

Vertical and spatial movements of sperm whale (*Physeter macrocephalus*) in Madeira and Azores archipelagos



Freitas, L.⁽¹⁾, Prieto, R.⁽²⁾, Alves, F.⁽¹⁾, Silva, M.⁽²⁾, Dinis, A.⁽¹⁾, Oliveira, C.⁽²⁾ and Cascão, I.

⁽¹⁾Madeira Whale Museum, Largo Manuel Alves, 9200-032 Caniçal - Madeira - Portugal

⁽²⁾Departamento de Oceanografia e Pescas, Universidade do Açores, 9901-862 Horta, Portugal

luisfreitas@museudabaleia.org - www.museudabaleia.org



INTRODUCTION

Sperm whales historically have been an important socio-economic and cultural role in Madeira and Azores archipelagos. These oceanic archipelagos with deep waters close to shore constitute adequate places to study this deep diving animal. Scientific studies have been carried out during the whaling period (e.g. Clarke, 1956; Ávila de Melo & Martins, 1985) and more recently research has been focused on the study of spatial and temporal patterns of distribution and abundance (Silva et al., 2003; Freitas et al., 2004), studies on the ventilation and dive pattern (Gordon & Steiner, 1992), on the short-term reactions to whalewatching (Magalhães et al., 2002; Dinis et al., 2004) and on photo-identification (Matthews et al., 2001). However, several questions remain unanswered namely, the ones related with sperm whales' habitat use in these archipelagos, like their diving, behaviour and local movements.

Following the end of the small scale shore based whaling, a new commercial activity has been growing in economic and social importance in both archipelagos - whalewatching. This activity has been growing fast in the last decade, especially in the Azores where sperm whale is the main target species of tour operators, leading to a growing need of scientific knowledge on the biology and ecology of this species in the area, in order to support solid managing strategies that may contribute for the sustainable development of the activity and to the species conservation.



Fig 1 - Map with the location of the study areas - Madeira and Azores archipelagos

RESULTS & DISCUSSION

	Tag deployment	Surface		Shallow dives		Deep dives (> 200m)			
		duration (hh:mm)	Duration (hh:mm)	Duration (hh:mm)	Duration (hh:mm)	Max depth (m)	Bottom time (hh:mm)	Average Desc. (m/sec)	Average asc. (m/sec)
Madeira	Total	7:27	3:22 (45%)	1:36 (22%)	2:29 (33%)				
	Average	3:43	1:41	0:06	0:37	957	0:11	1.4	1.1
	± sd	4:09	1:57	-	0:11	124	0:05	0.7	0.1
	N	2	2	16	4	4	4	4	4
Azores	Total	13:16	3:01 (23%)	1:57 (15%)	8:15 (62%)				
	Average	3:19	0:45	0:03	0:47	772	0:26	1.1	1.2
	± sd	2:10	0:34	-	0:03	69	0:09	0.2	0.3
	N	4	4	31	8	9	9	14	11
Md+ Az	Total	20:43	6:23 (31%)	3:33 (17%)	10:44 (52%)				
	Average	3:27	1:03	-	0:44	828	0:22	1.2	1.1
	± sd	2:31	1:05	-	0:09	122	0:08	0.4	0.3
	N	6	6	47	12	13	13	18	15

Table 1 - Summary of the tags data for Madeira and Azores archipelagos.

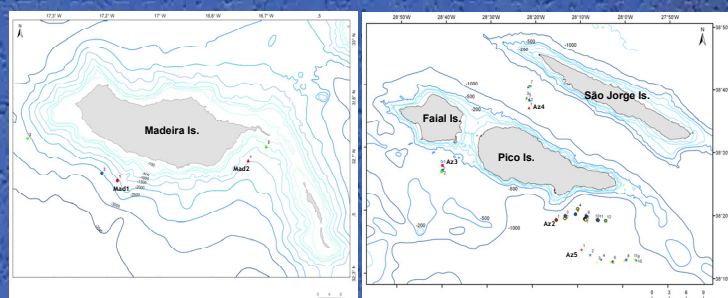


Fig 2 - Recorded positions of whales followed in Madeira (left side map) and in Azores (right side map). The numbers (1, 2, 3...) indicate the sequence of sightings for each tagged whale and the colours indicate position of tagging (red), whale diving (blue), whale at surface (yellow) and tag recovery (green).

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AIMS

To study sperm whales' diving behaviour and movements in Madeira and Azores archipelagos;

METHODS

The field work was carried out in the summer of 2005. Part was undertaken off the south coast of Madeira Island from a 6.5m rigid-inflatable and the other part was conducted in the surrounding waters of Faial, Pico and São Jorge Islands (Azores) from a 4m kayak. To study the whales' vertical movements we tagged the animals using suction-cups with attached TDR/VHF tags (Baird, 1998). Once the tags were deployed the whales were followed from a 16m motorsailor (Madeira)/11m motor boat (Azores) using a directional antenna/radio receiver (ATS - FM100) and visual observations. The tags used incorporated a Mk9 mold 161 time-depth recorder (Wildlife Computers) and a VHF radio transmitter (Telonics), housed in a custom-made syntactic foam body, attached to an Ø8cm suction-cup. TDR's were set to record depth (up to 2000m), light level, seawater resistance and temperature once per second. In the Azores tags were fitted with 2 galvanic elements to guarantee its release from the suction-cup in < than 6 hours. Tags were mainly deployed by using modified extensible 5m aluminum swimming-pool pole. When near the tagged whales, the group size, behaviour, position and the travel direction were recorded. Once tags were recovered data was downloaded and processed with the Wildlife Computer software Mk9Host and the Instrument Helper. Dives ≥ 200m were classified as deep dives and within these U shape dives with vertical displacements at the bottom phase were classified as foraging dives. Standard descriptive statistical analysis was used to characterize the dives of the tagged whales. A relationship between dive duration vs depth was determined by using only the complete dives.

A total of 7 whales were tagged, 2 in Madeira and 5 in Azores. However one in Azores was not recovered. The Madeira and Azores tags' analysis is resumed in table 1. All tagged animals were females or immature males (based on its size and behaviour and in one case genetically determined) from different groups. The tags provided a total track time of 20:43h, with an average tag deployment of 3:27h (± 2:31h, n=6). Overall the whales spent 52% of the time deep diving (>200m), 17% on shallow dives and 31% at the surface. When looking at the results by archipelago, we can see that whales tagged in Madeira spent more time on the surface (45%) or shallow diving (22%) than deep diving (33%); while the sperm whales tagged in Azores spent most of their time deep diving (62%) and much less at the surface (23%) or in shallow dives (15%). There are also differences between the archipelagos in the deep dives. The average maximum depth was deeper in Madeira (957 ± 124, n=4) than in Azores (772 ± 69, n=9). The average deep dive duration was longer in Azores than Madeira as a result of whales in the Azores having longer bottom times. From a total of 18 deep dives, 13 were considered foraging dives. When comparing these dives by archipelago, the percentage of time foraging was clearly different between Madeira (33%) and Azores (74%). These differences in sperm whales' diving behaviour observed between archipelagos may be related to effective differences in habitat use strategies (e.g. different prey availability), with time of the day sampled (Azorean animals were tagged and sampled during day time while Madeira animals were tagged and sampled at dusk/night time) or as a result of the small sample size. The sperm whales small scale spatial movements, reconstructed through surface sightings, indicate they move in a general direction, zigzagging or in a straight line. In two cases the animals seem to follow depth contour lines (Mad1 and Az2) but in other cases they do not (Mad2, Az3 and Az4). Further effort is necessary to increase data regarding diving behaviour and movements in both archipelagos before we are able to answer some of the questions posed in a conclusive way.

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