Aquatic Mammals 1998, **24.3**, 143–147

Matrix photo-identification technique applied in studies of free-ranging bottlenose and humpback dolphins

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Individual photo-identification has been used in field studies of a large number of cetaceans and proven to be a useful tool in the estimation of a variety of population parameters (Hammond *et al.*, 1990). For most dolphins and porpoises the shape of the trailing edge of the dorsal fin is the most diagnostic feature (Würsig & Jefferson, 1990). It abrades and tatters easily, resulting in clearly visible notches. As it is a result of incidental events, the notch pattern of the dorsal fin varies between individuals and has been used by many researchers for identification of free-ranging dolphins. An effective technique of analysing and cataloguing photographs of dorsal fins, based on their notch pattern, was developed by Defran *et al.* (1990) and used by many researchers since.

However, relying on a single identification feature may lead to misidentification. There are several other features which may help in identification of individual dolphins. These include shape of the dorsal fin, pigmentation patterns, wound marks and various scars occurring on the upper body. Identifying all these distinctive marks from photographs and 'grading' them, results in a matrix of features ensuring correct identification. With respect to this, colour positives provide several advantages over black and white negatives.

This matrix photo-identification technique was used extensively during long-term field studies of bottlenose *Tursiops truncatus* and humpback *Sousa chinensis* dolphins in the Algoa Bay region, Eastern Cape, South Africa (Karczmarski *et al.*, 1991; Karczmarski, 1996). The method has proven to be particularly useful for humpback dolphins. In this species, the notch pattern on the dorsal fin is seldom clear enough to ensure individual identification and, consequently, the 'traditional' approach sensu Defran *et al.* (1990) often fails. When applying the matrix photo-identification technique, over 90% of adult humpback dolphins and about 80% of adult bottlenose dolphins could be identified through external, recognisable features.

Analyses of photographs collected during boat-based photo-identification surveys were preceded by sorting the photographs into right and left side photos (dependently which side of the animal was photographed) and into duplicates of the same dolphin. Only one, the most clear photo-ID of each individual photographed during a particular survey, was used for further analyses. A modified 'Dorsal Fin Ratio' (Defran *et al.*, 1990) was used as one of the identification measures (Fig. 1). Its application for humpback dolphins, however, was limited by the fact that the notches on the dorsal fin often lacked clearly defined top and/or bottom points.

Generally, all visible natural marks of an individual were indexed and stored in computerised identification tables (Fig. 2). When 'coding' of the ID-photograph was completed, the whole identification table was examined for individuals with similar characteristics (resightings). To achieve this, the whole identification table (spreadsheet) was sorted column by column in descending order. When the possible resightings were isolated, the current and previous slides were examined visually using both slide projector and an 8 × loupe. If the ID-photographs did not match, the current photograph was considered a new sighting and the dolphin given an exclusive name or number and subsequently included into a photo-catalogue of dolphins identified during the study period.

Longevity and changeability of natural marks are of critical importance in studies which require long-term individual recognition (Carlson *et al.*, 1990; Gunnlaugsson & Sigurjonsson, 1990; Agler, 1993). The matrix photo-identification technique, although labour intensive, proved to be a powerful tool in overcoming such obstacles (Figs 3 and 4), whereas using a method based exclusively on

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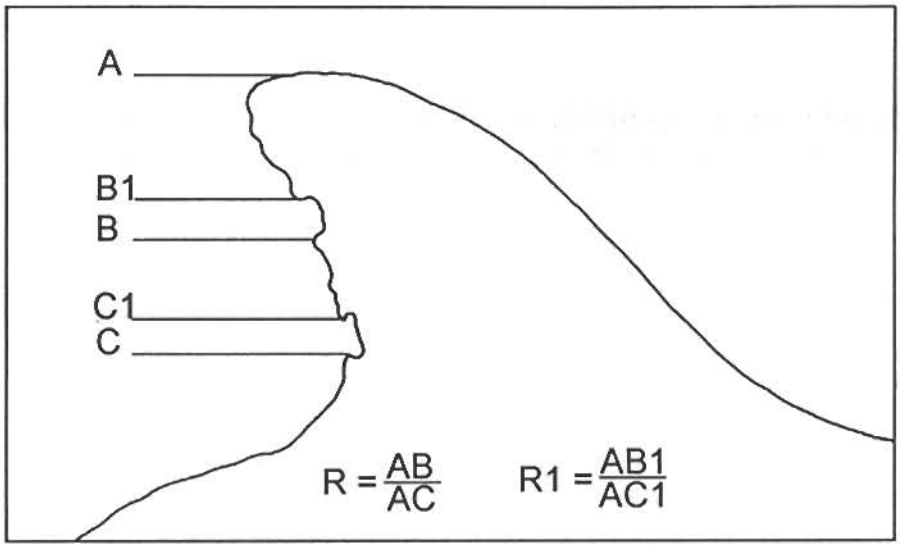

Figure 1. The modified Defran's 'Dorsal Fin Ratio': The colour positives were projected onto a grided screen. The distances between the top of the fin and the bottom points (R) and/or top points (R1) of the two biggest notches on the trailing edge of the fin were measured. The final ratios (R and R1) are relative measures and therefore not affected by the size of the fin on the picture or moderate cases of parallax. When only one notch occurred on the fin, the distance from the top of the fin to the top and bottom points of this notch were measured and the calculated ratio was recorded in the identification table as R.

dorsal fin notch pattern could result in animal misidentification and errors in matching photos of the same individual.

Furthermore, the matrix photo-identification technique permits the maximum use of photographic data collected during boat surveys. Occasionally even relatively 'poor' ID-photographs can be used if the photographed individual has an identifying feature that can clearly be discerned. It is particularly important, however, that the photographic catalogue be periodically reassessed and updated, to include the most recent photographs. This allows changes in the external appearance of individual dolphins to be monitored.

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Figure 2. Example of coded photo-ID of bottlenose (a) and humpback dolphin (b). The computerised catalogue of identified individuals included also the survey (sighting) number, date and locality where the dolphins were seen.

Table 1. Refer to Figure 2

	No. of notches			Ratio		Fin shape			Other marks					
Slide no.	*	**	***	R	R1	C/B/O	Hump mark	Shark bite	cf. #14	Mat.	Sex	Specific association	Remarks	ID
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	0	0	2	0.589	0.407	O	n/a	—	Yes	A	X	With #58	Pigmentation: upper side—black ventral side—light	Vincent
b	0	0	0	—	—	O	—	Yes	Yes	A	X	—	Net-like scratches on the dorsal fin; first sighting	Sharkie

*—number of notches on the leading edge of the dorsal fin.
**—number of notches on the tip of the dorsal fin.
***—number of notches on the trailing edge of the dorsal fin.
C/B/O—dorsal fin: chopped (C), bent (B) or of a normal shape (O).
Hump Mark—light (pink/white) patch on the dorsal fin and hump of adult humpback dolphins.
Mat.—relative maturity: adult (A), juvenile (J) or calf (C).
Sex—identified sex: female (F), male (M) or unknown (X).

Figure 3. Example of a humpback dolphin which has been re-identified despite a considerable variation in the shape of the dorsal fin. The positive re-identification was based on the shape and localisation of several scratches on the hump and dorsal fin as well as the general pigmentation pattern.

Table 2. Refer to Figure 3

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	0	0	5	0.608	—	O	Yes	—	Yes	A	X	With #2	Pink dorsal fin; V-shaped scratches in front/bottom of the pink dorsal patch	Anton
b	0	1	3	0.509	—	O	Yes	—	Yes	A	X	—	Pink dorsal fin; V-shaped scratches in front/bottom of the pink dorsal patch	Anton

Figure 4. Changes in the external appearance of a young humpback dolphin which could be monitored through the matrix photo-identification method. The photographs were taken approximately a year apart. The positive identification of this individual was confirmed by its close association with one particular adult (presumed mother).

Table 3. Refer to Figure 4

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
a	0	0	0	—	—	○	—	—	Yes	C	X	With #1	Dark shading on the tip of the dorsal fin	B/P–Fin
b	0	0	0	—	—	○	—	—	Yes	C	X	With #1	Dark shading (fin); scratches hump, fin and upper left side	B/P–Fin
c	0	0	1	0.728	—	O	—	—	Yes	J	X	With #1	Scratches on the dorsal fin, hump and upper left side	B/P–Fin