Differences in spatial distribution of two small delphinids (*Delphinus delphis* and *Stenella frontalis*) in two islands of the Azores Archipelago

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ABSTRACT

The archipelago of the Azores represents a special area of cetacean ocurrence, mostly due to its oceanic nature. In this area two small delphinids, the common dolphin and the Atlantic spotted dolphin, the former seeming to be present all year around, while the latter seems to be seasonal (summer). In this study we analyse their respective distribution in two different islands, Pico and São Miguel. Sighting records from 2005 to 2008 in Pico, and from 2008 in São Miguel, were pooled together, analyzed and incorporated into a Geographic Information System (ArcGis 9.3). In order to understand the relations between these species and the ecogeographical variables, a statistical treatment (Kruskal-Wallis) and an Ecological Niche Analisis (using Biomapper 4) were perfomed. While common dolphins and Atlantic spotted dolphins are statistically related with depth and slope in Pico, they are just statiscally related with depth in São Miguel. Moreover there are statiscal differences between their distribution in the two islands, suggesting differences on the ecological niche of the species depending on the island, probably related with differences on bathymetry features. There are also differences in distribution between common dolphins and Atlantic spotted dolphins in São Miguel, while in Pico they seem to cohabit in the same area, possibly indicating a niche overlap. In São Miguel, statiscal differences in the distribution between the two species (in depth and in slope) are present, atlantic spotted dolphins showing more tolerance to deep waters. These results suggest the existence of differences on these two delphind populations' distributions depending on the island, probably due to different bathymetric features. Further work is being conducted in order to better understand their distribution and interactions.

Keywords: *Delphinus delphis*, distribution, habitat, feeding grounds, Azores

INTRODUCTION

The common dolphin, *Delphinus delphis*, is present in Azorean waters all year around (Quérouil, 2007), along with the Atlantic Spotted Dolphin (*Stenella frontalis*), they are the most common small odontocete species sighted in the area (Silva, 2003). Usually the common dolphins are located in shallower waters and coastal waters (97–1618 m) than the Atlantic Spotted dolphins (341–2800 m), being the last ones usually encountered in offshore waters (Silva, 2003).

Generally *Delphinus delphis* is present all year around in the study area, with a decrease in the abundance during summer, *Stenella frontalis* has a reverse tendency, being a seasonal specie, documented mostly in summer months, with peak of high abundance, which would evidence a

potential movement of common dolphins and could suggest a kind of competitive relationship between the two delphinids. Some authors explain this arguing that they may co-occur in the same habitat (promoting a niche overlap) and feed on the same kind of preys (Dinis, 2008; Pereira, 2008; Quérouil, 2007, 2008), as documented in other study areas (Dos Santos, 2001) where *S.frontalis* and *D.delphis* have a quite similar trophic ecology. This movement of common dolphin is also similar to others documented in other regions of the world (López, 2004; Neumann, 2001; Pérez-Vallazza, 2008; Stockin, 2008).

The aim of this study is to analyse the spatial distribution of the two delphinids in two different islands, Pico and São Miguel, assess the differences in their distribution due to diversification of the ecogeographical variables and environment that would constitude their realized ecological niche, and understand their habitat preferences and interspecific relationships.

METHODOLOGY

Study Area

The archipelago of the Azores is located in the middle of the Atlantic Ocean, close to the mid-ridge system. In this study we focus in two islands, Pico, located at the Central Group, being a part of a complex system formed by a group of close islands, and the south coast of São Miguel, a more isolated island located in the Eastern Group and also further away from the mid-ridge system. Pico is characterized by a step slope and deep waters with no kind of platform, but in the south coast of São Miguel there is a platform close to 400 meters in extension, creating a more diverse environment.

Cetacean sightings

The data used on this paper comes from different databases; mostly from opportunistic platforms, from Whale-watching activities or from other kind of non-dedicated surveys. Sightings from Pico (Figures 1 and 2) were collected in 2005-2008 for *S.frontalis* (n=93) and *D.delphis* (n=160), generated by Nova Atlantis Foundation; in São Miguel the sightings (Figures 3 and 4) for *S.frontalis* (n=271) and *D.delphis* (n=216) were collected in 2008 from three different Whale-watching companies (Futurismo, Picos de Aventura and Terra Azul). All records yielded information on date, time, group size, behavior, detectability conditions (Beaufort Scale< X) and geographic coordinates.

Spatial analyses

Sightings were analysed and plotted on bathymetry and slope maps, using a geographical information system (ArcGis 9.3). In order to establish the relations with the ecogeographical variables an Ecological Niche Factor Analysis was processed with Biomapper 4 (Hirzel, 2002a; Hirzel, 2002b).In order to assess the differences in occurrence by ecogeographical variables (depth and slope) a Kruskal Wallis test was performed, concurring with the non parametrical distribution of the sample (Zar, 1996).

RESULTS

When analysing the sightings of the two delphinids for each island, the first thing worth to higlight is that there are statically significant differences on the distribution between islands in terms of depth and slope, for *D. delphis* (Depth: Kruskal Wallis Test: X^2:75.38, DF:1, **p<0.05**; Slope: Kruskal Wallis Test: X^2:161.79, DF:1, **p<0.05**) and for *S. frontalis* (Depth: Kruskal Wallis, X2: 33.41, DF: 1, **p< 0.05**; Slope: Kruskal Wallis, X2: 113.45, DF: 1, **p< 0.05**). Moreover, the spatial distribution between species in Pico suggest habitat overlap (Common dolphin vs Atlantic spotted dolphins - Depths: Kruskal Wallis, X^2: 2.87, DF: 1, **p> 0.05**, Slope: Kruskal Wallis, X^2: 100.4, DF: 1, p= 0.043), while in Sao Miguel there are statiscally significant differences between their realized niche (Common dolphin vs Atlantic spotted dolphins - Depths: Kruskal Wallis, X^2: 61.4, DF: 1, **p< 0.05**, Slope: Kruskal Wallis, X^2: 12.26, DF: 1, **p< 0.05**).

In Pico Island the distribution of both dephinids is related with slope and depth, but when looking to São Miguel, distribution might only be related with depth. Moreover, the spatial distribution between species in Pico suggest habitat overlap, while in São Miguel there are statiscally significant differences between their realized niche.

The latter is also supported by the values of marginality and tolerance; off Pico Island, both species seemed to inhabit areas with bathymetry and topography features diverging from the average condition of depths and slope. However, there should not be a particular limiting depth and slope class as proxy of spatial distribution according with the high value of the Tolerance Index (Table 1). The trend in São Miguel is of equal divergence of a particular niche from local average conditions of depth and slope, but with a much lower tolerance to deeper waters and steeper bottoms, as reflected in the values of the Tolerance Index reported in table 1.

.DISCUSSION

The Common Doplhin on the Azores should be all around the area but mostly in coastal waters (Silva, 2003), The spatial arragements of the species off the Central Group (Pico, Faial and São Jorge Islands), promoted an interspecies competition hypothesis between *D. delphis* and *S. frontalis* (Quérouil, 2007), assuming that they might share the same kind of prey. Hernandez-Milian *et al.* (2008) found evidences that seems to indicate that in the Azores area both delphinid species would share the same habitat, but would not feed on the same kindt prey. The fact of *D. delphis* and *S. frontalis* having the same distribution range and high levels of tolerance (>0.90) on Pico Island suggest the ocurrence of a niche overlapp on that area, where a step slope and an homogenuos range of depth would be significant factors affecting their distribution.

While in Pico the bathymetry is quite homogenuos, in the South coast of São .Miguel there are important bathymeric features that creates different habitats. In fact there are statistically significat differences on the distribution of both deplhinids; *D. delphis* occurred in shallower waters while *S.frontalis* occurs in deeper waters, and also for both species only the depth is relevant to explain the tendencies in distribution. The latter would be an evidence that they have different habitats in this area, suggesting a niche segreggation related with the bathymetry. It Is important to emphatize the finding of squids beaks and other prey items in common dolphin's stomach content from a recent stranding off São Miguel Island, this would suggest a big contribution of preys form the Deep Scatering Layer in Common dolphin diet (unpublished work). Further work is being conducted in order to better understand their distribution and interactions.

The non systematic nature of the data collected here might represent a caveat in this contribution.

ACKNOWLEDGEMENTS

We want to aknowledge the Whale Watching companies FUTURISMO, Empres de Tursimo Nautico, PICOS DE AVENTURA-Animação e Lazer, Lda. and TERRA AZUL – Animação Turística Lda., for the data and all the support provided.

REFERENCES

Dinis, A., Cascão, I., Alves, F., Freitas, L., Quérouil, S., 2008. Comparing the Epipelagic diet between Short-beaked Common Dolphin and Atlantic Spotted Dolphin in two Atlantic oceanic archipelagos. 22nd Annual Conference of the European Cetacean Society, March 10-12, The Netherlands.

Dos Santos, R.A., Haimovici, M., 2001. Cephalopods in the diet of marine mammals stranded or incidentally caught along southeastern and southern Brazil (21-34ºS). Fisheries Research 52, 99-112.

Hernandez-Milian, G., Goetz, S., Varela-Dopico, C., Rodriguez-Gutierrez, J., Romon-Olea, J., Fuertes-Gamundi, J.R., Ulloa-Alonso, E., Tregenza, N.J.C., Smerdon, A., Otero, M.G., Tato, V., Wang, J.J., Santos, M.B., Lopez, A., Lago, R., Portela, J.M., Pierce, G.J., 2008. Results of a short study of interactions of cetaceans and longline fisheries in Atlantic waters: environmental correlates of catches and depredation events. Hydrobiologia 612, 251-268.

Hirzel, A.H., Hausser, J., Chessel, D., Perrin, N., 2002a. Ecological-niche factor analysis: How to compute habitat- suitability maps without absence data? Ecology 83, 2027-2036.

Hirzel, A.H., Hausser, J., Perrin, N., 2002b. Biomapper 3.1. Lausanne, Lab. for Conservation Biology. URL: http://www.unil.ch/biomapper.

López, A., Pierce, G.J., Valeiras, X., Santos, M.B., Guerra, A., 2004. Distribution patterns of small cetaceans in Galician waters. Journal of the Marine Biological Associaton of the United Kingdom 84, 283-294.

Neumann, D.R., 2001. Seasonal movements of short-beaked common dolphins (*Delphinus delphis*) in the north-western Bay of Plenty, New Zealand: influence of sea surface temperature and El Nino/La Nina. New Zealand Journal of Marine and Freshwater Research 35, 371-374.

Pereira, J.N.G., 2008. Daily species checklist from whale-watching—studying the research potential with an Azorean case study. Journal of the Marine Biological Associaton of the United Kingdom 88 (6), 1283-1288.

Pérez-Vallazza, C., Álvarez-Vázquez, R., Cardona, L., Hernández-Brito, J., 2008. Cetacean diversity at the west coast of La Palma Island (Canary Islands). Journal of the Marine Biological Associaton of the United Kingdom 88 (6), 1289-1296.

Quérouil, S., Seabra, M.I., Silva, M.A., Magalhães, S., Prieto, R., Machete, M.A., Lafon, V., Santos, R.S., 2007. Spatio-Temporal Niche Segregation Between Two Sympatric Species of Dolphins in the Azores. 21st Conference of the European Cetacean Society, San Sebastian, Spain, 22-25 April 2007.

Quérouil, S., Silva, M.A., Magalhães, S., Seabra, M.I., Machete, M.A., Santos, R.S., 2008. Why do Dolphins form Mixed-Species Associations in the Azores? Ethology 114, 1183-1194.

Silva, M.A., Prieto, S., Magalhães, S., Cabecinhas, R., Cruz, A., Gonçalves, J.M., Santos, S. , 2003. Occurrence and distribution of cetaceans in the waters around the Azores (Portugal), Summer and Autumn 1999–2000. Aquatic Mammals 29 (1), 77-83.

Stockin, K.A., 2008. The New Zealand common dolphin (*Delphinus sp*.) - Identity, ecology and conservation. PhD, Massey University.

Table 1: Results of the ENFA statistical treatment (processed with biomapper 4) of the data, comparing between species and location.

	Delphinus delphis	***Stenella frontalis***
PICO		
Mean Depth:	-887.53(SD:485.68)	-917.41 (SD:470.57)
Mean Slope:	9.92(SD:5.34)	10.30 (SD:5.48)
Marginality:	0.58	0.60
Specialisation:	1.05	1.09
Tolerance (1/S):	0.94	0.91
S.MIGUEL		
Mean Depth:	-503.60(SD: 330.69)	-703.02 (SD: 378.04)
Mean Slope:	4.00 (SD: 2.27)	4.00 (SD: 2.82)
Marginality:	0.63	0.48
Specialisation:	1.95	1.65
Tolerance (1/S):	0.51	0.60

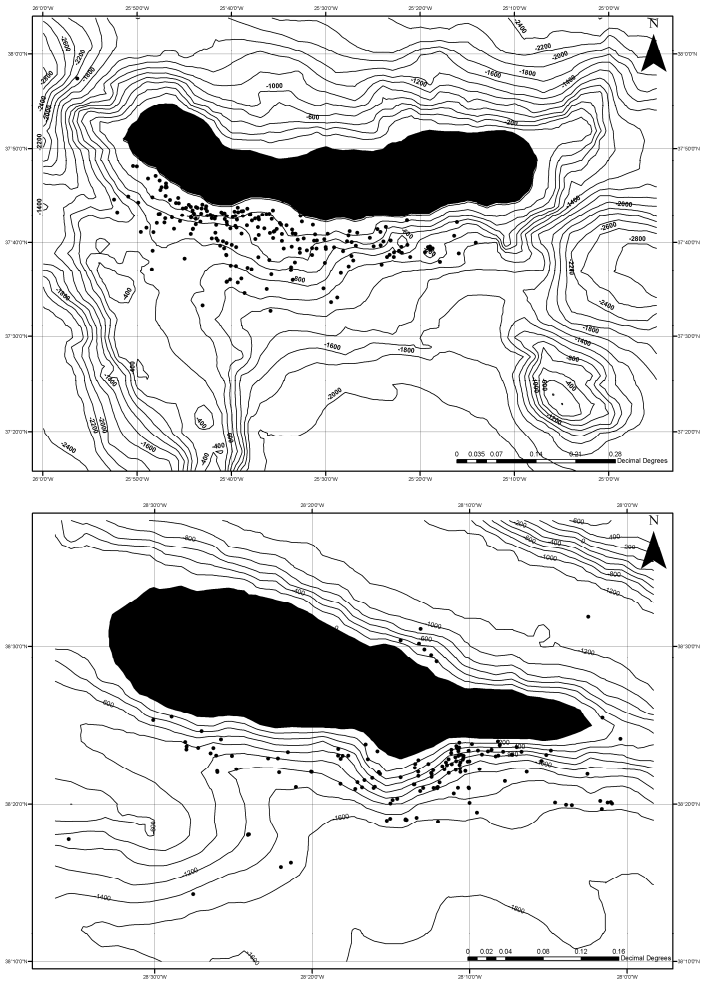

Figure 1. *Delphinus delphis* sightings in relation to bathymetry in Sao Miguel (up) and Pico (down) Islands

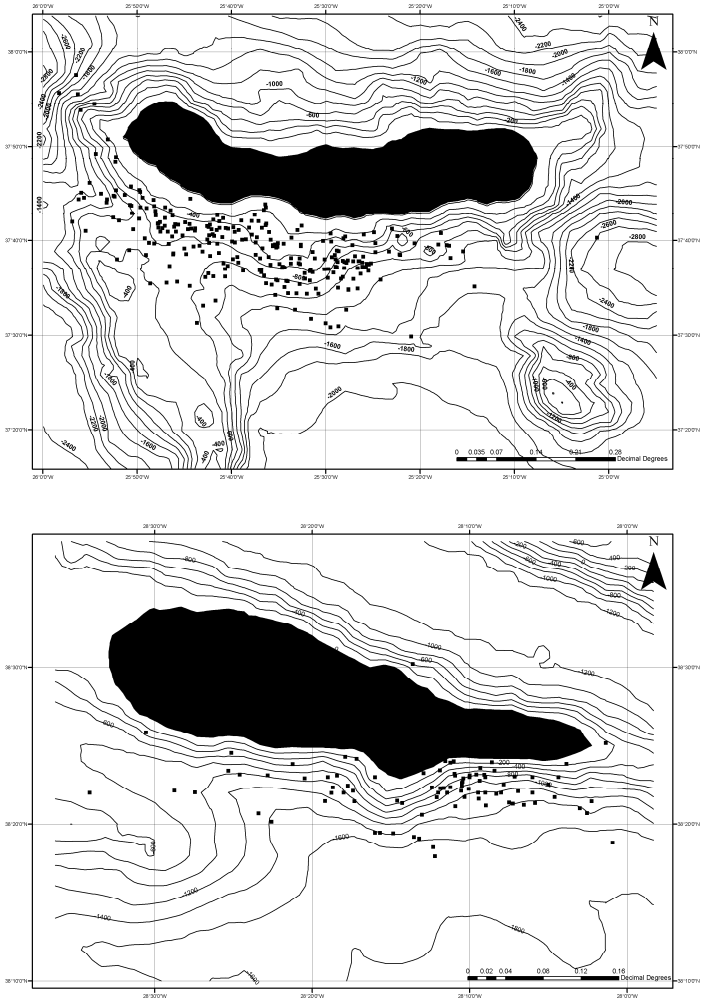

Figure 2. *Stenella frontalis* sightings in relation to bathymetry in Sao Miguel (up) and Pico (down) Islands