A note on strandings and age of sperm whales (*Physeter macrocephalus*) on the Brazilian coast

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ABSTRACT

This note compiles recorded strandings of sperm whales on the Brazilian coast. A known total of 95 sperm whales (62 single and one mass stranding of 33 individuals) stranded along the Brazilian coast from 1967-2000. A higher incidence of single strandings was observed in northeastern Brazil (~05°-17°S). No strandings occurred in lower latitudes (<14°S) from June-September. The seasonal and spatial pattern observed by the reported strandings may indicate higher stranding rates in higher latitudes (~18-25°S) between June and August (winter) and in lower latitudes (~3-7°S) between January and April (summer and spring). Strandings of smaller sperm whales (3-4.5m) were observed during the austral summer and autumn, indicating seasonality in the birth season. Growth-layer counts of three specimens provide the first data on age of sperm whales for Brazil.

KEYWORDS: SPERM WHALE; AGE ESTIMATION; STRANDING; BRAZIL; TEETH

INTRODUCTION

The distribution of sperm whales off eastern South America is known primarily from whaling data. Information was obtained from whaling stations operating in Costinha (7°S) and Cabo Frio (~23°S), Brazil in the 20th century (Paiva and Grangeiro, 1965; 1970; Williamson, 1975; and statistics originally provided to the Bureau of International Whaling Statistics and now held by the Secretariat of the International Whaling Commission). During the past 40 years, strandings have been regularly reported (e.g. Castelllo and Piñero, 1974; Clarke *et al.*, 1980; Alves *et al.*, 1996) although knowledge of sperm whale biology along the coast of eastern South America remains poor.

Length and age data of whales have been frequently used to infer the social structure of sperm whales from the Pacific and the North Atlantic Oceans (Martin, 1980; Avila de Melo and Martin, 1985; Arnbom and Whitehead, 1989). Age estimation by counting the growth layers groups (GLGs) in teeth (IWC, 1980) has become a standard procedure and a key parameter in assessing and managing marine mammal stocks (Scheffer and Myrick, 1980). Nishiwaki *et al.* (1958) were the first to analyse maxillary and mandibular teeth. They reported that the buried teeth in the maxillary gum are most useful for age determination of the sperm whale. Some authors consider that the first mandibular tooth is preferable for age determination, as it tends to be relatively unworn. However, for individuals that have worn mandibular teeth, it is preferable to use a straight, unerupted maxillary tooth (IWC, 1980).

A compilation of available strandings of sperm whales on the Brazilian coast is presented in this note, along with limited information on age estimation. Growth layer counts of three specimens provide the first information on age estimation of sperm whales in Brazilian waters.

MATERIALS AND METHODS

Strandings data on sperm whales reported in this paper were obtained from scientific literature, unpublished information, printed media files (e.g. newspapers and magazines) and collections from Brazilian museums for the period from 1967-2000. The distribution of strandings was analysed by geographical area: northern (~01°S), northeastern (~05°-19°S), southeastern (~20°-26°S) and southern (~27°-34°S) Brazil (Fig. 1).

To analyse seasonal and latitudinal distribution by category, specimens were classified as: mature males (>13m); females and immature individuals (7-12m); first-year individuals (5-6m); and calves (<4.5m) (Whitehead *et al.*, 1997). The interactive relationship between month and latitude of single strandings was analysed by distance weighted least squares using the 3D contour plot procedure of Statistic 5.5 for Windows.

Teeth of three specimens from the collection of the Museu Nacional, MN 50098 (#29 in Appendix Table 1) and MN 54999 (#44 in Appendix Table 1) and the collection of Universidade Federal de Santa Catarina, UFSC 1118 (#53 in Appendix Table 1), were used for age estimation. An etched half-tooth was used following the method and

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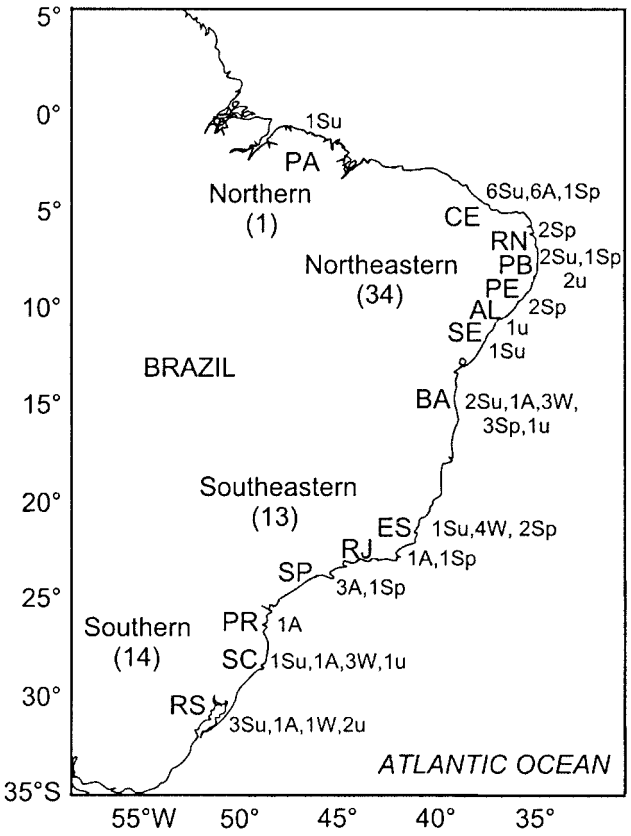

Fig. 1. Map of Brazil indicating the number of sperm whale strandings by geographical area and season. Geographical areas: northern (~01°S) - Pará (PA); northeastern (~05°-19°S) - Ceará (CE), Rio Grande do Norte (RN), Paraíba (PB), Pernambuco (PE), Alagoas (Al), Sergipe (SE) and Bahia (BA); southeastern (~20°-26°S) - Espírito Santo (ES), Rio de Janeiro (RJ) and São Paulo (SP); southern (~27°-34°S) - Paraná (PR), Santa Catarina (SC) and Rio Grande do Sul (RS). Season: Summer (Su) - December to February; Autumn (A) - March to May; Winter (W) - June to August; Spring (Sp) - September to November; and undated (u).

recommendations of Pierce and Kajimura (1980). One mandibular and one maxillary tooth from specimen MN 54999, one tooth of unknown position from specimen MN 50098 and one mandibular tooth from specimen UFSC 1118 were used. GLGs, consisting of a pair of adjacent layers, one prominent ridge and one groove in the etched tooth (IWC, 1980) were counted. The GLG counts for MN 50098 were made by four readers (RMAR, MB, W. Hoek and V.M. Kozicki) and the GLG counts for MN 54999 and UFSC 1118 were made by one of the authors (RMAR). The GLGs were counted with a binocular dissecting microscope with a magnification of 8x.

RESULTS

Strandings

A total of 95 sperm whale strandings (62 single and one mass stranding of 33 individuals) was recorded along the Brazilian coast during the period 1967-2000 (Fig. 1). Strandings are reported from Pará (~01°S) to Rio Grande do Sul (~34°S) States (Appendix Table 1). The highest incidence (54.8%) of single strandings was observed in northeastern Brazil (~05°-19°S). The stranding frequency in northern (~01°S), southeastern (~20°-26°S) and southern (~27°-34°S) Brazil was 1.6%, 21.0% and 22.6%, respectively.

Table 1

Summary of the strandings information given in Appendix Table 1.

	Total single strandings		With length information	
	Number	Percentage	Number	Percentage
Single strandings	62	100.0	38	61.3
Of which				
Males*	21	33.9	18[1]	85.7
Females	4	6.5	3[2]	75.0
Unknown	37	59.7	17[3]	45.9

* Includes three for which sex was inferred from their lengths (all were >*ca* 15m) – see Jefferson *et al.*, 1993.[1] Includes 3 calves and 1 probable yearling. [2] Includes 1 calf. [3] Includes 2 calves.

Table 1 breaks down the samples of single strandings by sex. Almost 60% of the animals were of unknown sex. The lengths of these animals, where known ($n = 17$) ranged from 3.0-12.0m. Males comprised about one-third of the total and the lengths of these, where known ($n = 18$) ranged from 3.1-18.0m. Only 6.5% of the animals were females and the three with known length ranged from 3.8-8.0m.

No records occurred in lower latitudes (< 14°S) from June-September (austral winter and early spring). However, during the austral spring and summer, from October-May, strandings of sperm whales occurred in both lower and higher latitudes (Figs 1 and 2).

The seasonal and latitudinal distribution for each estimated category is shown in Fig. 2. During the winter, mature male strandings were recorded only in higher latitudes (> 14°S). In contrast, during the summer, they were recorded only in lower latitudes (< 14°S). In spring and autumn, there were mature male records for both lower and higher latitudes. Strandings of sperm whales assigned to the class of females and immature individuals occurred along the Brazilian coast in all seasons except winter. The only probable yearling (see Discussion), a 5.7m male, stranded during summer in the lower latitudes. A higher percentage of the six strandings of calves (< 4.5m) occurred during the summer (83.3%), followed by the autumn (16.7%). Four calves were recorded in lower (< 14°S) and two in higher (> 14°S) latitudes.

Age estimation

The tooth of MN 50098, a *ca* 11.0m specimen of unknown sex, showed 21-22+ GLGs (Fig. 3A). The tooth was worn and the neonatal line could not be identified. This specimen was probably older than 21-22 GLGs, but presumably no more than one or two GLGs over this estimate, given the tooth size and shape.

The maxillary tooth of MN 54999, a 12.0m male, showed 33 GLGs (Fig. 3B). Based on the mandibular tooth of this specimen, 34 GLGs were estimated (Fig. 3C). Given the unworn condition of the teeth, the neonatal line was considered to be the first dark band. The maxillary tooth showed numerous accessory layers, mainly between layers 7 and 11, and osteodentine in three separate parts of the dentine (Fig. 3B).

The mandibular tooth of UFSC 1118, a 13.8m male, showed 40+ GLGs (Fig. 3D). The apical layers could not be identified. This tooth showed osteodentine in six separate parts of the dentine.

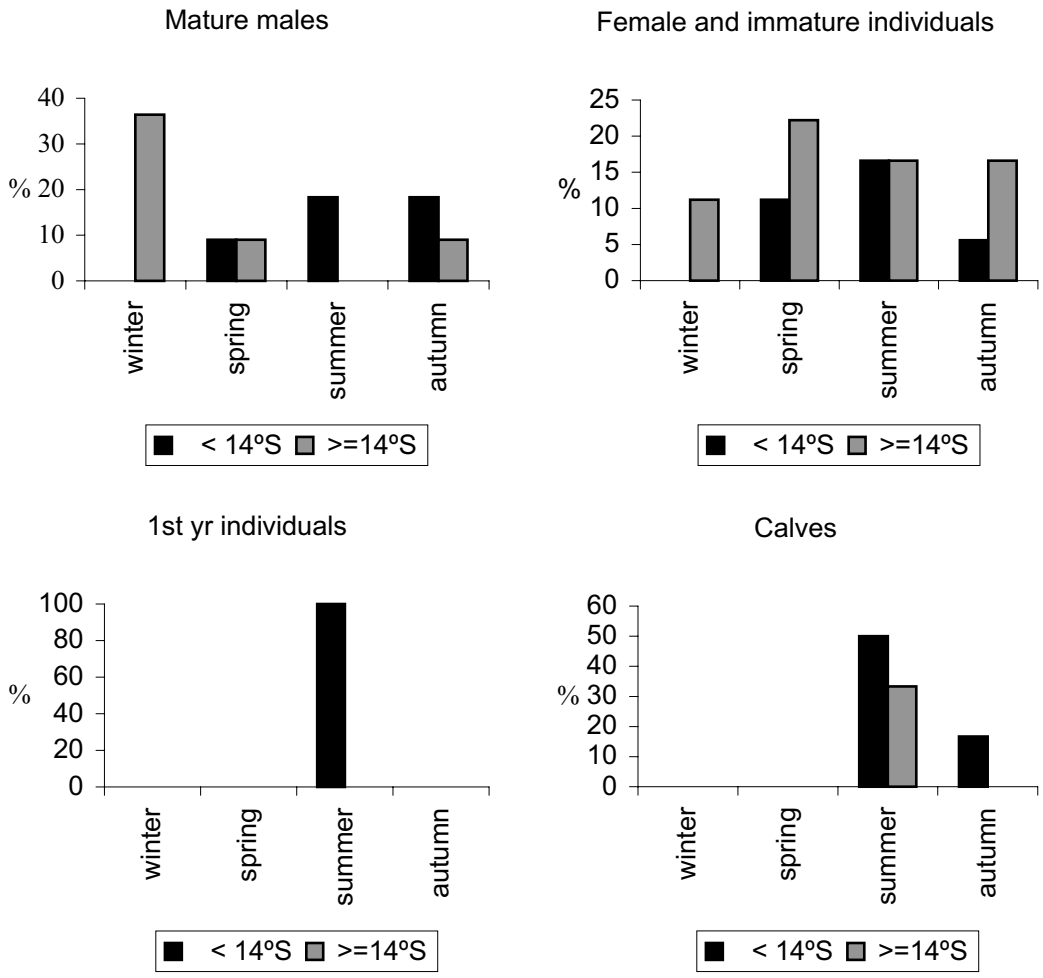

Fig. 2. Single strandings of sperm whales on the Brazilian Coast for each length-class: larger males (> 14m), females and immature individuals (7-12m), first-year individuals (5-6m) and calves (< 4.5m), by area (< 14°S and >= 14°S) and season.

DISCUSSION

Strandings data are difficult to interpret and it is not possible to draw many inferences about sperm whale distribution, seasonal occurrence or biology based solely on these data. However, some patterns were detected and are consistent with previous findings for the species.

The seasonal and spatial pattern observed by the reported strandings suggests greater incidence of strandings in higher latitudes (~ 18-25°S) between June and August (winter) and in lower latitudes (~ 3-7°S) between January and April (summer and spring), as may be seen in Fig. 4. This might be related to possible seasonal concentrations of animals. However, this needs to be confirmed by long-term directed studies.

Calves were observed to strand only in summer and autumn along the Brazilian coast, possibly reflecting a seasonal birth period. Sperm whales attain a length of 5-6m by the end of their first year (Whitehead *et al.*, 1997) suggesting that the 5.7m male, stranded in January 1996, was a yearling born during the previous summer. The possibility that sperm whale births occur in the summer-autumn period along the coast of Brazil concurs with observations from other areas. Whitehead *et al.* (1989) estimated that the birth season for the Galápagos Islands, in the Pacific Ocean, occurs during summer, with spring being the apparent peak of the breeding season. In the North Atlantic, conceptions have occurred by September or October (summer-autumn) and the breeding season also occurs during spring months (see Avila de Melo and Martin, 1985).

An age-length relationship was used here to infer maturity condition for the animals of known sex. According to a model for sperm whale dynamics (Allen, 1973; Perrin and Donovan, 1984), females are classified as either juveniles (0-2 years), sexually immature (3-9 years), or sexually mature (10+ years). Males are classified as either juveniles (0-2 years), sexually immature (3- ~ 20 years), sexually mature (~ 20-24 years), or socially mature (25+ years). The body lengths of males and females at sexual maturity ranges from 12.5-13.7m and 8.6-10.2m, respectively (Best *et al.*, 1984; Mitchell and Kozicki, 1984; Perrin and Donovan, 1984; Clarke and Paliza, 1988; Whitehead *et al.*, 1997; Hooker, 1998). Males over about 13.7m in length are considered to be socially mature (e.g. Best, 1984).

Male MN 54999 (33-34 GLGs) corresponds to an age class attributed to socially mature males, but its body length of 12.0m is small in comparison with lengths reported for males of similar age quoted in the literature. Male (UFSC 1118) measuring 13.8m, was just within range of the accepted socially mature males but its length was relatively short for males of its age (40+ GLGs). Thus in both cases, individuals were older than the corresponding size observed for other areas (Perrin and Donovan, 1984).

Given the very small sample size, this may reflect either natural variation (other studies have revealed a wide variation in age-at-length – e.g. Mitchell and Kozicki, 1984; Clarke and Paliza, 1988) or that animals off Brazil are

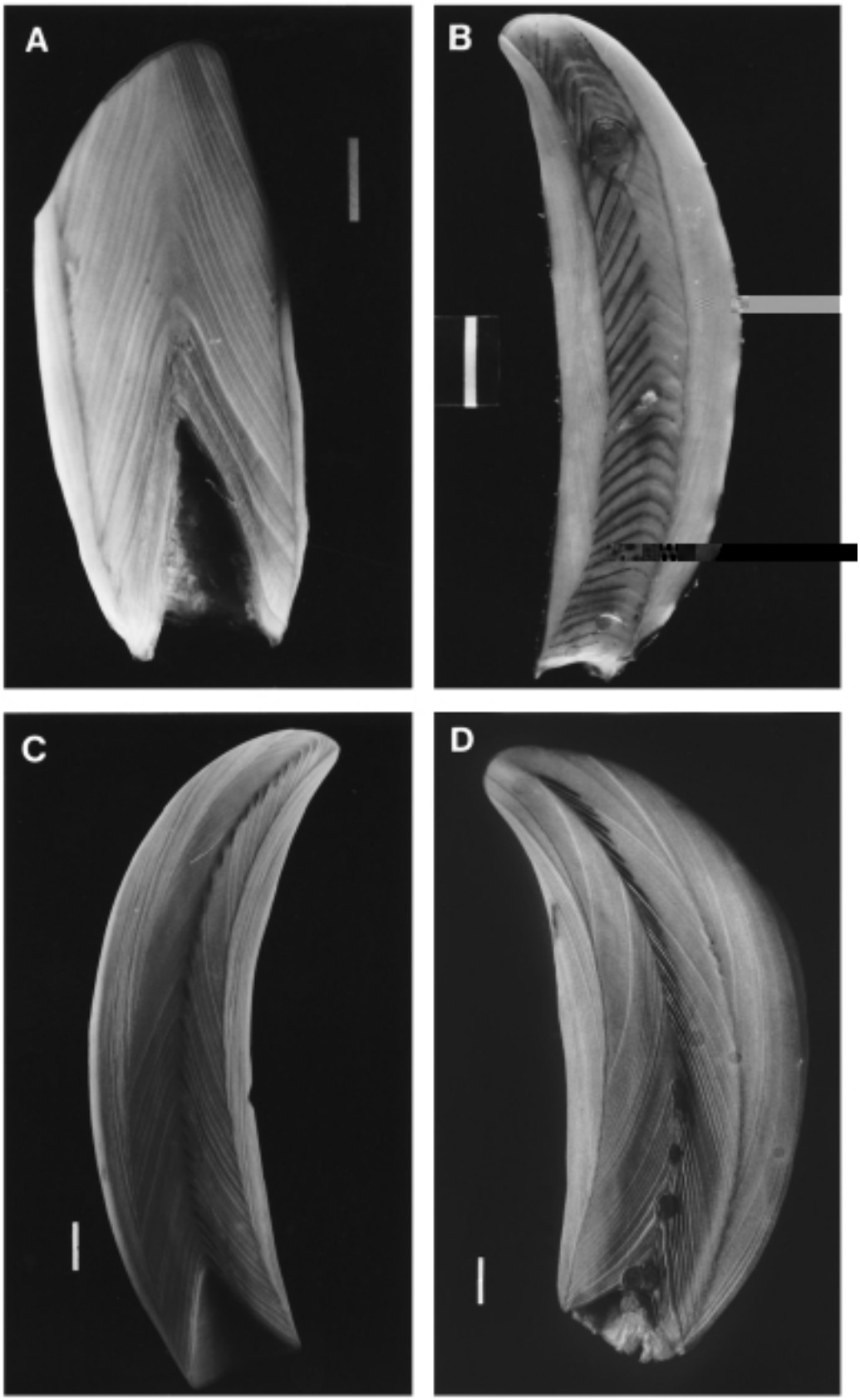

Fig. 3. Photographs of sperm whale teeth: (A) acid-etched tooth of 21-22 GLGs specimen MN 50098; (B) acid-etched maxilar tooth of 33 GLGs male MN 54999; (C) acid-etched mandibular tooth of 34 GLGs male MN 54999 and (D) acid-treated mandibular tooth of 40+ GLGs male UFSC 1118. Scale bar represents 1cm. (Photographs: Márcia Adriana Dutra and Arthur Rodrigues).

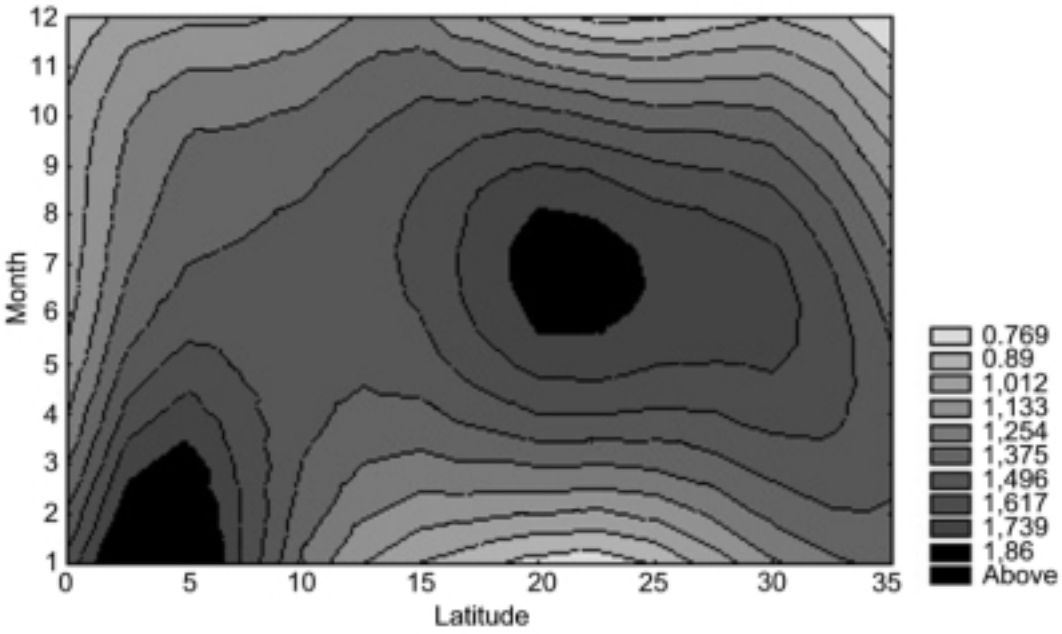

Fig. 4. Seasonal and spatial distribution of single strandings of sperm whales on the Brazilian Coast.

smaller than those in other areas. Clearly, a much greater sample size is required before any conclusion can be reached.

Further studies are needed on sperm whales off Brazil, including effort to collect biological data such as sex, age and the reproductive status of stranded sperm whales. The distribution, movements and population structure of sperm whales off eastern South America should be further investigated.

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REFERENCES

Allen, K.R. 1973. Report of the Scientific Committee, Annex E, Appendix 2. The computerised sperm whale population model. *Rep. int. Whal. Commn* 23:70-6.

Alves, T.T., Jr., Ávila, F.J.C., Oliveira, J.A., Furtado-Neto, M.A.A. and Monteiro-Neto, C. 1996. Registros de cetáceos para o litoral do Estado do Ceará, Brasil. *Arquivos de Ciências do Mar* 30(1-2):79-92. [In Portuguese].

Arnbom, T. and Whitehead, H. 1989. Observations on the composition and behaviour of groups of female sperm whales near the Galapagos Islands. *Can. J. Zool.* 67(1):1-7.

Avila de Melo, A.M. and Martin, A.R. 1985. A study of male sperm whale length data from the Azorean and Madeiran catches, 1947-82. *Rep. int. Whal. Commn* 35:209-15.

Barros, N.B. 1991. Recent cetacean records for southeastern Brazil. *Mar. Mammal Sci.* 7(3):296-306.

Best, P.B. 1984. Accuracy of shipboard estimates of the length of Antarctic minke whales. *Rep. int. Whal. Commn* 34:323-5.

Best, P.B., Canham, P.A.S. and MacLeod, N. 1984. Patterns of reproduction in sperm whales, *Physeter macrocephalus*. *Rep. int. Whal. Commn* (special issue) 6:51-79.

Bezerra, M.M., Reis, M.S. and Queiros, E.L. 1994. Ocorrencia de *Physeter macrocephalus* (Cetacea, Physeteridae) no litoral do Estado da Bahia - Brasil. XX Congresso Brasileiro de Zoologia, Rio de Janeiro. p.127 (Abstracts).

Bittencourt, M.L. and Zanelatto, R.C. 1992. Registros de mamíferos marinhos no litoral do Estado do Paraná entre 07/1989 e 04/1992. Paper presented at the 5a. Reunión de Especialistas en Mamíferos Acuáticos de América del Sur, Buenos Aires, Argentina, September-October 1992 (unpublished). [In Portuguese].

Castello, H.P. and Piñero, M.E. 1974. Varamientos de cachalotes, *Physeter catodon*, en las costas del Atlântico del Brasil y la Argentina (Cetacea, Physeteridae). *Physis. Secc. A Oceanos Org.* 33(86):371-4. [In Spanish].

Clarke, M.R., Macleod, N., Castello, H.P. and Pinedo, M.C. 1980. Cephalopod remains from the stomach of a sperm whale stranded at Rio Grande do Sul in Brazil. *Mar. Biol.* 59:235-9.

Clarke, R. and Paliza, O. 1988. Intraspecific fighting in sperm whales. *Rep. int. Whal. Commn* 38:235-41.

Geise, L. and Borobia, M. 1988. Sobre a ocorrência de cetáceos no litoral do Estado do Rio de Janeiro, entre 1968 e 1984. *Rev. Bras. Zool.* 4(4):341-6. [In Portuguese].

Hooker, S.K. 1998. Extensive scarring observed on female or juvenile sperm whales off the Galápagos Islands. *Mammalia* 62(1):134-9.

International Whaling Commission. 1980. Report of the Workshop on Determining Age of Odontocete Cetaceans, La Jolla, September 1978. *Rep. int. Whal. Commn* (special issue) 3:1-50.

Jefferson, T.A., Leatherwood, S. and Webber, M.A. 1993. *FAO Species Identification Guide. Marine Mammals of the World*. FAO, Rome. 320pp.

Martin, A.R. 1980. An examination of sperm whale age and length data from the 1948-78 Icelandic catch. *Rep. int. Whal. Commn* 30:227-31.

Mitchell, E. and Kozicki, V.M. 1984. Reproductive condition of male sperm whales, *Physeter macrocephalus*, taken off Nova Scotia. *Rep. int. Whal. Commn* (special issue) 6:243-52.

Nishiwaki, M., Hibiya, T. and Ohsumi, S.K. 1958. Age study of sperm whale based on reading of tooth laminations. *Sci. Rep. Whales Res. Inst., Tokyo* 13:135-53.

Paiva, M.P. and Grangeiro, B.F. 1965. Biological investigations on the whaling seasons 1960-1963, off the northeastern coast of Brazil. *Arq. Estac. Biol. Mar. Univ. Ceara* 5(1):29-64.

Paiva, M.P. and Grangeiro, B.F. 1970. Investigations on the whaling seasons 1964-1967, off the northeastern coast of Brazil. *Arquivos de Ciências do Mar* 10(2):111-26.

Perrin, W.F. and Donovan, G.P. 1984. Report of the Workshop on Reproduction in Whales, Dolphins and Porpoises, La Jolla, December 1981. *Rep. int. Whal. Commn* (special issue) 6:1-24.

Pierce, K.V. and Kajimura, H. 1980. Acid etching and highlighting for defining growth layers in cetacean teeth. *Rep. int. Whal. Commn* (special issue) 3:99-103.

Pimentel, G.P., Almeida, R.T., Silva, F.J.L. and D'Angelo, G.C. 1990. Encalhe de cachelote, *Physeter macrocephalus* (Cetacea, Physeteridae) e outras baleias no litoral nordeste, Brasil. IV Reunion de Trabajo de Especialistas en Mamíferos Acuáticos de América del Sur, Valdivia, Chile. p.56. Abstract. [In Portuguese].

Scheffer, V.B. and Myrick, A.C. 1980. A review of studies to 1970 of growth layers in the teeth of marine mammals. *Rep. int. Whal. Commn* (special issue) 3:51-63.

Secchi, E.R., Vaske Jr., T. and Santos, E.P. 1991. Sightings and strandings of cetaceans from 1987 to 1991 in the southern Brazil. Biennial Conference on the Biology of Marine Mammals, 5-9 December, 1991, Chicago, Illinois [Abstract] p.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.

Whitehead, H., Weilgart, L. and Waters, S. 1989. Seasonality of sperm whales off the Galápagos Islands, Ecuador. *Rep. int. Whal. Commn* 39:207-10.

Whitehead, H., Christal, J. and Dufault, S. 1997. Past and distant whaling and the rapid decline of sperm whales off the Galápagos Islands. *Conserv. Biol.* 11(6):1,387-396.

Williamson, G.R. 1975. Minke whales off Brazil. *Sci. Rep. Whales Res. Inst., Tokyo* 27:37-59.

Appendix

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