

## **Population Parameters of Beaked Whales**

Natacha Aguilar de Soto  
University of La Laguna  
Tenerife, Canary Islands, Spain  
phone: +34 922318387 fax: +34 922318311 email: [naguilar@ull.es](mailto:naguilar@ull.es)

Phil Hammond  
University of St Andrews  
St Andrews, KY16 8LB, Scotland, UK  
phone: +44 (0)1334 463222 fax: +44 (0)1334 463443 email: [psh2@st-andrews.ac.uk](mailto:psh2@st-andrews.ac.uk)

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### **LONG-TERM GOALS**

Beaked whales appear to be specifically sensitive to some acoustic sources, which can lead to mass strandings. The lack of knowledge about the population dynamics and reproductive parameters of these animals impedes the assessment of the population effects of stranding mortalities. The goal of this project is to continue a long-term photoID study started in the Canary Islands in 2003, in order to obtain a sufficient sample size for demographic modeling. This information will greatly augment the sparse knowledge of beaked whale population biology, facilitating the assessment of possible population effects of human impacts.

### **OBJECTIVES**

The overall objectives of the project are the following:

1. To assess the spatial fidelity of beaked whales to the study area in the Canary Islands.
2. To estimate population size and analyze the dynamics of the local populations of Blainville's and Cuvier's beaked whales over a 12 year period.
3. To study medium and long term individual associations and individual site-fidelity.
4. To obtain life history parameters of Blainville's beaked whales from long-term photoID data

### **APPROACH**

Determining when noise causes biologically significant effects requires making the transition from individual impacts, including mortalities, to population-wide effects. For this to be achieved it is essential to obtain data on vital rates and demographic parameters of the affected species (PCAD model, NRC 2005). Beaked whales (fam. Ziphiidae) are the most common taxa involved in mass strandings recorded in coincidence with naval exercises. However, because of their distribution in deep oceanic waters, they are usually difficult to study.

El Hierro (Canary Islands) holds resident populations of Blainville's and Cuvier's beaked whales in deep waters close to the shore (Aguilar de Soto 2006). This allows us to perform low-cost shore-based

research on these species. The combined efforts of observers from a coastal cliff and from a boat enables effective detection of groups of beaked whales occurring in the study area. The land and boat-based stations communicate by VHF radio and once a group is detected the boat approaches it to photograph the animals and obtain data on the composition and behaviour of the group.

PhotoID studies performed by ULL since 2003, largely with NOPP funding, have produced one of the largest individual catalogs available for these species. This catalog is freely accessible on-line at [www.cetabase.info](http://www.cetabase.info) and can be used by any entity or individual with beaked whale data, in the Canary Islands or elsewhere. Long-term monitoring provides an ideal opportunity to study social structure and demography in populations expected to be limited by natural variables such as habitat carrying capacity. Re-sightings of reproductive adults provide life-history data such as reproduction rates, essential to assess the recovery capacity of the species after mass mortalities.

Co-investigators on the project come from the University of La Laguna (N.Aguilar) and the University of Saint Andrews (P. Hammond). N. Aguilar directs and performs the scientific tasks, supervises researchers contracted to participate in the cruises and performs data analysis. P. Hammond is a qualified adviser, as a leader in the field of population abundance estimates and population dynamics of marine mammals, with an ample publication record in these subjects.

## **WORK COMPLETED**

The start-date of the project is the 28<sup>th</sup> of March 2012 although the final agreement ONR-ULL was achieved later, in May 2012. This report corresponds to the first months of the 3-year project covering the period from May to September 2012. During this period we have performed the following tasks, in accordance with the original plan of the project:

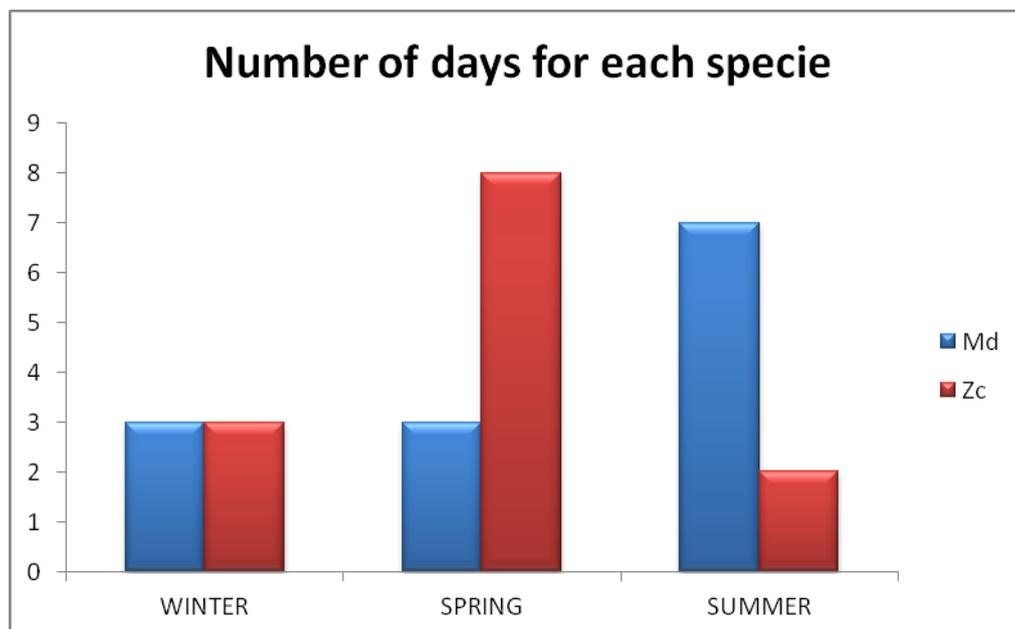
- a) Field work: We performed two seasonal photoID surveys off El Hierro (May and July 2012) focused on the two resident ziphiid species in the waters of the island: Blainville's and Cuvier's beaked whales (*Mesoplodon densirostris* and *Ziphius cavirostris*). The surveys achieved 19 days of effort at sea (nine days in spring and ten in summer). Eight researchers participated in each cruise, including the PI at ULL, two post-graduate students working for the project and students of biology from ULL. In addition, a third field-cruise was carried out by ULL in February 2012 and the data gathered in this cruise has been added to this project, summing 28 effort days until September 2012. The present ONR project is providing the opportunity to gather ancillary oceanographic data of the waters off El Hierro. We obtain measurements of temperature, salinity and nutrient concentration in order to keep a long-term dataset of the basic oceanographic parameters in the area of residence of the beaked whales.
- b) Online photoID catalogue: The open-access online database holding the catalog of beaked whales ([www.cetabase.info](http://www.cetabase.info)) has been updated after each seasonal survey. We included data on the new sightings of previously cataloged beaked whales and on the new individuals. Cetabase uses a logic database structure to store all information from the sightings and individual animals. The webpage also includes analytical tools targeted primarily for data extraction towards population abundance estimates. Software development is on-going to expand the analytical capabilities of Cetabase. For example, a new capability developed this year is that Cetabase now provides a csv file ready to import directly in *Mark* program for capture-recapture population analysis. This file is constructed from the data incorporated in Cetabase and the selection of animals for the file is based in flexible criteria set by the researchers. Although Cetabase offers open access to the photos, the analytical tools are only available for the account holders to work with their own data.

c) Statistical analysis of population abundance: ULL holds a beaked whale photo-ID catalog since 2003. The development of this catalog was an ancillary task carried out in parallel to the main tasks of several projects funded mainly by NOPP. Within the present project the overall database has been revised in order to perform a population abundance assessment from 2003 to 2012. A first overall analysis was performed, including population abundance estimates for pairs of years and a robust design analysis for the full database. The strict criteria used to select the individuals included in these analysis resulted in a low sample size that impedes an accurate performance of the statistical models. The analysis is currently being repeated using different criteria in order to increase the sample size. The new sample size for capture-recapture analysis includes 44 Blainville's and 51 Cuvier's beaked whales.

d) Meetings. The two IPs of the project met initially in April 2012 at the University of St. Andrews in Scotland to discuss the methods and planning of the project. A second meeting in August 2012 involved both IP and the two postgraduate students from ULL working in the project. This meeting was dedicated to data analysis using *Mark* software to assess the best suited models to obtain population abundance estimates. Fruit of the meeting was a new approach to extract data from the database in order to strengthen the statistical power of the analysis.

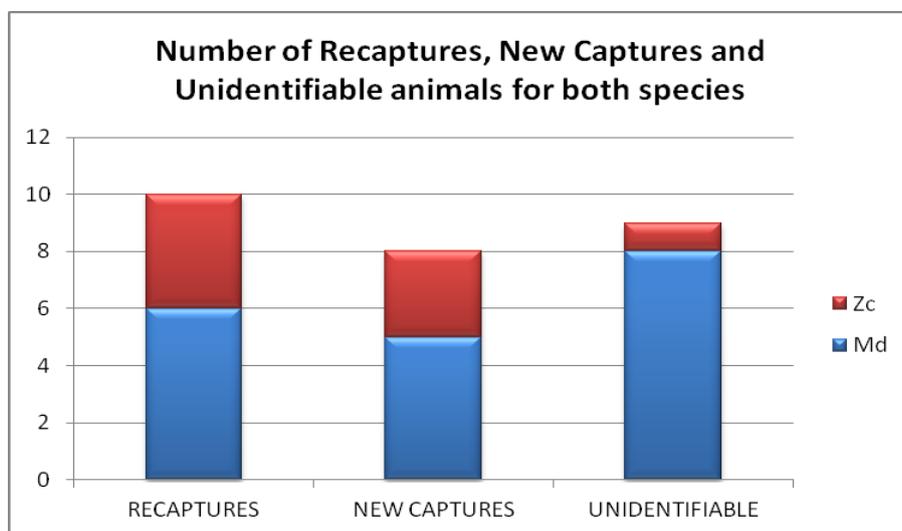
## RESULTS

Beaked whales were observed in the coastal waters of El Hierro in 98% of the 28 days of effort during the winter, spring and summer cruises, although the sighting rate for Cuvier's and Blainville's beaked whales in the area varied among seasons (Figure 1). The apparent alternation in the dominance of the two species during some cruises since 2003 (e.g. spring and summer 2012) is suggestive of inter-specific competition, but there are also numerous examples of cruises with similar sighting rates of both species, such as winter 2012 (Figure 1). An analysis of co-occurrence of both species from the last decade of sightings is on-going to study potential patterns in the relative abundance of the species in the study area.



**Figure 1. Number of days with sightings of Blainville's (blue, Md) and Cuvier's (red, Zc) beaked whales in the study area off El Hierro (Canary Islands). The total number of days of effort in each cruise was nine in winter and spring, and ten in summer.**

The number of ziphiid groups present in the study area in any given day is not always clearly defined. This is because the long dives of beaked whales sometimes impede researchers in the land-platform to identify with certainty if a given group is new or previously sighted that day. An expert best assessment is performed in each case, resulting on an estimated mean number of groups of ziphiids in the study area of three per day, resulting in an estimated mean number of animals of eight per day. A group is defined as a number of animals observed in close vicinity (< 5 body lengths) and with a similar behavior at the surface. More than 1000 photos were taken during the three cruises performed in 2012. A total of 26 individuals were recognized, of which ten were classified as recaptures from whales already cataloged in [www.cetabase.info](http://www.cetabase.info). Eight new individuals were included in the catalog based on animals with good quality photos and recognizable marks (new captures). The incorporation of new individuals to the marked population may be due to young animals having acquired marks or to transient whales in the study area. Nine animals were classified as unidentifiable, i.e. animals with good photos but without any recognizable mark. (Figure 2). The proportion of unmarked animals in the groups is averaged to obtain a mean correction value for the abundance estimations performed using only marked whales in the population.



***Figure 2. Number of recaptures, new captures, and unidentifiable Cuvier’s and Blainville’s beaked whales recorded in 2012. The apparent high number of unidentifiable whales is an artifact due to unmarked whales being distinguished individually only in the short-term (one day). The proportion of unmarked whales in each group is recorded and used to estimate the average proportion in the population to correct the results of the population abundance estimation based on marked individuals.***

The animals that were recaptured had been observed for first time in the previous two to nine years. Table 2 summarizes the capture history of each individual recaptured in 2012.

**Table 1. Sighting history of each whale recaptured in 2012 marking the years when each whale was photographed with good quality (1. indicates presence, not number of sightings). Results show that at least a part of the population of both species has a high fidelity for the waters of El Hierro, given the long history of recaptures and their relative abundance.**

| ID     | YEAR |      |      |      |      |      |      |      |      |      |
|--------|------|------|------|------|------|------|------|------|------|------|
|        | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 |
| MdH19  | 1    | 1    |      |      | 1    | 1    |      | 1    | 1    | 1    |
| MdH22  |      | 1    | 1    |      | 1    | 1    |      | 1    | 1    | 1    |
| MdH44  |      |      | 1    |      | 1    | 1    | 1    | 1    | 1    | 1    |
| MdH73  |      |      |      |      |      | 1    |      | 1    | 1    | 1    |
| MdH86  |      |      |      |      |      |      |      | 1    |      | 1    |
| MdHC31 |      |      |      |      |      |      |      | 1    | 1    | 1    |
| ZcH8   |      | 1    | 1    | 1    |      | 1    | 1    | 1    |      | 1    |
| ZcH10  |      | 1    | 1    |      |      | 1    | 1    | 1    |      | 1    |
| ZcH43  |      |      |      | 1    | 1    | 1    | 1    | 1    |      | 1    |
| ZcH60  |      |      |      |      |      | 1    | 1    | 1    | 1    | 1    |

Both species stood in the coastal waters off El Hierro in spite of the 6 months long volcanic eruption that started in October 2011, limiting the access of the whales to part of their foraging range in the slope of the island. During the surveys of February, May and July 2012 the sighting rate for both species was similar to that in the previous years. No signs of physical damage or anomalous behavior were observed in the animals (Figure 3).



**Figure 3. Two Blainville's beaked whales (MdhC31 and MdhX40) observed few kilometers from the eruption area that created a new volcanic peak raising from 500 to 200 m depth in the usual area of residence of beaked whales off El Hierro. The photo was obtained when the volcano was still active.**

## IMPACTS / APPLICATIONS

### *National security*

This work will provide important baseline data to assess the effects of naval activities, such as tactical sonar, on species protected under the US Marine Mammal Protection Act. To quantify the potential population effects of a given naval activity it is necessary to have knowledge about basic life history parameters of the species likely to be affected by the activity. These basic life history parameters include the size and dynamics of local populations, site fidelity and renewal rates (i.e. breeding rate, age of sexual maturation). Beaked whales are considered by the US Navy as species with enhanced sensitivity to intense acoustic sources, but there is still little or no information about the population dynamics of these species. This project is contributing data with direct applicability to perform modelling of potential population effects of human impacts.

### *Economic development*

Economic development is often related to increasing noise levels in the ocean e.g. from ship traffic or mining activities. An improved understanding of the abundance, habitat use and population dynamics of marine mammals will help to plan human activities and help making economic growth more sustainable.

### *Quality of life*

The project will contribute to the understanding of deep diving cetaceans, their use of the habitat, and their sensitivity to human interactions. The results will facilitate improved regional management with implications on ecosystem health.

### *Science education and communication*

The project produces information that is made available to the general public in [www.cetabase.info](http://www.cetabase.info). Results from the project will base three scientific publications covering abundance estimates, social structure and life history parameters of the study species, including interpretation of results to contribute to PCAD models. Graduate and postgraduate students are involved in all facets of the work.

## RELATED PROJECTS

### *Natacha Aguilar*

✦ Sound use in the marine ecosystem (European Commission Marie Curie Fellowship) March 2010 - Feb2013 (€297K). Current.

✦ Cetaceans, Oceanography and Biodiversity of Deep Waters in El Hierro and La Palma (Canary Islands). Spanish Ministry of Science and Education. Jan 2010, Jan 2013 (€153K + large oceanographic vessel usage). Current.

### *Phil Hammond*

✦ Chronic Ocean Noise: Cetacean Ecology and Acoustic Habitat Loss (European Commission Marie Curie Fellowship) Dec 2010 - Nov 2012 (£190K). Current.

✦ At-sea distribution, movements and behaviour of seals. (UK Dept of Energy and Climate Change). Apr 2010 - Mar 2012 (£235K). Current.

✦ Development of Seal Predation Logger (Scottish Government) Apr 2010 - Mar 2012 (£27K). Current.

▲ Harbour seal diet around Scotland: evidence for competition with grey seals (Scottish Government) Feb 2010 - Dec 2013 (£436K). Current.

## **PUBLICATIONS**

The on-going analysis of the historic photoID data is expected to produce a publication on local population abundance in Spring 2012.

Results have been presented to the Secretariat of the Convention of Migratory Species to propose the inclusion of Blainville's and Cuvier's beaked whales in Annex I of the Agreement.

## **REFERENCES**

Aguilar Soto, N. (2006). Acoustic and diving behaviour of short finned pilot whales and Blainville's beaked whales in the Canary Islands: implications for boat collisions and anthropogenic noise. PhD. Dept. Animal Biology. University of La Laguna. Tenerife. Canary Islands.

National Research Council (2005). Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. Committee on Characterizing Biologically Significant Marine Mammal Behavior. 142 pp.