

Third IWDG Humpback Whale Research Expedition: Cape Verde 2011

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Summary

Introduction

Humpback Whale Biology and Ecology

Humpback whales *Megaptera novaeangliae* (Borowski 1781) occur in all oceans and famously undergo the longest annual migration of any mammal. They summer in high latitude feeding grounds and winter in low latitude breeding grounds. They spend summer months feeding intensively in when productivity and hence food availability is highest. During winter, the whales are found in shallow tropical seas where calving and mating occurs simultaneously as the mothers are in oestrus while lactating and gestation is 11.5 months. No single consensus exists as to why they need to undertake such protracted migrations. It has been suggested that killer whale avoidance and the need for warm waters due to thermoregulatory challenges faced by small calves explain their migratory ecology. It has also been proposed that current migrations are a legacy from a time when the destinations were once close together, but have moved apart over time due to continental drift.

Given that humpback whales in the northern hemisphere will be at high latitudes during boreal summer when those from the southern hemisphere will be calving in low latitudes, they are always separated by several thousand kilometres of ocean. This is known as an 'anti-tropical' migration and has given rise to reproductively isolated populations of humpback whales within ocean bodies in the absence of any physical barriers to dispersal.

In the North Atlantic, there are believed to be than 10,600 humpback whales (Smith *et al.* 1999). The primary breeding ground is in the West Indies, particularly around Dominican Republic where the majority of humpbacks from the North Atlantic go to breed. These whales have been found to migrate to four main feeding areas; Gulf of Maine/Newfoundland, West Greenland, Iceland and northern Norway.

Current Knowledge on Cape Verdean Humpback Whales

A second North Atlantic breeding ground is known from whaling records and more recently from observational and photo identification studies. This breeding ground consists of Cape Verde but possibly extends to the west African continental shelf of Senegal and Western Sahara. The size estimate of the putative Cape Verde population was estimated by photo identification mark-recapture analysis at just 99 (CV=0.23) individuals, a mere relict of the *circa* 4000 whales there before whaling commenced (Punt *et al.* 2006). Given that humpbacks mate and calve in the same area (the breeding ground) it is likely that breeding populations are reproductively isolated from one another. As such, the Cape Verdean humpback whales are believed to be one of the most endangered populations in the world given the small population size. However, genetic analysis has never been carried out this population. Genetic analyses of Cape Verdean whales could be used to

challenge the theory that North Atlantic humpback whales comprise a panmictic population (Palsboll *et al* 1995).

Previous Research Expeditions

There are no cetacean research groups in Cape Verde. As such, collaborative cetacean research has been carried out by visiting scientists since the early 1990s including Frederick Wenzel, Beatrice Jann, Pedro Lopez-Suarez, Cornelius Hazevoet, Simon Berrow and Pádraig Whooley. The primary focus has always been on the humpback whales and the expeditions have been timed to coincide with the breeding period from January to May (Wenzel *et al.* 2009).

Aims for 2011 Expedition

1. To collect skin samples from humpback whales for molecular genetic analyses
2. To collect blubber samples for ecological tracer analysis (stable isotopes and toxicology)
3. To take photo identification images for matching Cape Verdean whales to those from elsewhere in the North Atlantic
4. To assess areas of particular importance to whales and nursing areas
5. To record singing males using a hydrophone

Methods

Study Area and Research Platform

Unlike previous expeditions to Cape Verde by the IWDG, the 2011 expedition was shore-based and confined to a single island; Boa Vista. The study area comprised coastal waters (out to 6km) of the west coast of Boa Vista from Ponta de Sol in the North to Santa Monica in the southwest (Figure 1). The study area was chosen based on access to suitable vessels, knowledge by local researchers and a high sightings rate from previous expeditions in this area. A 5 metre rigid-hulled inflatable (RIB) with a four-stroke 50 horse-power outboard motor was used for the fieldwork (Figure 2). Fieldwork commenced and ended at Sal Rei where the boat was moored.



Figure 1. Research vessel (5m rigid-hulled inflatable) with a humpback whale passing-by

Survey Methodology

Searches were carried out at an average speed of 10 knots (20 km/hr) with two observers (CR and PLS) scanning the sea with the naked eye. This search effort: speed, location and time were recorded continuously using a Garmin Etrex GPS. By recording search effort, a more thorough analysis of sightings within the study area can be carried out (i.e. sightings per unit effort, number of sightings per unit area) to identify critically important locations for the whales and specifically calves. When whales were sighted they were approached from behind at 45° to their direction of travel and tracked until a biopsy sample and photo ID was taken. If an animal was re-sighted within a survey it was not tracked. The whale's location, the group size and the presence of calves were all recorded. Biopsying was carried out by CR, photo ID was carried out by PLS and SB and FB was the skipper.



Figure 2. Survey team: Conor Ryan with biopsy crossbow and GPS (left), Félix Busto, skipper (middle), Pedro Lopez Suarez photo ID camera and Dictaphone.

Photo Identification

Photo identification is a method of studying individual whales by using images of features that are unique to those individuals. The pigmentation patterns on the ventral surface of humpback whale flukes are believed to be unique to individuals. Dorsal fins also exhibit a certain degree of individuality in shape and scarification. Tail fluke ID images were taken for comparison with those in the North Atlantic Humpback Whale catalogue (Allied Whale, Maine). Fluke ID images will enable us to investigate for movements between the Cape Verdean breeding grounds and the high latitude feeding grounds (and indeed the other breeding and feeding areas). As the whales do not always show their flukes upon diving, particularly in shallow waters, ID images of the dorsal fins were taken in order to recognise individuals that had already been biopsy sampled. The photo ID catalogue was brought out on the boat in order to facilitate the identification of individuals in the field. This helped to keep duplicate biopsy sampling to a minimum.

Biopsy Sampling

Two sampling crossbows were used: a Barnett Panzer V and a Barnett C5 (both 150lb draw-strength). Standard CETA-DART (Finn Larsen) bolts with 40mm sampling tips were used. The bolts were not tethered but float after striking the animal and are brightly coloured to aid retrieval. Between sampling, the tips were scrubbed in hot soapy water, sterilized over a flame and treated with 99% ethanol. These measures were taken to prevent infection in the whales and so that cross-contamination of DNA did not occur between sampling events.

Individual whales were identified in the field using a catalogue of dorsal fin images (left and right). For those that had not yet been biopsied, their behaviour state was recorded and an approach was made. Approaches were carried out at 45° from behind the whales and a parallel course was maintained with them thereafter. Optimal sampling distance was 15-20m. Shots were aimed at the region below the dorsal fin, where a large area is presented above the water as the whales arch their backs to dive. The reaction to the dart was recorded on a scale of 0 to 4:

1. No discernable reaction
2. Slight acceleration and/or large fluke 'footprint' on the water's surface
3. Flinch and/or tail-flick
4. Trumpet-blow and/or lob-tailing
5. Breaching and/or head-lobbing (where this did not occur immediately before sampling)

Samples were wrapped in aluminium foil and were processed in the lab within 3 hours of sampling. In the lab skin and blubber samples were frozen in aluminium foil for stable isotope and toxicological analyses. Half of the skin from each biopsy was preserved in a vial of salt-saturated 20% DMSO (Dimethyl sulf-oxide) and frozen for later DNA analysis.

Acoustic Recordings

When singleton whales were stationary or when their dives exceeded 10 minutes in duration, a hydrophone was deployed in order to record whale song. Recordings were made for 20 minutes each in order to record the entire song which generally lasts 10 minutes, but is repeated.



Figure 3. Pedro Lopez Suarez recording whale song

Ancillary Sampling

On previous research expeditions, phytoplankton and zooplankton samples were collected. This was repeated in 2011. Plankton samples were taken using phytoplankton net with a 75 μ m mesh for Dr Cillian Roden (GMIT). Samples were preserved in Lugol's Iodine for later analysis in the lab. Stalked barnacles were collected opportunistically for a study into natural adhesives from the marine environment (used by stalked barnacles for attachment to debris/buoys). Amphipods were also sampled opportunistically for Dr David McGrath (GMIT).

Results

Sightings

A total of 45 surveys were carried out in a mean Beaufort sea state 4 (minimum 1, maximum 6) amounting to 1746km of search effort during which 77 sightings of humpback whales were recorded (Figures 4 and 5). There were only two surveys in which no sightings were made. Mean group size was 2.04 (SD=1.29) with maximum group size of 7 and 31 singletons were recorded. 20 sightings of calves were recorded throughout the six weeks of fieldwork and they were generally found in larger groups. Calf sightings were distributed throughout the study area and were not confined to shallower waters, with sightings up to 6km offshore (Figure 6). Most sightings of singletons occurred in the middle of Baia de Sal Rei, while larger group sizes were generally found off the north-western-most point of Boa Vista (Ponta do Sol) (Figure 5). Group size was found to be greatest in mid-April. Sightings recorded into mid-May came as a surprise, given that the whales are believed to begin their migration north in mid-spring. Two sightings of 7 and 3 rough-toothed dolphins *Steno bredanensis* were also made.

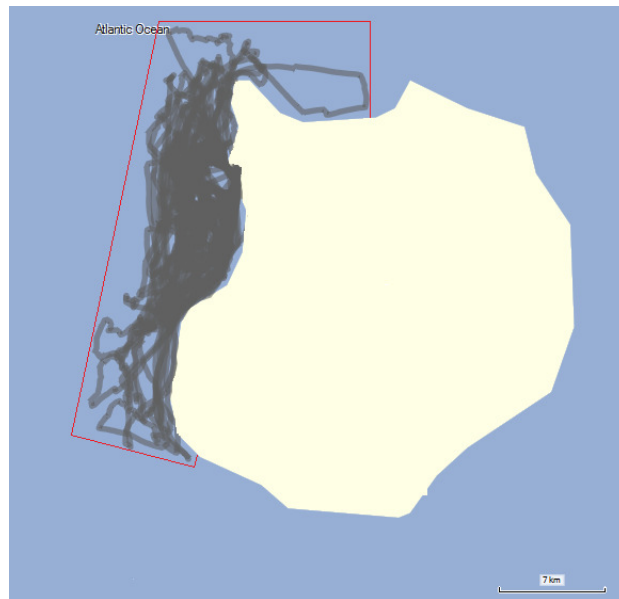


Figure 4. Search effort (grey track-line) carried out between 10 April and 17 May 2011, red box shows

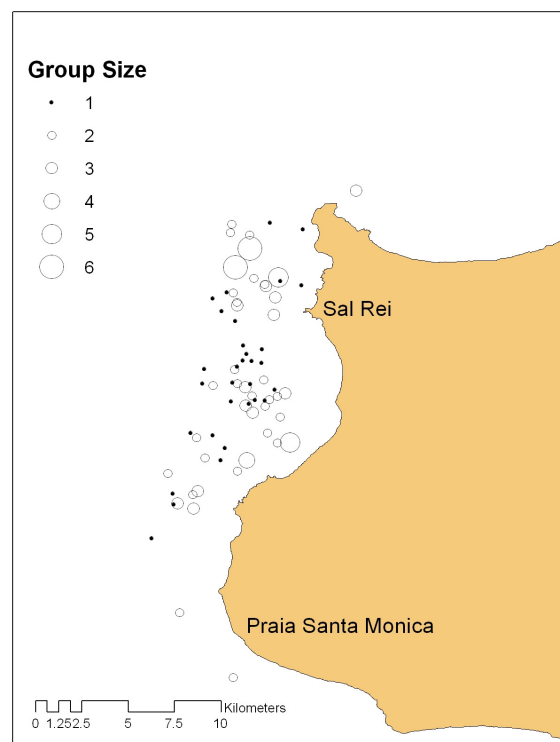


Figure 5. Distribution and group size for Humpback Whale sightings off Boa Vista in April and May 2011.



Figure 6. Locations of calf sightings around Boa Vista in April and May 2011. Calves were never observed alone.

Biopsies

A total of 28 biopsy samples were collected from 24 individuals. While every effort was made to avoid duplicate sampling of individuals, four whales were sampled twice but none were sampled three times. Among the 28 samples were three mother-calf pairs. 27 of these samples were collected from the research rib, however one was taken aboard the whale-atch boat *Tartaruga II*. Reactions to biopsy sampling were generally low, on seven occasions no discernable reaction was noted while no strong reactions (level 4) were recorded (Figure 7). On two occasions, whales approached the boat after they were biopsy sampled, apparently inquisitive behaviour.

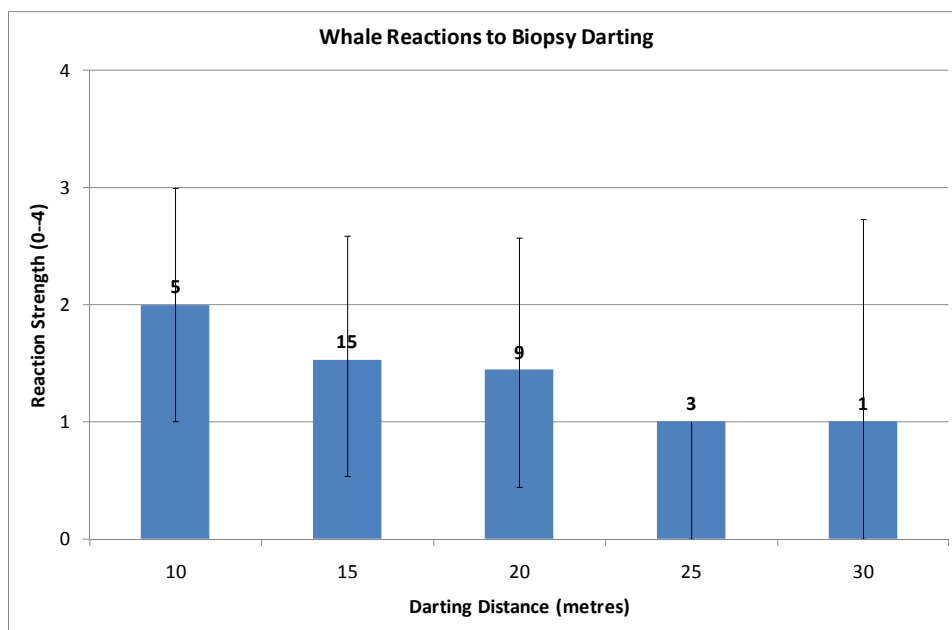


Figure 7. Mean reaction strength (\pm Standard Deviation) by the whales to biopsy sampling at different distances. Number of samples at respective distances is given in parenthesis over the bars. Distance was estimated by eye using boat length for scale.



Figure 8. Biopsy dart rebounding with a sample after striking a whale.

Photo ID Matching

Dorsal fin photo IDs were taken for all of those whales ($n=24$) that were biopsied while tail fluke photo IDs were collected for most of those whales that were biopsy sampled (Figures 9 and 10). Overall, tail fluke images from 35 whales were taken. Tail fluke IDs are assigned a unique alpha-numeric code as they are catalogued in the North Atlantic Humpback Whale Catalogue; "NA####". Many of the whales that were biopsied were re-sighted in the study area within several days of the sampling event indicating that the sampling does not cause the whales to leave the area. Matching

of photo ID images with the North Atlantic Humpback Whale Catalogue at College of the Atlantic, Maine is currently underway. Preliminary results from the matching are presented in Table 1.



Figure 9. Tail fluke photo ID image of a humpback whale lob-tailing in Baia Sal Rei



Figure 10. Dorsal fin photo ID image used for in-the-field recognition of individuals in order to avoid duplicate sampling of individuals.

Table 1. Photo ID matches made to date from the matching process with the North Atlantic Humpback Whale Catalogue (matching as yet incomplete). “no #” indicates that no North Atlantic Catalogue number has yet been assigned to this individual (In progress).

Date First Sighting in 2011	Locations and Years of previous sightings	North Atlantic ID
15/03/2011	Azores, 2010; Cape Verde, 2010	NA4749
25/03/2011	Azores, 2006; Cape Verde, 2009	NA4795
03/04/2011	Cape Verde 2005, 2010	NA4877
05/04/2011	Cape Verde, 2004	NA4789
06/04/2011	Cape Verde, 2002, 2003, 2006, 2008, 2010	NA4962
07/04/2011	Cape Verde, 2009	NA4755
13/04/2011	Bear Island, Norway, 1984; Cape Verde, 2004	NA4810
07/04/2011	Cape Verde, 2009	NA4756
19/04/2011	Cape Verde, 2002	NA4948
22/04/2011	Cape Verde, 1991; 2003; 2009; 2010	NA4817
25/04/2011	Sal Rei, 2010	NA4744
25/04/2011	Cape Verde, 2002	no #
01/05/2011	Cape Verde, 2002	NA4950
04/05/2011	Cape Verde, 2010	no #
09/05/2011	Cape Verde, 2009; 2010	no #
13/05/2011	Bear Island, Norway, 1995; Cape Verde, 2008	NA4820
15/05/2011	Cape Verde, 2002	NA4960
15/05/2011	Cape Verde, 2009	no #

Acoustic Recordings

10 separate acoustic recordings were made totalling 145 minutes. The longest recording was 27 minutes and the shortest was 7 minutes. These have been sent to Beatrice Jann (Swiss Whale Society) for analysis.

Ancillary Samples

Plankton samples were collected at 9 stations at a range of depths in the study site. Qualitative analysis (species identification and species richness) will be carried out in Ireland by Dr Cilian Roden (GMIT). We hope to publish a descriptive short communication on the plankton species occurring off Boa Vista, given the paucity of published literature in this field from Cape Verdean waters. Stalked barnacles (*Lepas* sp.) and a single amphipod were collected from a ghost net which was taken from the sea to prevent entanglements by turtles, seabirds and fish.

Discussion

The present project represents the most intensive systematic attempt to biopsy sample humpback whales on their Cape Verde breeding grounds to date. It is the first time that a sample large enough to undertake genetic studies has been achieved. The genetic results are much anticipated considering the unknown status of this small breeding population. Of particular interest will be the degree of reproductive isolation between this and other breeding populations, namely the West Indies. It is hoped that with more samples, an effective population size (N_e) may be derived using microsatellites. The most recent population estimate is just 100 individuals (Punt *et al.*, 2006), however a more precise estimate is needed.

Uses for Biopsies

DNA will be extracted from skin using extraction kits. Sexing, sequencing of the mitochondrial D-Loop (*circa* 500bp) and genotyping at up to 20 microsatellite loci will be carried out. This will be done in collaboration with Per Palsbøll and Martine Bérubé, who are currently concluding analyses on the 7500 samples from project MONAH (More years Of the North Atlantic Humpback whale) from throughout the North Atlantic. Biopsies from Irish and UK waters will be included in an analysis ($n=13$) and more biopsy fieldwork is planned for the winter feeding season along the south coast of Ireland as part of CR's PhD.

Distribution of Sightings

The humpback whale breeding season is believed to occur between January and May in Cape Verde (Hazevoet *et al.* 2011). During 2011 at least some of the whales remained in inshore waters of Boa Vista until late May (reported to PLS on 23 May). Females with young of the year are thought to leave the breeding grounds first. Our sightings confirmed this to be the case as mother-calf pairs were observed well into May. However, sightings of competing and singing males were also recorded into mid-May. A more detailed study on the distribution of whales, stratified by group-size, calf presence in relation to search effort is underway. It is hoped that this will identify areas of critical habitat for the whales and form a paper for publication which may be useful for management of whale-watching or designation of protected areas.

Photo ID Matching

Preliminary matching (Table 1) already shows interesting results, namely that of the *circa* 35 photographed whales, 11 have previously been observed in Cape Verdean waters during the past 20 years. The high incidence of inter-annual re-sightings for such a small sample is further evidence of a very small population. Long distances matches between Cape Verde and Bear Island, Norway (a distance of over 7000km spanning almost 60° of latitude) have been made in the past for two humpback whales (Wenzel *et al.*, 2009). Both NA4810 and NA4820 were recorded in Cape Verde once again during 2011 indicating fidelity to the Cape Verde breeding ground (Wenzel *et al.* 2009). Both individuals were biopsied in Cape Verde during the present study. Strong site fidelity was found for several whales as revealed by inter-annual re-sightings. One whale, NA 4962 has now been recorded in Cape Verde in six different years since 2002, and in consecutive years on two occasions. To date, the whale with the longest spanning re-sighting history is NA4817 which has been recorded in Cape Verde five times since 1991, and every consecutive year since 2009. No matches have yet been made between Ireland and Cape Verde.

Sustainable Development of Whale-watching in Cape Verde

Whale-watching is undoubtedly the most rapidly developing marine enterprise on Boa Vista. During 2011 five tour operators were offering boat-based whale-watching tours. The number of boats is increasing steadily and at least seven companies plan to operate out of Sal Rei in 2012. *Naturalia* is a locally owned eco-tourism company which provides trained guides and a marine biologist on the whale excursions. Their mission statement is to promote eco-tourism, sustainable and responsible use of natural resources on Boa Vista, support conservation and contribute to a better knowledge of threatened habitats and species through scientific research. Most (but not all) of the tour operators contract *Naturalia* guides to provide interpretation to whale-watchers and to oversee a voluntary code of conduct for responsible boat handling in the presence of whales. A more formal code of conduct would ensure that whale eco tourism continues to be carried out with minimal disturbance to the whales. A responsible whale-watching certification system may provide incentive for tour operators to continue to contract professional guides to educate the whale-watchers – a critical component of effectual conservation. Land-based whale-watching is an unexploited activity on Boa Vista. High vantage points are found around the coast, providing good potential for land-based whale-watch tourism; an activity which obviously does not disturb the whales.



Figure 11. Whale watchers on a Naturalia-guided whale excursion.

Future Work

- Another biopsy sampling trip similar in structure to the present one.
- More extensive search effort including the southeast coast of Boa Vista, Sao Nicolau, Maio and Sal. Extending search effort to the shelf waters between Cape Verde and west Africa (Senegal, Guinea-Bissau, Western Sahara) given that this area is poorly studied but likely represents a continuous breeding area for humpback whales. The Bijagos Archipelago in particular is thought to be visited by both northern and southern hemisphere humpback whales, which merits further research (Hazevoet *et al.* 2011)
- Aerial Survey: humpback whales are good candidates for aerial abundance estimation given their highly visible large white pectoral fins. Furthermore, the shallow and clear inshore waters of Cape Verde make the whales visible from the air. An aerial survey of the entire archipelago is feasible given most islands have airports and the skies are often clear.
- Satellite tagging of whales – the equipment and expertise are in place and the INDP have expressed interest to be partners should this be pursued.

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