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Evaluation of the video-identification technique applied to bottlenose dolphins (*Tursiops truncatus*) in Cagarras Archipelago, Rio de Janeiro, Brazil

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*Reliable methods to identify and monitor cetacean individuals are important to assess population behaviour and ecology. We describe and evaluate the application of the digital video-identification technique (DVI) for the acquisition and analysis of dorsal fin images in the study of bottlenose dolphins (*Tursiops truncatus*) in the Cagarras Archipelago, Rio de Janeiro, Brazil. Between August and November 2004, we identified and catalogued 20 individuals; 80% were re-sighted more than twice. The Individual Residence Index varied between 1.0 ($N = 1$) and 0.2 ($N = 4$). Compared with traditional photo-identification methods, DVI offers significant advantages in respect to production of sequential images and speed of editing and processing.*

Keywords: evaluation, video-identification, bottlenose dolphins, Cagarras Archipelago, Rio de Janeiro, Brazil

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INTRODUCTION

The comprehensive study of population dynamics, ecology, feeding habits, and reproduction of cetaceans in their natural habitat is fundamental for the understanding of their life history. Photo-identification (photo-id) and mark–recapture techniques have been used to estimate population size, distribution and migration patterns, site-fidelity, survival strategies, and life history (summarized in Mann, 2000), and to monitor natural skin patterns (Lockyer & Morris, 1990; De Oliveira, 2006; Hardt, 2005; De Oliveira & Monteiro-Filho, 2008) of many cetacean species. Nevertheless, there are many logistic and methodological challenges for acquisition of this information, depending on species behaviour, equipment specification and its use for achieving specific objectives.

Over the past 35 years, the study and individual identification of cetaceans was facilitated by the use of high-quality still cameras (Würsig & Würsig, 1977; Defran *et al.*, 1990; Würsig & Jefferson, 1990). More recently, the development of high-resolution digital video equipment introduced a new perspective, providing image quality at low cost, easy handling (small camera size and weight), and fast image editing with computer software. The apparent advantages of the digital video identification technique (DVI) were demonstrated in studies of *Tursiops truncatus* Montagu, 1821 (Sanino & Yánez, 2001; Zolman, 2002) and *Sotalia guianensis* (De Oliveira, 2006; Hardt, 2005; De Oliveira & Monteiro-Filho, 2008). Kreb (2004) suggested that video images were a valuable supplementary tool to still photography in the identification of individual dolphins. Additionally, Markowitz *et al.* (2003) and Mazzoil *et al.* (2004) reported that digital technology offers a more efficient analysis of cetacean features compared with traditional photography.

We verified and evaluated the applicability and viability of DVI for the acquisition and analysis of dorsal fin images in the study of bottlenose dolphins in the Cagarras Archipelago, Rio de Janeiro State, Brazil. The results of the study are discussed within the framework of improving method performance considering the advantages and limitations of the technique.

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MATERIALS AND METHODS

The Cagarras Archipelago is located off the coast of Rio de Janeiro (23°02′S; 43°12′W) with three islands (Cagarras, Palmas and Comprida) providing shelter from high sea states, facilitating observation and image acquisition of bottlenose dolphins.

Fieldwork was conducted by a single researcher, working from a 10 m, 40 HP motorboat, between August and November 2004. Favourable weather conditions for image acquisition occurred when the Beaufort sea state was ≤ 2. Images were acquired between 0930 and 1500 h when light conditions were appropriate. A Sony Hi-8 Handycam DCR-TRV330 (320 pixels; 400 lines resolution) video camera with $25\times$ optical zoom and $750\times$ digital zoom was employed to record images on Hi-8 tapes (60 min). Tapes were numbered, dated, and the first recording included a short sequence of an identification board bearing the same information to facilitate editing. Images of the dorsal region and dorsal fin were acquired following the recommendations in the literature (Defran *et al.*, 1990; Würsig & Jefferson, 1990; Sanino & Yánez, 2001). After visualizing dolphins at a distance, we used the optical zoom to fill the frame, obtaining distortion-free high-resolution close-up images of different dorsal fins with accurate focus.

Relevant images were selected from the originals in the editing laboratory, using a TV monitor connected to the camera. Time information was taken from the camera time-stamp and recorded on appropriate forms. The selected film segments were imported into Adobe Premiere software (version 6.0) under Windows XP, via a FireWire cable hooked into a computer, with a Mercury WDM TV Tuner video card. Sequences were analysed frame-by-frame and images presenting best focus, contrast, clarity and framing were exported to folders labelled with the corresponding expedition date, in Tagged Image File Format (TIFF) preserving image resolution. Adobe Photoshop software was employed to cut and frame the images ('cropping') according to a standard style and size (380 × 304 pixels) suitable for digital comparison.

Images of dorsal fins showing distinctive features were labelled, coded, and compared with each other. We used several tools within Adobe Photoshop software to verify dorsal fin identities, avoiding false positive/negative errors. These included overlapping, inverting dorsal fin positions, comparing colours and regulating the zoom level. Two independent researchers carried out the analysis, working for periods of no more than 2 hours.

After characterizing and confirming the distinctive features of all different dorsal fins, images were collated on a catalogue form elaborated in CorelDRAW (version 12), which contained all the collected information of the identified animal. To associate specific features with each individual, the marks exhibited on the dorsal fins were classified according to their positions in logical quadrants (Posterior Superior (PS), Posterior Inferior (PI), Anterior Superior (AS) and Anterior Inferior (AI)), and grouped into 15 categories (Figure 1) thus enabling images with similar characteristics to be mutually compared. Four additional complimentary categories (C1, presence of non-pigmented areas; C2, presence of scratches or scars; C3, presence of non-pigmented areas, scratches and scars on the head, along the dorsal surface of the body, and/or dorsal fin; and C4, silhouette peculiarities and deformities present in the dorsal fin) were created to minimize cataloguing errors. Specific marks were highlighted and indicated by arrows in the catalogue, to facilitate dolphin visual recognition in their natural habitat. Each individual was given an identification code with a double letter prefix (CA for Cagarras Archipelago) followed by a three digit number. The identity of each coded individual was verified three times to ensure identification reliability. The re-sighting patterns were quantified using the Residence Index (RI = number of sightings/total number of surveys) (Pérez *et al.*, 2004). We estimated an index of identification success by dividing number of identified individuals per filming time in minutes.

RESULTS

We conducted a total of 3960 minutes of direct observations on 11 field expeditions, recorded 840 minutes (21.2% of the total observation time) in 14 Hi-8 videotapes, pre-selected 557 film segments (162 minutes), and obtained 1233 images. From these, 181 (14.7%) were very high quality and used in the mark–recapture investigation.

We identified and catalogued 20 different individuals, 80% were re-sighted more than twice. The RI varied between 1.0 (N = 1) and 0.2 (N = 4) (Table 1).

The rate of identification success was 2%, time spent selecting and editing images was 3240 minutes, including 1440 min in 'cropping' and 1800 minutes in processing.

DISCUSSION

In the present study, DVI provided valuable information for the recognition of *T. truncatus* in the Cagarras Archipelago. Advantages of DVI included the easy handling of the small sized equipment in the field, particularly in our case where the base platform was a moving boat. Dolphin movements on the surface were followed sequentially, increasing the chances of obtaining good quality images for reliable animal identification. Kreb (2004) observed that video-id made possible the observation of the entire movement of dolphins at the surface, providing different angles of the dorsal fin for identification. Another positive aspect of the 'plug-and-play' camcorder was its easy connectivity to a television set and a computer, for data transfer and image analysis, reducing processing time. These results were consistent with previous findings (De Oliveira, 2006; Hardt, 2005; De Oliveira & Monteiro-Filho, 2008), which suggested that DVI was more efficient for obtaining images of cetaceans in the field. Once the videos were transferred to digital media, tapes were re-used, minimizing research costs (Sanino & Yánez, 2001), and providing additional environmental benefits.

Our identification success (around 2%) was lower than other photo-id studies. De Oliveira (2006), Hardt (2005) and De Oliveira & Monteiro-Filho (2008) obtained rates between 3 to 11% (average = 7%) in studies of *S. guianensis*, whereas Sanino & Yanez (2001) and Zolman (2002) obtained rates of 7 to 9% (average = 8%) in the study of *T. truncatus*. The fact that image quality depends on video equipment, the ability of the camera operator, animal size and number of animals in a population or group, and the geomorphology of the study area, probably influenced these success rates. Although species behaviour (e.g. social activity and tolerance to close observation) is also an important factor to consider, bottlenose dolphins may be considered ideal targets for video-identification. They usually approach boats and often exhibit cuts, non-pigmented spots, scars and scratches in the dorsal fin or the dorsal region (Würsig & Würsig, 1977; Lockyer & Morris, 1990, Würsig & Jefferson, 1990, Wilson *et al.*, 1999), minimizing behaviour effect on the lower rate of identification success.

Image selection was the most time-consuming task, demanding individual experience and concentration for the correct identification of individuals, although pre-selecting segments facilitated cropping, and the image classification scheme reduced the effort for image comparison. This result was consistent with Hardt (2005), which reported that image editing took five times longer than image capturing. Traditional photo-id may take between 30 minutes to 3 hours of processing time per photograph, depending on the target species (Paulo Flores, Centro Mamíferos Aquáticos—CMA-IBAMA, personal communication). Mazzoil *et al.* (2004) observed that digital photo-id may take even less time for processing. Still, DVI

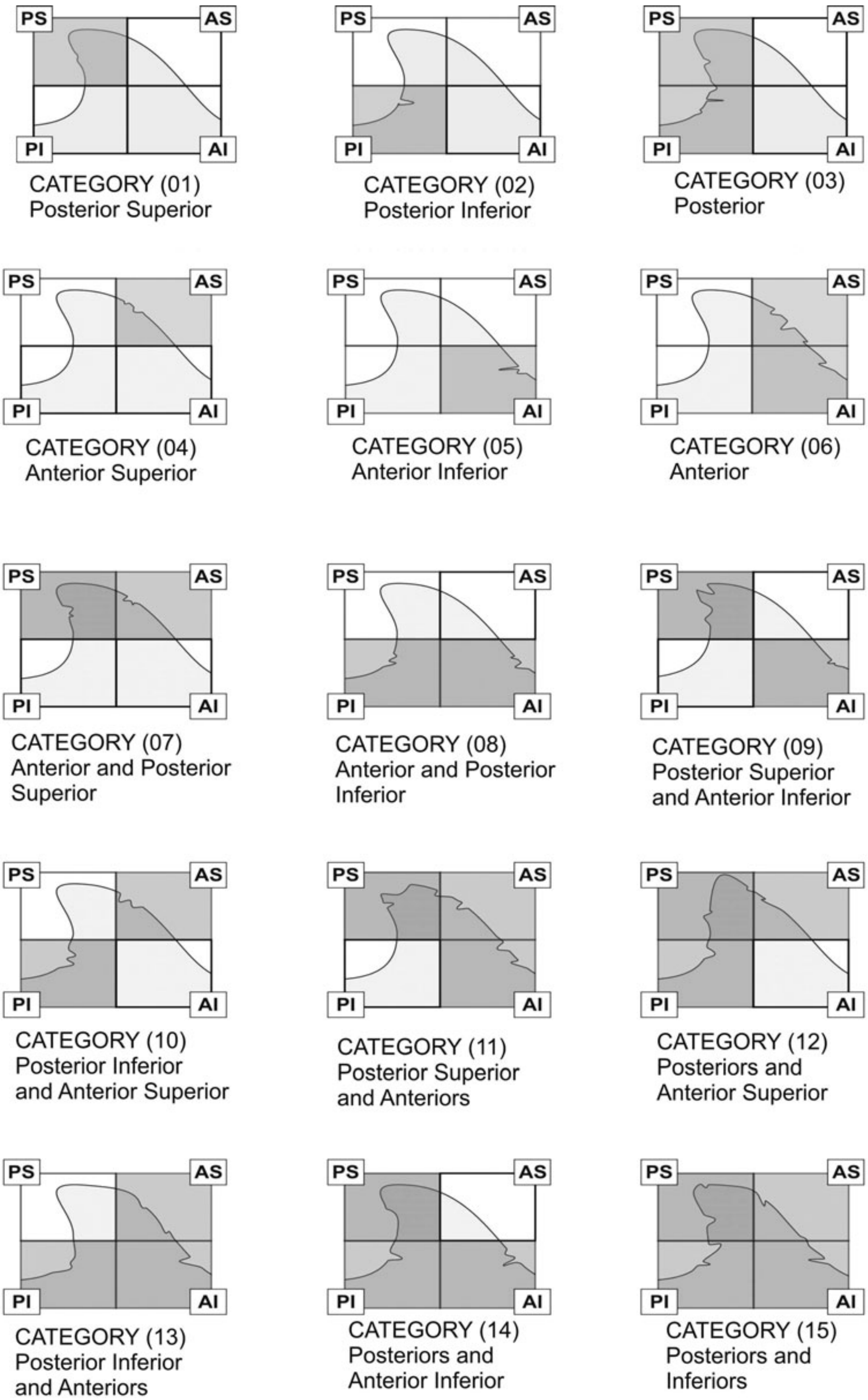

Fig. 1. Categories (N = 15) originated from the possibilities of marks exhibited by the dorsal fins according to their positions within the logical quadrants.

had the advantage of producing film sequences that helped not only to identify individuals but also to understand their behaviour within the group. In fact, Kreb (2004) suggested that video recording is an important tool for social structure studies.

Our study yielded useful information on high quality video images, providing excellent cost–benefit results. The fact that only a single researcher shot the images probably reduced variability and increased success for obtaining good quality sequences.

Despite the advantages of DVI observed in our study, its efficiency must be tested with different cetacean species, and methods improved as new technology reaches the market. Currently, the comparative studies using animals identified by different researchers is limited due to lack of consistency in the

Table 1. Records of individual *Tursiops truncatus* sightings recognized by video-identification in the Cagarras Archipelago, Brazil from August through to November 2004.

Identification code	August	September					October		November			Residence Index
	06/08	03/09	07/09	10/09	17/09	24/09	29/10	30/10	05/11	06/11	26/11	
CA#016	■	░	░	░	░	░	░	░	░	░	░	1.0
CA#013	■	░	░	░	░	░	□	░	░	░	░	0.9
CA#005	□	■	░	░	░	░	░	░	░	░	░	0.9
CA#001	□	■	░	░	░	░	□	□	░	░	░	0.7
CA#018	□	■	░	░	□	░	□	░	░	░	░	0.7
CA#017	□	■	░	░	░	░	□	□	░	░	□	0.6
CA#009	□	■	░	░	░	░	□	░	░	□	□	0.6
CA#004	□	□	□	□	□	■	░	░	░	░	░	0.5
CA#006	□	□	■	░	□	░	□	□	░	░	░	0.5
CA#007	□	□	□	■	□	░	□	□	░	░	░	0.5
CA#014	□	■	░	░	░	░	□	□	□	□	░	0.5
CA#015	□	■	□	□	░	░	□	░	░	░	□	0.5
CA#019	□	□	■	░	░	░	□	□	░	□	□	0.5
CA#012	□	□	□	□	░	□	■	░	░	░	░	0.4
CA#010	□	□	□	■	□	░	□	□	░	□	░	0.3
CA#011	□	□	□	□	■	░	□	□	░	░	□	0.3
CA#002	□	■	□	□	□	□	□	□	░	□	░	0.2
CA#003	□	□	■	░	□	░	□	□	□	□	□	0.2
CA#008	□	■	░	□	░	□	□	□	□	□	□	0.2
CA#020	□	□	□	■	░	░	□	□	□	□	□	0.2

■, initial sighting; ░, re-sighting; □, no sighting.

criteria for image organization, the multiplicity of formats for image capture and editing, and the diversity of computer software employed in the process. Clearly, standardization of protocols for recording and analysing images is urgently required.

Currently there is a general tendency to use digital video cameras and computer equipment to study marine animals, including cetaceans. DVI offers the potential to reduce time, and improve efficiency and accuracy on the identification and analysis of cetacean individuals from images taken in the field. Furthermore, it may help information exchange between researchers. Whilst such techniques will clearly facilitate image acquisition, extraction, editing and processing, standardized procedures are needed to facilitate this information exchange. New technology, including higher-resolution CCDs, new formats for bulk memory storage, and refinements in the techniques employed, should result in massive benefits for future scientific investigation in this area.

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