Preliminary results of large whale calls recorded at low latitudes in the southwestern Indian Ocean

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ABSTRACT

Large whale calls were detected from data recorded over one year (2003/2004) on a hydrophone of the International Monitoring System (IMS) deployed offshore off Possession Island, Crozet Archipelago in the Indian Ocean. The low frequency (< 100 Hz) sea noise spectrum was dominated by a band of sound at 18-35 Hz which intensity varies over one year. This band mainly contained abundant calls assimilated to baleen whale calls. Among the call detected, Antarctic blue whale (*Balaenoptera musculus intermedia*), Pygmy blue whale (*B. m. brevicauda*) and Fin whale (*B. physalus*) were positively identified and were the most frequently recorded.

INTRODUCTION

During the 20Th century, many species of large whale such as blue (*Balaenoptera musculus*) and fin whales (*B. physalus*) were severely depleted by commercial harvest in the Southern Ocean (Clapham and Baker, 2001). Given the historical records, approximately 99% at 95% of respectively blue and fin whales were removed from the Southern Ocean (Clapham and Baker, 2001) and current research underscore the lack of information on large whale abundance, ecology and seasonal migrations in Antarctic waters (Sirovic *et al.*, 2004, Stafford *et al.*, 2004).

Research efforts to document the status of this endangered species in different Antarctic regions have been recently conducted (Thiele *et al.*, 2004). Visual surveys were conducted every year in summer along the routes of the vessel *Marion-Dufresne* between La Reunion Island and the French research stations of the Southern Indian Ocean (Amsterdam, St Paul, Crozet and Kerguelen archipelagos). Nevertheless, no study was conducted in southwestern Indian Ocean thorough a whole year mainly because weather and sea conditions do not allow visual surveys during winter months. In this context, the field work in the Southern Ocean represents considerable and expensive logistical constraints and the need for employing alternative methods to study whale populations is obvious.

Passive acoustic survey is an important tool in surveying remote areas of the sea that are difficult to investigate by more traditional techniques (Nieukirk *et al.*, 2004). Once the correspondence between the whale species and its call is established, acoustics monitoring is a powerful means of identifying the species present (Stafford *et al.*, 1999) and determining patterns of seasonal distribution and relative abundance (Stafford *et al.*, 1999, 2001).

The aim of this work was the use of a low frequency hydrophone arrays deployed at Crozet Archipelago to provide the first long term recording of acoustic signals in the southwestern Indian Ocean. The status of large whales in the Indian Ocean is unclear and knowledge about seasonal migration is limited (Stafford *et al.*, 2004). This method should provide valuable information as the calls characteristics of whales in the southwestern Indian Ocean and the seasonal distribution pattern of several whales species through these various low-frequency calls over one year.

METHODS

The data set (May 2003 – April 2004) was recorded by hydrophone of the International Monitoring System (IMS) deployed in support of the Comprehensive Nuclear-Test-Ban Treaty (CTBT) and designed to check the natural and artificial activity in the oceans (Roueff *et al.*, 2004). The IMS data used in this study were made available in support of a broader project of South Indian Ocean biological noise identification and characterization in order to discriminate biological noise of records, under contract from the Commissariat à l' Énergie Atomique (CEA). In southwestern Indian Ocean, IMS Station consisted of a set of three hydrophones called Underwater Monitoring Unit (UMU) deployed in a triangular configuration (triads) with approximately 1.5km spacing between instruments in north and south of Crozet archipelagos (French Indian Ocean Territory) (Fig. 1). Data were analysed from only one UMU in north triad (46, 16436°S, 51, 80246°E) here called Crozet North. This instrument was moored to the seafloor, floated at a depth near the sound channel axis. Data were transmitted via cable to shore and were available at the Commissariat à l'Énergie Atomique DIF / DASE - Bruyères-le-Châtel FRANCE. The Crozet North station recorded continuously with a sample frequency of 250Hz, with a dynamic on 24 bits (S/N: 126.5dB), and had a flat (±3dB) frequency response from 1.2-102.5Hz. At this sample rate, the instrument is capable to record the low frequency calls of blue and fin whale but is not sufficient to record sounds from humpback and minke whale, toothed whales such sperm or killer whale.

At the time of writing this document only a preliminary analysis of the data had been completed. Large whale calls were simply recognized while using spectrogram visualisation and the determination of the species calling whale was based on literature comparison. Through further analysis is required to verify these observations by using automatic detection with spectrogram correlation.

SUMMARY OF PRELIMINARY RESULTS

The preliminary results have provided a clear indication that three species of large whales occur in the region.

Antarctic blue whale calls

One common signals detected were long, patterned sequences of low frequency sounds in the 28-18Hz band. This call type is similar to spectrograms displayed by Ljungblad *et al.* (1998) from Antarctic blue whale calls recorded off Antarctica in 1997. This call consists of three components repeated in patterned sequences every 40-50s during few minutes or hours. The first component is a constant frequency tone centred at 28Hz followed by a short frequency-modulated (FM) downsweep from 28Hz to 20Hz ending with the third component, a slightly modulated tone (20-18Hz). This call lasts approximately 26s but sometimes only the first two components or only the first component was present. This degree of variability in the presence of the three individual components was previously reported (Stafford *et al.*, 2004; Rankin *et al.*, 2005).

Pygmy blue whale calls

Based on literature comparison with the first pygmy blue whale call description established by Ljungblad (1998), the pygmy blue whale low frequency call were often present in the data set. Like Antarctic blue whale call, these signals occur in patterned sequence of long tonal call every 90-100s during few minutes or hours. Each sequence is composed of a repeated two long distinct components. The first component is primarily a constant frequency tone at 35Hz

lasting 15-20s. A silent (approximately 20s) separate the two-part phrase. The second components start with a 1-2s 15-28Hz FM downsweep that ends with a long (20s) slightly modulated tone. Each component has strong associated harmonics.

Fin whale calls

A third call type commonly observed in our data set was a short (1s) pulsed call occurred with regular interpulse spacing (10s) in bouts of several hours. The call sweep down from 30Hz to 15Hz but main intensity was around 20Hz. Previous workers have attributed calls similar to these as being produced by fin whales (Watkins *et al.*, 1987).

These three different calls were visually detected year round with probably various peaks calling in season for each species. After preliminary analysis, others signals were visually detected but the species of vocalising whale have yet to be identified. While the data exploration is in its early stages, its promise is demonstrated by the great quantity, quality variety of biological signal recorded during almost one complete year. Furthermore using this data base we intend to address in the near future the question of the spatial distribution and the relative abundance of these 3 whales species off Crozet Archipelago.

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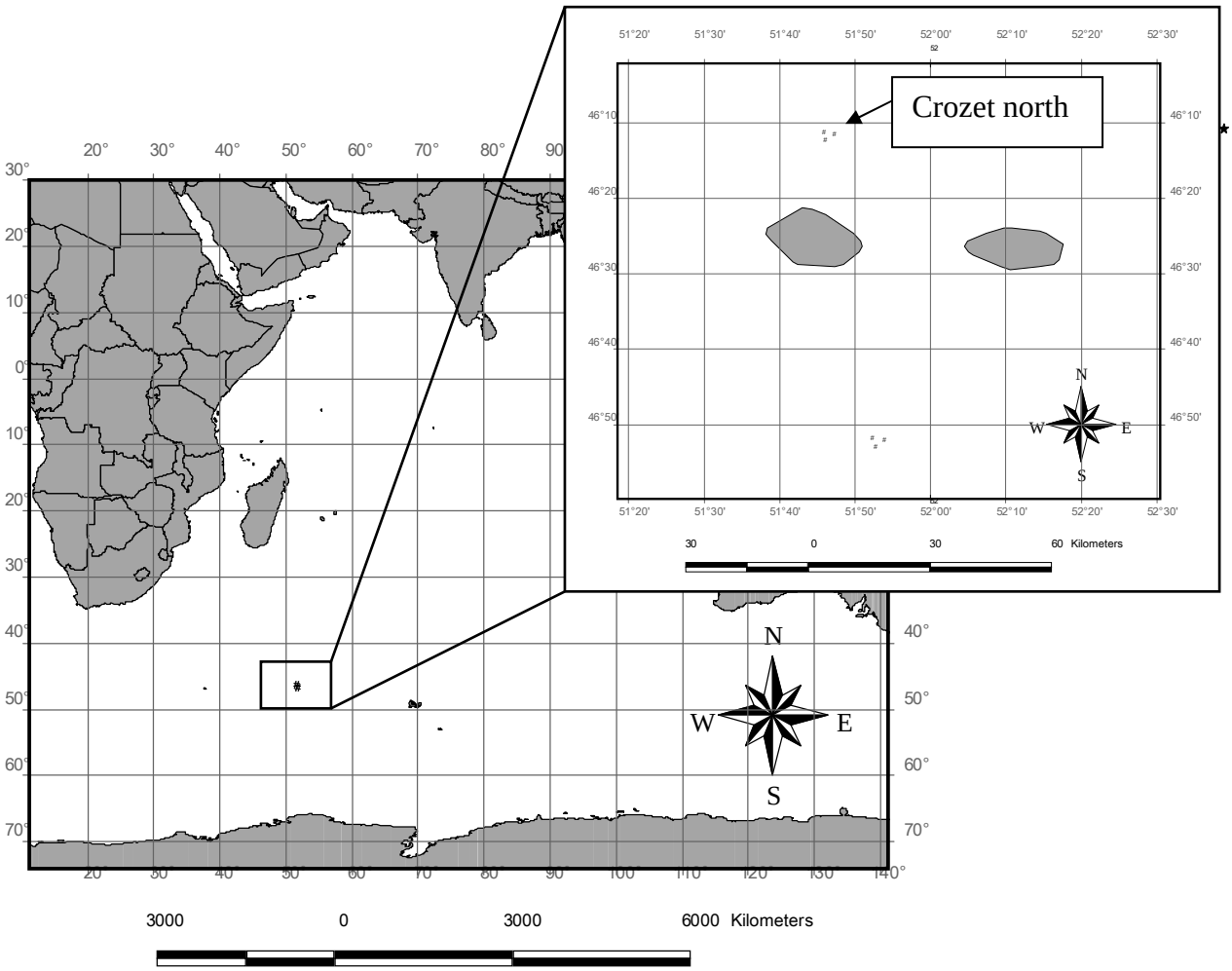
Fig. 1. Crozet North location