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Assessment of all the photo-identification data available for killer whales in Crozet archipelago.

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ABSTRACT

Since 1964, a long term photo-identification monitoring, realised on killer whales occurring around the Possession Island, Crozet archipelago, has provided a large picture database. Since 1998, a supplementary photo-identification effort was also realised from the fishing vessels, in the Crozet Exclusive Economic Zone, when killer whales came to interact with long-lines. Nevertheless, few many studies have been realised on those killer whales which stay largely unknown. Our aim is to assess all the available data which could be useful for future studies. Using the software Access©, we realised a database which allowed us to easily extract individuals information from pictures. A total number of 9807 pictures was realised during the whole study period even if the photo-identification effort varied from year to year. Pictures were found to present an average of 1.4 individual of which more than a half had a bad quality, i.e. blur and/or far. However, using the method developed by Bigg (1982), a total of 195 different killer whales have been identified. Some of killer whales firsts identified inshore, since 1987, present a strong site fidelity whereas killer whales firsts identified offshore were never re-observed near the shore but thousand kilometres from there, in the Kerguelen EEZ.

Keywords: Indian Ocean, Photo-Id, Killer whales, *Orcinus orca*, Fisheries.

INTRODUCTION

Interactions between marine mammals and Patagonian toothfish (*Dissostichus eleginoides*) fishery activities have been reported to occur all around the world (Baird and Gorgone, 2005; Barlow et al., 1994; Lauriano et al., 2004; Mussi et al., 1998; Space et al. 1998), especially with killer whales (*Orcinus orca*) and with sperm whales (*Physeter macrocephalus*) (Ashford et al., 1996). Two symposiums were thus realized around this problem in 2002 (Donoghue et

al., 2002) and 2006 (in press.). During these interactions, cetaceans retrieved fish from long-lines or nets.

In Crozet and Kerguelen Exclusives Economics Zones (EEZ), fishery of Patagonian toothfish started in the mid 1990's and known a quickly growth as far back as 1998. However, at present, only seven vessels are authorised to fish.
In Crozet and Kerguelen EEZ, fishermen used long-lines formed by a succession of 1km long sections (up to height sections) composed of 1000 hooks each and maintained in depth by weights at each end. Long-lines are generally set at a depth ranging between 800 and 1200m which are unreachable by killer whales which are not known to dive to depths much exceeding 300m (Bowers and Henderson, 1972). Killer whales can only have access to the fish when the line are retrieved and consequently they have to come close to the fishing vessel to do so.

Killer whale (*Orcinus orca*) is one of the largest marine species with 6-7m and 4–5m in length for males and females respectively. It is found in nearly all marine environments throughout the world and is one of the most widely ranging mammals on earth (Heyning and Dahlheim, 1988; Ford et al., 1994). This species also plays an important role within its ecosystem, occupying a position of top predator what induced a strong interest for searchers. Although killer whale's biology was pretty well known (Wandrey, 1997), its global status stay largely unknown.

In Crozet archipelago, killer whales presence was first reported in 1825 (Lesquin, 1840) and previous to the fishing activity they were exclusively observed from the shore of the Possession Island. The studies realised allowed to approach the diet (Guinet, 1992) and survival rate (Guinet, 1991) of killer whales occurring around the coasts of the Possession Island, but since 1992 no new study has been published on this population.

Between 1964 and 2006, a large number of opportunistic pictures of killer whales was realised from the coasts of the Possession Island, and since 1998 we took opportunity of the presence of observers onboard of fishing vessels to conduct an extensive photo-identification work on killer whales interacting with the fishery. A killer whales photo-identification database was so realised at the same time from shore and from fishing vessels.

The aim of our study is to compile all the information available from picture data to evaluate the potential of our database for the development of several studies on demographic parameters, population size and social structure of killer whales occurring in Crozet archipelago on the one hand, and on cetaceans/fishery interactions on the other hand.

MATERIAL AND METHODS

Data collection

This study relies on the photo-identification method. Opportunistic photographs of killer whales occurring in the very inshore waters of Possession Island (46°25'S, 51°40'E; Fig.1) were taken between 1987 and 2006, using a photo-identification protocol, by the staff wintering on the Alfred Faure Research Station. Under this protocol, and according to Bigg (1983), photographers shoot completely exposed dorsal fin and saddle patch of surfacing

killer whales, with the best possible magnification. Dorsal fin close-ups, allowed to identified individuals from the natural features or "marks" of their dorsal fin (shape, notches, scars; Bigg, 1982) and characteristics of their saddle patch (colour, form and scars). In our study, the anterior part of eye patch was also used.

Thought data were collected since 1964, most of the inshore photo-identification effort was conducted over three majors' campaigns: 1987-1990, 1998-2000 and 2003-2006. During the two firsts campaigns, fieldworkers essentially photographed killer whales from the coasts of Possession Island (=inshore). Whereas, during the third one, observers took particularly pictures from fishing vessels (=offshore), when killer whales came near the boat to retrieve Patagonian toothfish from the long-lines.

Database structure

Our data were first entered in an Excel© database. As to find out the information easily it is necessary to structure and treat data on a hierarchical basis, we created an Access© database.

To start to organise the data, we started to define three different categories: sighting, picture and individual.

We defined an encounter (= sighting) like a continuous observation of killer whales from the moment when the first individual was located until the last was seen, either by the departure of the killer whales or the observers. This category contains general data on the observation, e.g. date, place, number of observed individuals and their species, which will be necessary to further define individuals movements and social organisation.

In the picture category, all information on photograph are naturally included, e.g. author and picture type.

Individuals' information organisation was more complex. Indeed, all the data allowing to characterise an individual are not on a single picture, they are dispersed. According to the quality and especially to the killer whale position on the picture, each picture could not present the entire individual. For example, it is difficult to have the saddle patch and the eye patch on the same picture. Now to well identify an individual, it is necessary to have all the information concerning it. We therefore realised two different tables: the first one described all the individuals' characteristics on each picture where they were present and the second one summarised all the data available for each individual (even if those none identified). The last tables concerned notches and reproductive status evolutions which will be useful for demographic studies.

Individual's data harvesting

All slides were looked at with an 8x magnifying eyepiece on a light table while digital pictures were watched on a high resolution computer screen (1,3G pixels). All the necessary information are entered in the Access© database (*cf.* previous part).

We characterized each individual on each picture by several information:

(1) A number, attributed at each killer whale present on the picture according to its distance to the photographer (n°1 is the nearest, n°2 the second, etc). When several individuals were at the same distance, we numbered them from the left to the right.

(2) An animal angle, relatively to the observer. We defined 12 sections, increasing from the left to the right. Body axes corresponded to 0° (head) and 180° (tail).

(3) An individual quality, defined in three classes: Q0 = bad quality, individual blur and/or far; Q1 = average quality, individual nearer but badly directed and/or not sharp; Q2 = good quality, individual near, well directed and sharp.

(4) Exposure of dorsal fin, saddle patch and eye patch, i.e. are they completely or partially out of the water.

(5) A dorsal fin mark level: M0 = no mark on dorsal fin; M1 = small notches; M2 = medium-size notches and M3 = characteristics notches.

(6) Importance and location of each notch on dorsal fin.

Unless its marking level was M2 or M3, a killer whale was only considered like photo-identified when it exhibit the same identifying features (scars, nicks…) on at least two different pictures, not take sequentially.

A name was attributed for every newly photo-identified individual which was then assigned to a broad age/sex class category.

RESULTS

Access© database

The Access© database consisted in four principal tables: sighting, picture, individual analyse and individual identify which were complete by three additional tables: code position, historical reproductive status and historical identificability (Fig. 2).

Photo-identification data

From 1964 to 2006, 9807 pictures of killer whales were realised: 45.4% inshore and 54.6% offshore. 10.6%, 10.9% and 75.8% of the pictures were realised during each major campaign respectively (1987-1990, 1998-2000, 2003-2006) what makes a total of 97% of the pictures realised during the three sessions. The number of pictures varied from year to year between 0 to 3876 with an average of 228 pictures by year.

The number of individuals present on each pictures varied from 1 to 11 with an average of 1.4 individual by picture. On the whole pictures 56%, 39% and 5% of the individuals had a Q0, Q1 and Q2 quality respectively.

During the two firsts majors photo-identification efforts, 55 and 20 killer whales were identified respectively. Since 2003 the significant photo-identification effort lead at the same time from shore and from fishing vessels allowed to identify 120 news killer whales. Over the whole study period a total of 195 different killer whales were therefore identified: 104 inshore and 91 offshore. Among all the identified individuals 44.1% had a mark level of M0, 26.2% of M1, 17.9% of M2 and 11.8% of M2. The ratio between the total number of identified individuals and the number of marked identified individuals (>M0) was estimated at 1.8. This

value correspond to a proportion of individuals marked on the dorsal fin of around 53%. Nevertheless, the ratio of individuals easily identified (>M2) in the population was re-evaluated at around 30%.

A large majority of killer whales first identified inshore were never re-observed offshore and only 9 killer whales first identified inshore were latter re-observed both inshore and offshore. On another hand, some of those killer whales were re-observed over 20 years apart. One of them was even observed 36 years apart.

None killer whales first identified offshore was re-observed from the shore of Possession Island. But interestingly, in 2006, some of them were re-observed thousand kilometres from Crozet EEZ, in the Kerguelen EEZ, interacting with fishing vessels.

CONCLUSION

Several individuals being recognised many years apart, the photo-identification method was validate. The photo-identification effort realised the last 40 years is therefore used to start news studies on survival rate and population size estimates of Crozet archipelago killer whales. These analyses are yet under development. Firsts social structure analyses are developed as well for inshore and offshore killer whales separately.

Our database also allowed to highlight for the first time that killer whales are able to follow a fishing vessel by several thousand kilometres, between two fishing areas.

The maintenance of a constant photo-identification effort, at the same time inshore and offshore, seem therefore necessary to collect supplementary continuous data. The long-term continuous database thus create will allow us to first improve our knowledge of Crozet archipelago killer whales, but also to define cetaceans/fishery interactions' mechanisms. In the current context of fish rarefaction, those mechanisms could have strong implications for futures management procedures.

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FIGURES

Figure 1: Crozet archipelago map.

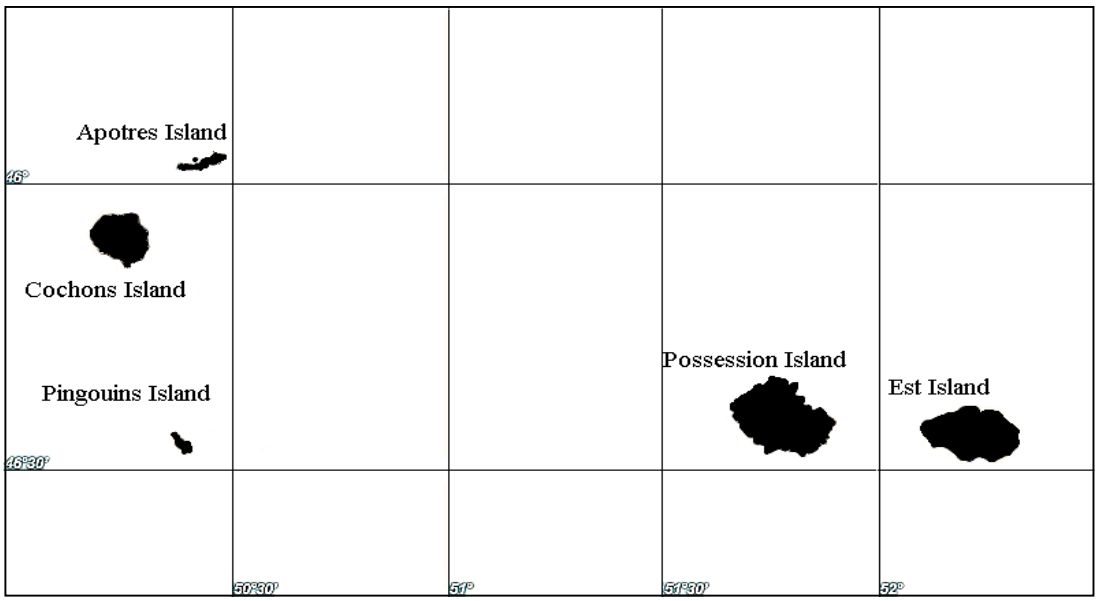

Figure 2: Structure of the Access© database.