctorado en Cs. Biológicas, FCEyN-UBA, Argentina
[5] Roteiros de Charme, Rio de Janeiro, Brazil
[6] Universidade da Região de Joinville, Departamento de Ciências Biológicas, Laboratório de Nectologia.
[7] Instituto de Pesquisas de Cananéia, Cananéia, São Paulo, Brazil
[8] Instituto de Estudos da Ecologia de Mamíferos Marinhos, Niterói, Rio de Janeiro, Brazil
[9] Projeto Cetáceos do Maranhão, Ilha do Caju Institute, Parnaíba/PI, Brazil
[10] Projeto BioPesca, SP, Departamentos de Biologia e Genética, IOC-FIOCRUZ, Brazil
[11] Instituto Mamirauá, Tefé, Amazonas, Brazil
[12] Mote Marine Laboratory, Sarasota, Florida, USA
[13] BIOMA, Oceanographic Institute, University of São Paulo, Brazil
[14] Instituto de Biofísica Carlos Chagas Filho, Universidade Federal do Rio de Janeiro, Brazil
[15] Laboratório de Mamíferos Aquáticos e Bioindicadores 'Profa. Izabel Gurgel', Faculdade de Oceanografia, Universidade do Estado do Rio de Janeiro, Brazil
* Corresponding author, e-mail: kike@cenpat.edu.ar, kike.crespo@uv.es

for fishing resources (Lodi and Capistrano, 1990; Di Beneditto *et al.*, 1998; Monteiro Neto *et al.*, 2000; Nery *et al.*, 2008b; Pinheiro and Cremer, 2004; Loch *et al.*, 2009).

In the central Amazon of Brazil, tucuxis interact with several types of fisheries, such as those using set or floating gillnets and '*lampara*' seines (Best and da Silva, 1989). Artisanal fishermen with traditional gear such as hooks, arrows, and '*tarrafas*' (throw-nets) look for dolphins in order to detect concentrations of fish (Barthem and Goulding, 1997). For the most part, they do not perceive dolphins as competitors or enemies. In contrast, fishermen who set driftnets in the main channels of the rivers to catch large silurids (catfish) regard dolphins as pests. They sometimes shoot them with guns or throw poisoned fish at them. Even though the fishermen recognize that other fishes (*e.g.* family Cetopsidae, whale catfishes) may steal or mutilate their catch and cause losses to the fisheries, they often use the dolphins as scapegoats.

Tucuxis are generally not hunted, but they appear to be extremely vulnerable to entanglement in gillnets. A study of by-catch in the mouth of the Amazon based on interviews with fishermen indicated a kill of more than 1050 tucuxis in a single year (Beltrán, 1998). Loch *et al.* (2009) reported two carcasses of *S. fluviatilis* found dead with signs of perforations and cuts in the western Brazilian Amazon. In Colombia, river dolphins are killed in order to sell their body parts (including eyes, teeth, genital organs and oil), which are used as aphrodisiacs and amulets in local markets in Leticia (Amazonas) and Puerto Carreño (Vichada) (Trujillo, 1990). It was mentioned that in some cases an eye can be sold by $10 USD (F.A. Magalhaes, pers. obs.). It is of concern that a market could be developed and that an incidental catch could turn into a directed one (Alves and Rosas, 2008).

In the coastal zone, several types of fishing gear are involved in incidental captures of dolphins, such as gillnets, driftnets, beach seines, trawling nets, long-lines and fixed traps (Siciliano, 1994). However, more than 90% of catches have been reported in gillnets. Many records exist of strandings along the species range. An unknown proportion may be caused by incidental captures, suggesting potentially high levels of by-catch.

When dolphins are caught incidentally, sometimes they are killed with knives in order to remove eyes and genital organs. However, the most common use of incidentally caught specimens in the coastal zone is to take advantage of blubber as bait for long-lines (Siciliano, 1994). Guiana dolphins along with franciscanas (*Pontoporia blainvillei*) are the most commonly caught small cetaceans in Brazilian coastal gillnet fisheries (Siciliano, 1994; Monteiro Neto *et al.*, 2000; Di Beneditto, 2003). The Guiana dolphin may also be the cetacean most commonly taken as a by-catch in coastal fisheries of the southern Caribbean Sea (Vidal *et al.*, 1994).

Recent work has been carried out on Guiana dolphins to mitigate fisheries interactions, including experimentation with pingers. From 1996 to 1998, a series of trials were carried out in Iracema Beach, Fortaleza, Brazil by Monteiro Neto *et al.* (2004). Experiments with functional, dummy and control trials were tested in a sheltered area where dolphin groups were monitored. Significant differences in the distribution of dolphins were observed between areas with functional pingers compared to areas with dummy ones or control trials, where no pingers were set. The average sighting frequency was lower than that observed in areas with active pingers. These results suggested that functional pingers affect dolphin distribution.

Pollution

Persistent Bioaccumulative Toxicant (PBT) concentrations are generally found in marine mammal species that inhabit coastal or fluvial waters of the highly industrialized and/or populated countries. Due to heterogeneity in the distribution of people and industries in Latin America, as well as to peculiarities of land use, there are hotspots of chemical pollution along the distribution of *Sotalia* species. This is especially the case for the coastal environments in Brazil.

Trace element concentrations reported for Guiana dolphins were found to be within the expected range for coastal cetaceans (Lailson-Brito, 1994; 2000; Monteiro Neto *et al.*, 2003) and, in some situations, they were even lower than the levels verified in cetaceans inhabiting other less disturbed regions (Lailson-Brito and Fernandez, 1997[16]; Lailson-Brito *et al.*, 2000). This has been the case for cadmium, that does not seem to constitute a toxicological problem for Guiana dolphins (Lailson-Brito *et al.*, 2000; Kunito *et al.*, 2004; Dorneles *et al.*, 2007; Seixas et al., 2009a; 2009b); however, other heavy metals such as tin and mercury show higher concentrations.

A recent investigation comprised the evaluation of cetacean exposure to organotin compounds (OTs) through hepatic total tin (TSn) concentrations in Guanabara Bay (Rio de Janeiro State, Brazil), the most degraded area along the distribution of *S. guianensis* (Lailson-Brito, 2007). The study demonstrated extremely high levels of TSn, and comparatively higher than those measured in Guiana dolphins from Espírito Santo State (~20°S) or in other delphinid species that inhabit continental shelf and oceanic waters off Rio de Janeiro State (Dorneles *et al.*, 2008a).

Total mercury (THg) and methylmercury (MeHg) have been found in high concentrations in muscle and liver

[16] Lailson-Brito Jr., J. and Fernandez, M.A. (1997) Concentrações de metais pesados em tecidos do golfinho-de-clymene, *Stenella clymene*, e do boto-cinza, *Sotalia fluviatilis*, da costa nordeste do brasil. In *XI Encontro de Zoologia do Nordeste*, Fortaleza, 1997.

samples of Guiana dolphins from Guanabara Bay; however, they probably do not have toxicological consequences for the dolphins (Lailson-Brito *et al*., 2002; Lailson-Brito, 2007).

With reference to organochlorine compounds (OC), most of the studies addressing *Sotalia* have focused on dichlorodiphenyltrichloroethane and its metabolites (ΣDDT), as well as on polychlorinated biphenyls (PCBs). High ΣDDT and ΣPCB concentrations were found in blubber samples from Guiana dolphins from Guanabara Bay (Lailson-Brito *et al*., 2003; Torres *et al*., 2006; Lailson-Brito *et al*., 2010) and southern São Paulo and northern Paraná States (Yogui *et al*., 2003; 2010; Kajiwara *et al*., 2004). The organochlorine levels observed in these studies are comparable to those found in cetaceans from highly industrialized regions of the Northern Hemisphere, and higher than OC concentrations found for the same species in other coastal bays (Sepetiba, Ilha Grande and Paranaguá bays) in Brazil (Lailson-Brito *et al*., 2010; Vidal, 2010). Concentrations of the most toxic OCs, i.e. polychlorinated-dibenzo-p-dioxins (PCDDs), -dibenzofurans (PCDFs) and some polychlorinated-biphenyls (PCBs) called dioxin-like PCBs (dl-PCBs), have also been detected in blubber samples from Guiana dolphins from Guanabara Bay (Dorneles *et al*., 2008b) .

Only a few investigations based on a small sample size have been carried out outside Brazil. Koeman *et al*. (1972) reported micropollutant concentrations in a Guiana dolphin collected in Suriname. Duinker *et al*. (1989) analyzed micropollutant (ΣDDT and ΣPCB) concentrations from a male and a female Guiana dolphin from Colombia and found them to be similar to the lower range of concentrations found in south and southeast Brazil and Suriname.

Regarding organohalogen compounds other than organochlorines, high concentrations of perfluorooctane sulfonate (PFOS) have been found in hepatic samples of Guiana dolphins from Guanabara Bay, even among the highest ever reported for cetaceans (Dorneles *et al*., 2008c). Similar values of Polybrominated diphenyl ethers (PBDEs) in Guiana dolphins from Guanabara Bay have been found with those reported by Covaci *et al*. (2002) in North Sea harbor porpoises (*Phocoena phocoena*) (Dorneles *et al*., 2010).

Regarding tucuxi dolphins, due to the history of chemical contamination in the Amazon basin, Hg and DDT are the micropollutants that raise the highest environmental concern. It is interesting, however, that none of the liver samples from 22 Guanabara Bay dolphins analyzed by Lailson-Brito (2007) rendered an hepatic Hg concentration higher than the one found in a tucuxi from Negro River, in the Amazon, where less mining has occurred (Lailson *et al*., 2008).

Noise pollution

The influence of background noise created by human activities is poorly studied. Despite the lack of sound pollution assessments, noise produced by boat engines seems to affect the whistle production and acoustic structure of Guiana dolphin whistles (Dias, 2007). Surface behavioral responses of Guiana dolphins to boats have been reported for southern Brazil, where dolphins usually avoid different types of boats regardless the type of approach (Pereira *et al.,* 2007). Other sources of noise, such as those from dredges and pile-drivers, as well as other heavy machines used for harbor enlargement, have been argued to be the cause for the abandonment of the harbor inlet by the dolphins in Babitonga Bay, Brazil (Cremer *et al.,* 2009). Diazgranados *et al.* (2002)[17] recorded changes in the acoustic signals, respiratory patterns and behavior of tucuxi and botos in the Colombian Amazon before, during and after exposure to outboard propellers from boats crossing the river in high speed.

Emerging diseases

Several diseases have been documented in *Sotalia* dolphins such as viral genital papillomatosis from Brazil (M. Marcondes, pers. comm.), generalized poxvirus infection in a Guiana dolphin calf from Brazil (S. Siciliano, pers. comm.), toxoplasmosis in a Guiana dolphin from Brazil (Bandoli and de Oliveira 1977) and lobomycosis and lobomycosis-like disease in Guiana dolphins from several localities (Caldwell *et al*. 1975, Symmers 1983, Paniz-Mondolfi *et al*. 2007, Van Bressem *et al.* 2007; 2009).

Potential threats

Other contaminants

Regarding chemical pollution, it is likely that Guiana dolphins inhabit several hotspots of environmental contamination by polycyclic aromatic hydrocarbons (PAHs). Oil spills have been mentioned as a potential threat in Peru (McGuire, 2006[18]). The use of biomarkers

[17] Diazgranados, M.C., Mejía, P. and Acosta, A. (2002) Effect of boat traffic on the vocal and surfacing behavior of river dolphins: A key for abundance estimation methods (Abstract 5pAB3). Page 2431 *in* Proceedings, *First Pan-American/Iberian Meeting on Acoustics*, December 2002, Cancún, Mexico. *Journal of the Acoustical Society of America* 112(5)(Pt. 2).

[18] McGuire, T.L. (2006) Ecology and conservation status of riverine tucuxi (*Sotalia fluviatilis*) in the Pacaya-Samiria Reserve, Peru. Page 17 *in* Siciliano, S., Borobia, M., Barros, N.B., Marques, F., Trujillo, F. and Flores, P.A.C. (Eds), Book of Abstracts, *Workshop on Research and Conservation of the genus* Sotalia, 19-23 June 2006, Armação dos Búzios, Rio de Janeiro, Brazil. *Latin American Journal of Aquatic Mammals* 8(1-2) (supplement). http://dx.doi.org/10.5597/lajam00147.a007

of exposure to and/or effects of pollutants might become a valuable tool (Aguilar, 1987).

Planned water development in the Amazon and Orinoco basins

Dams and other types of barriers have been constructed in many of the world's rivers for hydroelectric power generation, flood control, and irrigation, producing population fragmentation and major changes in the physical and ecological attributes of the environment (Smith and Reeves, 2000; Smith *et al.*, 2000). In the Amazon and Orinoco basins several large dams have already been built, and numerous others are planned or are being considered (Best and da Silva, 1989). Another consequence of the construction of dams is the increase in methylmercury synthesis by microorganisms, associated with anaerobic degradation of the flooded organic matter (Guimarães *et al*., 2000). It is likely that these barriers have affected (or will in the future) riverine species such as *Sotalia*.

Shrimp farming in the coastal zone

The impacts of shrimp monoculture on coastal wetlands and mangroves are unambiguous. They involve extreme hydrologic and topographic transformation of the intertidal flat. The occupation of coastal habitats also takes place on a landscape-level scale. As coastal habitats such as estuaries, lagoons and mangroves are important to *Sotalia* (see da Silva *et al*., 2010, this volume), with shrimp farming occurring in various portions of its range. It was suggested at the Workshop that shorebirds have the potential to be used as indicators of regional coastal wetland functional integrity; however, marine mammal conservation must be seen as an integral part of coastal resource and biodiversity conservation to support sustainable fisheries.

Habitat loss in coastal areas and Amazon basin

Many Guiana dolphin populations are located near the most populated cities or close to strategic tourism destinations or large-scale aquaculture developments, which make them vulnerable to habitat degradation and loss associated to coastal ecosystems like beaches, mangroves and '*restingas*'. A high number of construction works are planned for the establishment of harbors, shipyards and industries on coastal bays and estuaries along Brazil and it is likely that their fate will follow the same degradation path of Guanabara Bay. A documented case is the Bay of Santos, were in the beginning of the 20th Century Guiana dolphins used to be found (Luederwaldt, 1919). The largest port in South America was built in the area ca. 120 years ago (CODESP, 1992) and today no dolphins are found in this highly impacted estuary.

The distribution of tucuxi dolphins in Ecuador overlaps areas of intensive use by human populations (Utreras *et al*., 2000; Zapata-Ríos and Utreras 2004), where habitat degradation of river and lake systems is likely to be a principal threat to local tucuxi populations. Moreover, growing human populations, the intensification of oil industry activities and the expansion of large-scale agriculture in the Ecuadorian Amazon threaten with water pollution, an increase use of outboard motors, and fishing using nets and explosives, as well as with chemical agents.

Conservation status

Legal framework

Sotalia species have been included in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix I since 1982 (ITIS, in Appendix II of CMS, and listed as 'Data Deficient' by IUCN). As threats can be different in each country, the IUCN has promoted Red Data Books of endangered species for each one. The category for *Sotalia* varies from 'Data Deficient' in Brazil (IBAMA, 2001), 'Vulnerable' in Colombia (Rodríguez-Mahecha *et al*., 2006) and Venezuela (Rodríguez and Rojas-Suárez, 2008) to 'Endangered' in Ecuador (Tirira, 2001). Despite these local categorizations, the IUCN adopted a different classification at the international level, and *Sotalia* species are considered 'Data Deficient' (Secchi, 2010)[19].

In Brazil, Peru, and Colombia national legislation protects cetaceans, including *Sotalia* dolphins (Culik, 2004). *Sotalia* dolphins are indirectly protected by various legal frameworks in Ecuador, Venezuela, Guyana and French Guiana (Table 1).

Small cetaceans are considered under the Convention on Migratory Species of Wild Animals (Culik, 2004), which is a multilateral legally binding agreement fostered under the auspices of the United Nations Environment Programme (CMS-UNEP). The Regional Seas Programme of UNEP has also promoted regional conservation of marine mammals through the adoption of Regional Marine Mammal Action Plans by member Governments. Two of them are relevant for *Sotalia* species: the Action Plan for the Conservation of Marine Mammals in the South-East Pacific and the Action Plan for the Conservation of Marine Mammals in the Wider Caribbean Region.

Protected areas

A number of countries along the distribution of *Sotalia* species have established marine protected areas for the conservation of cetacean populations. To date, however, the only known protected area explicitly created with

[19] Secchi, E. (2010) *Sotalia fluviatilis*. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.4. <http://www.iucnredlist.org>.

the aim of protecting a local *Sotalia* population is the 'Anhatomirim Area of Environmental Protection,' established by Law in 1992 (Decreto 528/1992). After 18 years of existence, however, no management plan, as required in the Brazilian National Legislation, has been adopted, nor have management actions been enforced in this area. The lack of such management measures indicates that the protected area is not fully functional and has yet to respond to the objectives for which it was established (Wedekin *et al*., 2005).

The Cayos Miskito Reserve, established in 1991 in Nicaragua, is located within one of the larger tracts of wilderness remaining in Central America (Edwards and Schnell, 2001) and the mangrove-lined lagoons and rivers that characterize the coastline of the Reserve form a continuous estuarine region and support significant numbers of Guiana dolphins (Carr and Bonde 2000).

The Pacaya-Samiria Reserve, in the Peruvian Amazon, appeared to contain a significant number of tucuxis, as indicated by population estimates in the Samiria River system over the period 1991-2000 (Leatherwood, 1996; Henningsen, 1998; Zúñiga, 1999; McGuire, 2002; 2006[18]).

Recommendations from the Workshop

GENERAL RECOMMENDATIONS

1) Develop a Geographic Information System (GIS) tool to map layers on (a) incidental catch, (b) direct catch, (c) chemical contamination of different types, (d) development activities associated with chemical contamination, (*e.g*. oil/gas; mining), (e) tourism and other human activities.

Table 1. National legislation applicable to the conservation of *Sotalia* dolphins.

COUNTRY	LEGISLATION
Honduras	No information available
Nicaragua	Presidential Decree (1991) - Create Cayos Miskito Reserve
Costa Rica	No information available
Panama	No information available
Colombia	Law (2005) from the Ministry of Environment and Territorial Development of Colombia. *Sotalia guianensis* was declared as *vulnerable* species under the criteria of the IUCN. Prohibited the intentional capture and captivity of this species. *Sotalia fluviatilis* was declare as *endangered* in Colombian territory.
Venezuela	Presidential Decree No. 1485 (1996). Species protected from hunting Presidential Decree No. 1486 (1996). On endangered species
Brazil	Federal Laws • Nº 5197 (03 Jan. 1967). Protection of Fauna. Modifications: Nº 7653 (17 Feb. 1988) and Nº 9111 (10 Oct. 1995) • Nº 6938 (31 Aug. 1981). National Environmental Policy, its objectives and implementation mechanisms. • Nº 7643 (18 Dec. 1987). Prohibition of hunting or any form of intentional harassment of cetaceans in national jurisdiction waters. • Nº 9605 (12 Feb. 1998). Penal and administrative sanctions from detrimental behavior and activities to the environment (a.k.a. Environmental Crimes Law). • Nº 9985 (18 Jul. 2000) – National System of Protected Areas Federal Decrees • Nº 88218 (06 Apr. 1983). Create the Abrolhos National Marine Park • Nº 528 (20 May 1992). Create and define the limits of the Anhatomirim Environmental Protection Area, specially created to protect the local population of *Sotalia fluviatilis*. • Nº 3179 (21 Oct. 1999). Regulations pertaining to the Environmental Crimes Law. Regulations • IBAMA(Instituto Brasileiro de Meio Ambiente e Recursos Naturais Renováveis). Nº 117 (26 Dec. 1996. Regulations to prevent harassment in national jurisdictional waters. • IBAMA Nº 05-N (20 Jan. 1998. Establish regulations to safeguard the reproduction, resting, and calving of *Sotalia fluviatilis* in the Anhatomirim Environmental Protection Area, Santa Catarina. • IBAMA Nº 98 (14 Apr. 2000). Regulations for the maintenance and management of aquatic mammals in captivity with the objectives of rehabilitation, research, education and public display.
Ecuador	Resolution of Ministry of Environment No. 105, Register No. 5 (28 Jan. 2000). Prohibits hunting of *Sotalia fluviatilis*.
Peru	The Pacaya-Samiria Reserve

2) Further develop existing stranding networks and sampling programs in order to collect tissues of *Sotalia* as well as biopsies for integrated ecological studies.

Specific recommendations

Incidental and direct catch

1) Enhance and further develop systematic and standardized collection of data on mortality, fishing efforts, detailed description of nets involved and biological information from animals caught, including the origin and magnitude of dolphin meat consumption or use of dolphin parts in rituals.
2) Based on the evaluation of the above in item 1, place mortality in a relative context to population size.
3) Based on the items 1 and 2, develop mitigation measures tailored to local socio-economic contexts and realities, recognizing that without such considerations mitigation measures might not be effective.

Chemical pollution

1) Increase the geographic extent of ecotoxicological investigations.
2) Increase the effort on determination of highly toxic emerging compounds (*e.g.* PBDEs, PFCs).
3) Perform studies on trophic transfer of pollutants in ecosystems used by *Sotalia* species, especially in critical areas from South and Southeast Brazil.
4) Conduct contaminant-specific biomarker assays of exposure and effects.
5) Perform pollutant level monitoring of *Sotalia* through remote biopsy sampling of skin and blubber.

Acoustic pollution

1) Investigate the potential effects of man-made noise (including seismic activities) on behavior, habitat use and sound emissions of *Sotalia*.

Water dams and gold mining

1) Establish a baseline of information on at least two potentially important types of threat: water development projects and gold mining operations. Produce a document similar to the Register of Water Development Projects Affecting River Cetaceans in Asia (Smith *et al.*, 2000). It should list all dams and other artificial barriers as well as gold mining sites in the river systems inhabited by one or both South American river dolphin species. Technical and geographic details and accurate maps showing the locations of water development and gold mining projects should be included. This initiative is viewed as an important first step in evaluating the magnitude of these threats and recommending appropriate mitigation and management.

Tourism

1) In partnership with stakeholders (public and private sector, academia, etc.), develop measures to improve tourism management, such as codes of conduct, especially for dolphin watching activities within the limits of protected areas, including licensing and training of operators and personnel involved.
2) Develop management plans for protected areas of relevance to *Sotalia* along with monitoring of benefits generated.
3) Recommend Brazilian authorities to urgently elaborate, publish and implement the management plan for the APA Anhatomirim.
4) Further assess the potential impacts of boat traffic (speed of pleasure boats and jet skis) in both the marine and freshwater environments.

Habitat loss

1) Monitor habitat use patterns by *Sotalia* populations and anthropogenic activities within protected areas.
2) Integrate *Sotalia* dolphin research and conservation into ecological studies and educational programs in existing protected areas.
3) Define areas of great relevance for the conservation of the species aiming the definition of new protected areas or other measures to reduce the impacts on important habitats for the species.
4) Enforce regulations where protected areas already exist.

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Managed by Marcos Santos.