ABUNDANCE AND DENSITY ESTIMATES FOR *Sotalia guianensis* (CETACEA, DELPHINIDAE) IN BABITONGA BAY, SOUTHERN BRAZIL

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Abstract
Sotalia guianensis is subject to great threat throughout its entire area of distribution. The occurrence of this species in the Babitonga bay estuary, north coast of Santa Catarina state, Brazil, is continuous all year. Boat samplings were conducted to get information about its abundance and population density in this area between 2000 and 2003. The sampling was aleatory and stratified, with 46 transects established in 5 large distributed areas, in a total area of 160 km2. The data collection was conducted following the linear transect sampling method, using Distance 4.0 software for analysis. A total of 1,174.7 km were scanned in effort and 163 groups of dolphins were counted. Areas 2, 3 e 5, positioned in the central region of the bay represented the greatest number of registers. Area 4, located in the innermost area of the bay do not showed any register. Area 1, where is the harbor entrance channel, showed a low number of registers. Group size ranged from 1 to 30 animals (5.34 ± 5.59). The depth ranged from 1 to 22.8 meters with an average of 7.59 meters. An inverse correlation was observed between depth and group size for 2002 and 2003 years. In 2001 it was not observed any correlation. Density and abundance were derived for each sampling period and Model 1 (Half-Normal) fitted the data best in all situations. Abundance was estimated in 231 (95% CI: 147 - 365) (2001), 137 (95% CI: 78 – 240) (2002) and 154 (95% CI: 71 – 332) (2003) animals. The highest density was obtained in 2001, with 1,446 ind./km2 (95% CI: 0.917 – 2.28); 0.857 ind./km2 (95% CI: 0.49 – 1.5) in 2002 and 0.962 ind./km2 (95% CI: 0.446 – 2.075) in 2003. The monitoring of this population is considered fundamental because of the great number of impacts on the bay that represents a continuous threat to its conservation.

Key words: *Sotalia guianensis*, density, abundance, group size, distribution

Introduction

Considering management and conservation purposes, the knowledge of a population size is a fundamental parameter to be analyzed (Ricklefs, 2003). During the last decade there has been an increase in the number of censuses of marine mammal populations designed to estimate absolute abundance, resulted from an increased concern for the status of potentially endangered stocks of marine mammals (Hammond, 1986).

The estuarine dolphin, *Sotalia guianensis*, is a small cetacean that occurs only in Southern America and in a portion of Central America. In this work the definition of Monteiro-Filho et al. (2002) is adopted, that define as *S. guianensis* the marine form of the genus Sotalia, and S. fluviatilis the riverine form, that occur only in the Amazon basin. Its distribution is continuous from Florianópolis, Santa Catarina (Simões-Lopes, 1988), to Nicaragua (Carr and Bonde, 2000). Considering that this specie commonly occurs in coastal

areas, it is constantly subject to the impacts resulted from human activities.
Although many studies about ecology of the species are being conducted in the last years, population parameters estimates are still scarce. Population density estimates were conducted in Nicaragua (Edwards & Schnell, 2001), and in different bays in south and southeastern Brazil, like Guanabara bay (Geise, 1991), Paranagua estuary (Filla, 2004), Guaratuba bay (Filla, 2004) and Guaraqueçaba bay (Bonin, 1997). In Emboraí bay, northern Brazil (010 01´39.8´´S; 460 27´39.9´´W), Torres and Beasley (2003) estimated abundance values from individuals counted along transects, without a statistical analysis.

The occurrence of resident populations was already confirmed for many areas along the specie distribution in Brazil, like Guanabara bay (Pizzorno et al., 1996), Cananéia estuary (Santos et al., 2001), Babitonga bay (Cremer, 2000; Hardt et al., 2002) and North bay (Flores, 1999). Pizzorno (1998) used photoidentification data for abundance estimates working with capture-recapture methods. The research presented here aims an analysis of *S. guianensis* population density and abundance in Babitonga bay.

Material and Methods

Study area
Babitonga bay is located on the Santa Catarina state northern littoral, in the Brazilian southern region (26o02' - 26o28'S and 48o28' - 48o50'W), including an area of 160 km2 (Figure 1). The bay is connected with the ocean only through a 1.7 km wide channel. The maximum depth is 28 meters in the main channel, with a mean depth of 6 meters, and extensive sandbanks. The estuary receives many rivers, being considered however a homogeneous estuary in its physical-chemical parameters (IBAMA, 1998). In the interior there are many islands and the margins consist of mangroves, rocky shores and sand-muddy beaches. The region suffers a strong anthropogenic pressure, arising from the urban occupation of the banks and the utilization of the area for harbor, fishing and leisure activities that represent direct and indirect threats to the cetacean populations that live in the bay.

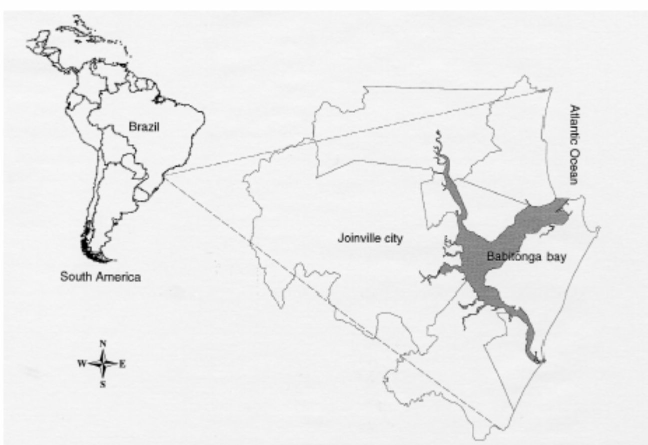

Figure 1 – Location of the study area: Babitonga bay, southern Brazil (26°02' - 26°28'S and 48°28' - 48°50'W).

Sample design

For the abundance estimates we used the line transect method (Buckland et al., 2001). The samplings were realized during three periods. Between December 2000 and November 2001, we conducted monthly samplings as we also did between April 2002 and February 2003. In 2003, the samplings were seasonal throughout the four seasons.

The transects cover the whole study area represented in the Nautical Charts N. 1804 and 1805 from DHN (Board of Naval Hydrography) on a 1:28 000 scale (Figure 2). Whenever possible, transects were traced transversally to the coastal margin. However, the presence of islands and sandbanks in some places forced us to trace some transects parallel to the coastal margin. In this way, 46 transects were established, with a distance of 400 meters between them when parallel. Transects were distributed in 5 wide areas of different size that were arbitrarily defined, with the aim of conducting a stratified that took the nonhomogeneous distribution of the population in the area into consideration. The characteristics of each area are presented in Table 1. In each sampling period (month or season), transects in each area were selected at random, with the exception of Area 4 that had only one transect. Adjacent transects were not traced because of areas overlap, considering the previous experience of the team in connexion with observation of the species.

Table 1 – Characteristics of 5 areas defined in Babitonga bay for conduct density and abundance estimates of estuarine dolphins.

Area	*Size*	*Principal characteristics*
1	42.94 km^2	Comprehend the area of the channel that connect with the ocean; major depths of the bay (> 20 metre). Margins with mangroves and sand-muddy beaches.
2	25.24 km^2	Comprehend the central area of the bay, involving the harbor inlet and São Francisco do Sul city; depth with medium values; high submerged rock concentration; islands. Margins with mangroves, sand-muddy beaches and rocks.
3	31.40 km^2	Comprehend the inner area where occurs the main currents encounter; depth with medium values; high submerged rock concentration; many islands; great size sandbanks. Margins with mangroves, sand-muddy beaches and rocks
4	7.67 km^2	Comprehend the environment with more freshwater characteristics of the bay; highest concentration of mangroves that cover almost all margins; depth with medium values.
5	52.90 km^2	Comprehend the area of Linguado channel, closed in 1938, that suffers an intense sedimentation process; high mangrove concentration that cover almost all margins; connection with Saguaçu lagoon, that receive the main drainage of Joinville contaminants.

Data collection

The first months of standardized sampling collection were considered as a training period and the data was not used in the analysis. This took place in October and November 2000 and included 41 transects, 143.3 km, and 10 sightings. Throughout the entire study period, the same team of observers was maintained. In the training period, observers used reticulated binoculars for the estimation of the radial distance of the sightings.

During the sampling period, two boats were used, both of 5.5 meters in length, equipped with 40 and 60 Hp outboard motors. All the samplings were conducted in the presence of two observers standing on the boat's prow, and the pilot doing the recording. The pilot was not generally involved in the animal observations, but occasionally helped in the counting of individuals. The diary effort was variable, dependent on the environmental conditions, which was also the case of the sampling schedule. However, the samplings were normally conducted in the morning when the wind was lower. The speed of the boat was always between 10 and 15 km/h and the samplings were carried out in sea conditions of Beaufort 0 and 1. Poorer sea conditions were considered to be too limiting for the detection of the species. When the sea conditions altered during transect, the effort was stopped and the sampling discarded. Immediately after a sighting was detected, the angle (angle board), radial distance (visual estimate), time, depth (ecobatimeter), geographic position (GPS) and group size were recorded. The calves counted in this study were not finally considered because their identification at some distance was doubtful.

Data analysis
Data analysis included only the registers obtained "in effort", without consider the training period. The sightings that occurred between transects ("off effort") were recorded as being complementary.

The data was analyzed using Distance 4.0 _ software. The criterion used by the program to choose the model that best fitted the data was the smallest AIC (Akaike Information Criterion) (Akaike, 1973). Perpendicular distance data were truncated at 500 m. The estimated probability of detection on the trackline was assumed to be equal to one here (g(0) = 1) for all the study period, because of three factors: low speed of the boat during transects (Y 15 km/h), good environmental conditions during transects (Beaufort Y 1) and small boat size. Many potential detection functions were initially tested together with various adjustment terms. The analyses were made considering the area as a whole, with 155 km2, for each sampling period. For each area we also conduct an analysis, resulting in density estimates of the population that were after statistically compared.

Results
In all three years population shows a very high heterogeneous distribution in the bay, with the highest concentration in area 3 (Table 2).

Table 2 – Number of *S. guianensis* groups registered on each sampling area in the period between 2001 and 2003.

AREA	*2001*	*2002*	*2003*
1	8	3	0
2	15	11	10
3	43	30	22
4	0	0	0
5	13	5	2

Group size and depth
Considering the entire study period, 163 groups of estuarine dolphins were registered, totaling 871 individuals. Table 3 presents the data of each period.

Table 3 – *S. guianensis* group size parameters during transects sampling on Babitonga Bay, northern littoral of Santa Catarina state.

Study year	Minimum – Maximum	Mean ± SD (95%)	Mode	Individuals	Groups
2001	1-30	5.28 ± 5.49	3	417	79
2002	1-30	6.50 ± 6.43	2	318	49
2003	1-22	3.88 ± 4.14	2	136	35
Total	1-30	5.34 ± 5.59	2	871	163

Depth in the areas of occurrence varied between 1 and 22.8 meter, with a mean depth around 7 meter (Table 4).

Table 4 – Depth distribution of estuarine dolphins in the Babitonga bay, northern littoral of Santa Catarina state.

Study year	Minimum – Maximum	Mean ± SD (95%)
2001	1 - 22.8	7.19 ± 4.05
2002	1.5 – 20.5	7.85 ± 4.20
2003	1 – 13.2	7.73 ± 3.11

Analysis of depth and group size correlation (Spearman Rank Correlation) result in absence of correlation in 2001distribution (r = 0.053; p = 0.659 > 0.05; n = 72) and an inverse correlation in 2002 and 2003 distribution (2002: r = - 0.373; p = 0.014 < 0.05; n = 42) (2003: r = - 0.424; p = 0.011 < 0.05; n = 35).

Abundance and density estimates

We spent 92 days, with 1,294.40 km conducted in effort along the three years period. Table 4 summarizes the information about effort.

Table 4 - Line transect effort along three years for *S. guianensis* population estimates in the Babitonga bay, northern littoral of Santa Catarina state.

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Year	*Days*	*Kilometers*
2001	42	554.2
2002	35	391.8
2003	15	294.4

For abundance estimates we conduct one analysis for each year, considering the total area. The half-normal model, without data adjustments, was the best fit for perpendicular distance data, in all the analyses realized.

Table 5 summarizes the results of densities and abundance for the three periods. In 2001, the population density estimative as well as the abundance were the highest along the years, with an abundance of 231 individuals (CI = 147 - 365; _ = 0.05) (%CV = 22.92). Figure 2A, 2B and 2C shows the distribution of perpendicular distances and the detection function adopted for each analysis. The medium abundance between the three years correspond a one population of 174 individuals.

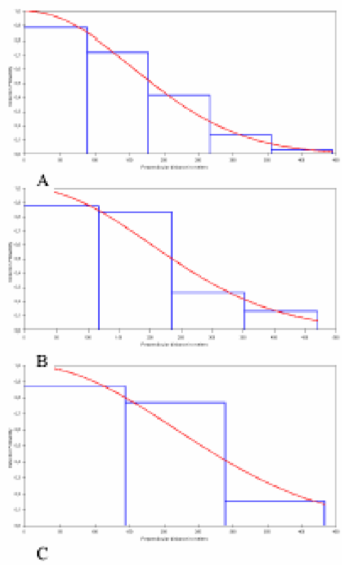

Figure 2 –Frequency distribution of perpendicular distances of *S. guianensis* sightings. The continuous line represents the best fit function, being the Hal-normal model in all years. A) 2001; B) 2002; C) 2003.

Table 5 - Model parameters used, density and abundance for estuarine dolphins in Babitonga Bay, SC, Brazil.

Parameter	Point estimate			Standard error			% CV			95% CI		
	2001	2002	2003	2001	2002	2003	2001	2002	2003	2001	2002	2003
f (0)	0.005	0.004	0.003	0.0004	0.0004	0.0005	8.50	10.68	14.43	0.004-0.006	0.003-0.005	0.003-0.005
P	0.437	0.525	0.597	0.037	0.056	0.086	8.50	10.68	14.43	0.369-0.517	0.423-0.650	0.446-0.800
ESW (km)	194.31	246.72	258.72	16.515	26.344	37.331	8.50	10.68	14.43	164.11-230.06	199.15-305.66	193.26-346.36
Encounter rate (n/L)	0.142	0.122	0.119	0.026	0.027	0.036	18.42	22.67	30.37	0.097-0.208	0.076-0.197	0.0590-0.240
Density of groups (groups/km^2)	0.367	0.248	0.230	0.074	0.062	0.077	20.68	25.06	33.62	0.243-0.553	0.149-0.414	0.111-0.474
Average group size (s)	3.941	3.453	4.186	0.420	0.436	0.688	10.66	12.64	16.43	3.189-4.871	2.680-4.449	3.004-5.834
Density of individuals	1.446	0.857	0.962	0.331	0.240	0.360	22.92	28.07	37.42	0.917-2.280	0.490-1.500	0.446-2.075
Abundance	231	137	154	52.935	38.449	57.629	22.92	28.07	37.42	147-365	78-240	71-332

Discussion

Abundance estimates

Distance sampling method was considered very useful for estimate population parameters for *S. guianensis*. Some problems, related to the use of this method, could be ignored in this case. Responsive movement, as mentioned by Palka and Hammond (2001), was not detected, maybe because this population is habituated to the continuous boat traffic in the bay and does not show the bow-riding behavior. Total detection capacity of animals on the trackline, an important assumption in the method (Thomas et al., 2002a) was believed to be also attended.

The abundance estimate reported in this paper corresponds to a specific population, that occurs year round in Babitonga bay, as confirmed with photoidentification studies (Cremer, 2000; Hardt, 2005). That constitutes a characteristic feature in the species´ distribution along the coast.

Until now population abundance estimative for *S. guianensis* are based on photoidentification techniques. Pizzorno (1999), using mark-recapture methods through photoidentification, estimated Guanabara bay (BR) population obtaining values between 69 and 75 animals (95%). Estimated density in other sites along the specie distribution show different values, using different methods too. Edwards and Schnell (2001), using strip transects in northern distribution limit of the specie founded a very similar density value, of 0.967 ind./km2 for the area of highest concentration. In Paranagua bay density was very higher, resulting in an estimate of 11.56 ind./km2, varying between 0.48 ind./km2 and 19.52 ind./km2 (Filla, 2004). In Guaratuba bay density was very lower, of 0.14 ind./km2 (Filla, 2004). Because the use of different analysis methods, it is no possible to compare our results with those obtained in other works with *S. guianensis* population estimates.

The mean abundance estimated in this study is considerably higher that the population estimated for Tursiops truncatus in Sarasota, Florida. Wells et al. (1980), using photoidentification techniques, estimated a population of 100 individuals for a 85 km2 area. However, *T. truncatus* is a bigger specie (around double size) and the area considered was a half of the size.

In Babitonga bay, *S. guianensis* population is sympatric of a Pontoporia blainvillei population, both occurring along the year in this area (Cremer and Simões-Lopes, 2005). Estimated density for that population was of 75 individuals (95% CI: 41-135) (Cremer et al., 2004), lower that of *S. guianensis*. Maybe, P. blainvillei is more sensitive, considering the impacts that the area is suffering. However, this is the only area along brazilian coast were this specie occur continuously.

Differences between density and abundance of small cetacean populations in different areas probably reflect differences in productivity of the areas and availability of prey, so as the effect of human impacts caused by overfishing, habitat degradation, contamination by chemicals and incidental mortality in fishing gear. It is probable that all these impacts affect population parameters such as abundance and density; therefore, long time monitoring is needed to evaluate this impact.

Acknowledgments

The authors are indebted of the students Angelita Marcucci and Alexandre Herbst, that helps in the field work. The research was possible with the financial support provided by the Universidade da Região de Joinville through their Fundo de Apoio À Pesquisa. Paulo Simões-Lopes and Francisco Barreto provided review. We are grateful to IPE/CI that promoted the Quantitative Ecological course in 2003.

References

Akaike, H. (1973). Information theory and an extension of the maximum likelihood principle. In: International Symposium on Information Theory. 2nd. B.N. Petran and F. Csaàki (Eds). Akadèemiai Kiadi, Budapest, pp. 267-281.

Baumgartner, M.F. (1997). The distribution of risso´s dolphin (*Grampus griseus*) with respect to the physiography of the northern Gulf of Mexico. Marine Mammal Science 13(4): 614–638.

Bonin, C. A. (1997). Estimativa de densidade populacional do golfinho *Sotalia fluviatilis guianensis* (Cetacea, Delphinidae), na Baía de Guaraqueçaba, litoral do estado do Paraná. Monografia Bacharelado), Universidade Federal do Paraná, Curitiba, 44 pp.

Bordino, P. and Tausend, P. (1998). Avistabilidad y estimacion preliminar de densidad del delfin franciscana *Pontoporia blainvillei* en Bahía Anegada, Argentina. Page 28 in Resumos, XVIII Reunião de Trabalho de Especialistas em Mamíferos Aquáticos da Américo do Sul, 25-29, Outubro Olinda, Brasil.

Buckland, S.T., Anderson, D.R.; Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. (2001). Introduction to Distance Sampling. Oxford University Press, London.

Carr, T. and Bonde, R.K. (2000). Tucuxi (*Sotalia fluviatilis*) occurs in Nicaragua, 800 km of its previously known range. Marine Mammal Science (16): 447-452.

Clemmons, J.R. and Buchholz, R. (1997). Linking conservation and behavior. In: Behavioral approaches to conservation in the wild. J.R. Clemmons and R. Buchholz (Eds). University Press, Cambridge, pp. 23-47.

Cremer, M. J. (2000). Ecologia e conservação do golfinho *Sotalia fluviatilis guianensis* (Cetacea, Delphinidae) na Baía de Babitonga, litoral norte de Santa Catarina. Dissertação de Mestrado. Universidade Federal de São Carlos. 226p.

Cremer, M. J., Hardt, F. A. S., Marcucci, A., Tonello Jr., A. J. & Simões-Lopes, P.C. (2004). Estimativas de abundância da população de toninhas, *Pontoporia blainvillei*, na Baía da Babitonga, SC, Brasil. Pages 51-52. in Abstracts, XI Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur. 11-17, September Quito, Ecuador.

Cremer, M.J. & Simões-Lopes, P.C. (2005). The occurrence of *Pontoporia blainvillei* (Gervais & D´Orbigny) (Cetacea, Pontoporiidae) in an estuarine are in southern Brazil. Brazilian Journal of Zoology. 22 (3): 717-723.

Di Beneditto, A.P.M., Ramos, R.M.A. and Lima, N.R.W. (1998). Fishing activity in Northern Rio de Janeiro State (Brazil) and its relation with small cetaceans. Brazilian Archives Biology of Technology. 41(3): 296-302.

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

Edwards, H. H. and Schnell, G.D. (2001). Status and ecology of *Sotalia fluviatilis* in the Cayos Miskito Reserve, Nicaragua. Marine Mammal Science. 17(3): 445-472.

Filla, G. 2004. Estimativa da densidade populacional e estrutura de agrupamento do boto-cinza *Sotalia guianensis* (Cetacea: Delphinidae) na baía de Guaratuba e na porção norte do Complexo Estuarino da Baía de Paranaguá, PR. Dissertação de Mestrado. Universidade Federal do Paraná, Curitiba.

Flores, P. A. C. (1999). Preliminary results of a photoidentification study of the marine tucuxi, *Sotalia fluviatilis*, in Southern Brazil. Marine Mammal Science, 15 (3): 840-847.

Geise, L. (1989). Estrutura social, comportamental e populacional de *Sotalia* sp. (Gray, 1886) (Cetacea, Delphinidae) na região estuarino-lagunar de Cananéia, SP e na Baía de Guanabara, RJ. Dissertação de Mestrado. Universidade de São Paulo, São Paulo, 198 pp.

Geise, L. (1991). *Sotalia guianensis* (Cetacea, Delphinidae) population in the Guanabara Bay, Rio de Janeiro, Brazilian Mammalia, 55(3), 371-379.

Hammond, P. S. (1986). Line transect sampling of dolphins populations. In M. M.Bryden & R. Harrison (Eds). Research on Dolphins. Oxford. Clarendon Press.

Hardt, F. A. S., Cremer, M. J., Tonello Junior, A. J., Herbst, A., Marcucci, A., Pinheiro, L. 2002. Uso de Fotoidentificação para estudo da população de *Sotalia guianensis* na Baía da Babitonga, Santa Catarina, Sul do Brasil. Pages 91- 92 in Abstracts, X Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur. 14-19 Octubre, Valdivia, Chile

Hardt, F. A. S., (2005). Padrões de residência do golfinho *Sotalia guianensis* (CETACEA, DELPHINIDAE) na Baía da Babitonga, litoral norte de Santa Catarina, Brasil. Dissertação de Mestrado. Universidade Federal do Paraná, Curitiba.

Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. 1998. Proteção e Controle de Ecossistemas Costeiros: manguezal da Baía de Babitonga. Coleção Meio Ambiente: Série Estudos – Pesca. Edições IBAMA, Brasília, DF.

Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis. (2001). Mamíferos aquáticos do Brasil: Plano de Ação. Brasília: Grupo de Trabalho Especial de Mamíferos Aquáticos, Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis,Edições IBAMA, Brasília, DF.

Monteiro-Filho, E. L. A.; Monteiro, L. R. Reis. S. F. (2006). Skull shape and divergence in dolphins of the genus *Sotalia*: a tridimensional morphometric analysis. Jornal of Mammalogy, 83 (1):125-134.

Palka, D.L. & Hammond, P.S. (2001). Accounting for responsive movement in line transect estimates of abundance. Canadian Journal of Fisheries and Aquatic Science. 58: 777-787.

Pizzorno, J. L. A. (1999). Estimativa populacional do boto-cinza, *Sotalia fluviatilis*, na Baía de Guanabara, por meio de catálogo de fotoidentificação. Dissertação de Mestrado. Universidade Federal Rural do Rio de Janeiro, Seropédica, RJ. 47 pp.

Pizzorno, J. L. A.; Lailson-Brito, J. Jr., & Gurgel, I. M. G. do N. 1996. Observações do boto cinza *Sotalia fluviatilis* (Gervais, 1853), na Baía de Guanabara, RJ-Brasil. Page 88 in Abstracts, XII Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur. 22-25 Octubre, Viña del Mar, Chile.

Pizzorno, J. L. A.; Lailson-Brito, J. Jr., & Simão, S. M. 1998. Estimativa populacional do boto-cinza, *Sotalia fluviatilis*, na Baía de Guanabara (RJ, Brasil): dados preliminares. Page 165 in Abstracts, Reunión de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur. 14-19 Octubre, Valdivia, Chile.

Primack, R.B., and Rodrigues, E. (2001). Biologia da Conservação. E. Rodrigues, Londrina.
Reeves, R.R., Smith, B.D., Crespo, E. and Notarbartolo di Sciara, G. (2002). Dolphins, whales and porpoises. 2002 – 2010 Conservation Action Plan for the world's cetaceans. International Union for the Conservation of Nature.

Ricklefs, R. E. (2003). A Economia da Natureza. Quinta Edição. Rio de Janeiro: Guanabara Koogan.503 p.

Rosas, F.C.W. and Monteiro-Filho, E.L.A. (2002). Reproduction of the estuarine dolphin (*Sotalia guianensis*) on the coast of Paraná, southern Brazil. Journal of Mammalogy 83 (2): 507-515.

Santos, M. C. O., Acuña, L. B. and Rosso, S. (2001). Insights on site fidelity and calving intervals of the marine tucuxi dolphin (*Sotalia fluviatilis*) in southern Brazil. Journal of the marine Biological Association of the United Kingdom, 81, 1049-1052.

Secchi, E.R., Ott, P.H., Crespo, E.A., Kinas, P.G., Pedraza, S.N. and Bordino, P. (2001). A first estimate of franciscana (*Pontoporia blainvillei*) abundance off southern Brazil. J. Cetacean Research Management 3(1): 95-100.

Selzer, L.A., and Payne, P.M. (1988). The distribution of white-sided (*Lagenorhynchus acutus*) and common dolphins (Delphinus delphis) vs. Environmental features of the continental shelf of the northeastern United States Marine Mammal Science. 4(2): 141-153.

Siciliano, S. (1994). Review of small cetaceans and fishery interactions in coastal waters of Brazil. Reports of International Whaling Commission 15: 241-250.

Simões-Lopes, P. C. (1988). Ocorrência de uma população de *Sotalia fluviatilis* (Gervais, 1853) (Cetacea, Dephinidae) no limite sul de sua distribuição, Santa Catarina, Braisl. Biotemas, 1 (1): 57-62.

Simões-Lopes, P.C. and Ximenez, A. (1993). Annotated list of the cetaceans of Santa Catarina coastal waters, Southern Brazil. Biotemas 6 (1): 67-92.

Thomas, L., Buckland, S. T., Burnham, K.P., Anderson, D. R., Laake, J.L., Borchers, D.L. & Strindberg, S. (2002). Distance sampling. In: El-Shaarawi, A. H. & Piegorsch, W.W (Eds).. Encyclopedia of Environmetrics. John Wiley & Sons, Chichester.

Thomas,L., Laake, J.L.,Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson,D.R., Burnham, K.P., Hedley, S.L. and Pollard, J.H. (2002). Distance 4.0 Release 1. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. Available from http://www.ruwpa.st-and.ac.uk/distance/

Torres, D., and Beasley, C.R. (2003). Pattern of use of a small bay in northern Brazil by *Sotalia guianensis* (Cetacea: Delphinidae). Amazoniana XVII (3/4): 583-594.

Wells, R. S., Irvine, A. B. and Scott. M. D. (1980). The social ecology of inshore odontocetes. In L. M. Herman (Ed.). Cetacean behaviour; mechanisms and functions. New York, John Wiley, p. 263-317.

Whitehouse, A.M., Hall-Martin, A.J. and Knight, M.H. (2001). A comparison of methods used to count the elephant population of the Addo Elephant National Park, South Africa. African Journal of Ecology 39: 140 – 145.