Assessment of cetacean diversity, hunting, by-catch and stranding in South of Madagascar

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Abstract

We here report on several studies that have been conducted to assess cetacean diversity, dolphin hunting and fisheries bycatch off ten villages in the southwest (Toliara) and southeast (Fort Dauphin) of Madagascar, reporting on socio-ecological interview data covering the period 1975-1999, and a combination of both boat-based surveys and interview data collected during 2000-2018. The boat-based surveys and interviews indicated that 18species of cetacean (5 species of whales and 13species of dolphins) have been observed in the waters in the southwest region, and interview surveys indicate that 14 species (6 species of whales and 8 species of dolphins) have been reported in the waters of the southeast off Fort Dauphin. The socio-ecological surveys revealed the identification of several stresses on the cetacean population, including hunting, stranding and fisheries by-catch on seven species of cetacean: bottlenose, spinner, and Indo-Pacific humpback, pilot whale, Risso's dolphin, humpback whale and sperm whale. Two types of fishing gear, harpoon and gill net, are used in the two regions to hunt cetaceans, and incidental by-catch occurred in gill nets. At least 2750 cetaceans were killed between 2000 and 2018 and 25cetaceans were reported stranded in the two regions. The whales and dolphins caught were reported used for local consumption and to sell in the region. Finally, we describe conservation efforts involving community engagement in two separate groups of villages in the southwest, which yielded drastically different outcomes. In the Anakao community, a self-sustaining conservation program was established resulting in the apparent near-cessation of hunting, whereas in the Befandefa community a similar program was launched but then abandoned midway before becoming self-sustained, and resulted in the community returning to large scale drive hunts of small cetaceans. These outcomes highlight both the potential for success of community engagement, and the critical importance of follow-through and diligence on the part of conservation organizations.

Key words: cetacean, hunting, stranding, by-catch, Toliara, Fort Dauphin, Madagascar

INTRODUCTION

Madagascar has a wide variety of marine habitats that characterize this country, and are home to a rich and varied marine fauna. Consequently, a diversity of cetaceans are among the organisms observed in the waters of Madagascar. But compared to research on other marine resources and biodiversity, marine mammals are among the least studied zoological groups the and unknown. In general, there is little available information on the general status of many

marine mammals, particularly small cetacean populations. Cetaceans, like many other marine organisms, are hunted, incidentally taken in fishing gear and stranded in the waters and the coast of Madagascar. In particular, for a long time cetaceans have been hunted and consumed by Malagasy traditional fishermen, especially the Vezo tribe in the southwest region.

Some of the research presented here was conducted in the southwest of Madagascar, from 1999 to 2013 as a collaboration of our marine sciences Institute (IHSM) University of Toliara with the Wildlife Conservation Society, and more recently independently as a the continuation of the studies initially conducted by Andrianarivelo Norbert and Salvatore Cerchio. Some of the results reported for this period were previously presented in Andrianarivelo (2001), Cerchio *et al*.(2009), Cerchio *et al.* (2014) and Cerchio, Andrianarivelo &Andrianantenaiana (2015). In addition from 2010-2018, we continued the data collection related to cetacean species diversity, directed hunts, incidental by-catch and strandings in both the southwest and southeast coasts of Madagascar, conducted primarily by IHSM students.

The objectives of these studies are as follows:

- Assessing cetacean population status within the targeted zones ;
- Assessing the importance of local marine mammals fishery ;
- Identifying whetherthere is incidental by-catch and other problems on marine mammals.

1. MATERIAL AND METHODS

1.1.Study sites

Surveys were done in ten villages in south of Madagascar: seven villages in southwest region (Anakao, Soalara Sud, Saint Augustin, Ankiembe, Mahavatse, Ambohitsabo and Bevohitsy) around Toliara town and three villages (Amparihy, Libanonaand Sainte Luce) in the south east region around Fort Dauphin town.

1.2.**Methods**

We used interviews and boat-based surveys to assess the species cetacean and evaluate the extent and cause of dolphin mortalities in all villages. The interview surveys were carried out annually from 2010 to 2018 (and previously in 1999 as presented in Andrianarivelo 2001). Some of the data have been collected from either the studies of the students of IHSM or the local colleagues who are working closely with us in some villages. During the interviews, we asked local fishermen including women, members of diving clubs and hotel owners to provide information on cetacean species, hunting techniques, the targeted species, the number of animals killed by direct hunt, by-catch and stranding and the commercial use of cetaceans. Prepared questionnaires and a cetacean field guide were used during interviews to identify the species and the local vernacular names of the species.

On occasion, we conducted opportunistic surveys simultaneously with other research surveys aboard the research boat of IHSM in order to take photos of cetacean for the identification of the species observed.

2. RESULTS

2.1.Diversity of the species

The interviews and the boat surveys yielded the following results on species of cetaceans at each of the sites:

2.1.1. SouthwestRegion (Toliara):

We identified in total 18 species of cetaceans. Systematic boat-based surveys off the single village of Anakao during 2004-2009, and 2013(Cerchio *et al.*2009, Cerchio & Andrianarivelo, unpublished data) identified 15 species of cetaceans (Table 1). Interview and opportunistic boat-based studies of IHSM students during 2010-2018 in other villages in the waters of Toliara identified 16 species, including an additional 3 species of cetaceans not observed in the previous boat-based surveys (Table 1).

Table1 : Cetacean species observed in sea waters in South West of Madagascar

PERIOD		**2004-2009, 2013 (Cerchio *et al*. 2009, Cerchio & Andrianarivelo, unpublished data)**	**2010-2018**
CETACEAN SPECIES	**Large Cetacean**	*-Megapteranovaeangliae* *- Eubalaenaaustralis* *- Physetermacrocephalus*	*-Megapteranovaeangliae* *- Eubalaenaaustralis* *- Balaenoptera musculus* *- Balaenoptera edeni* *- Physetermacrocephalus*
	Small Cetacean	*- Sousa plumbea* *- Tursiopsaduncus* *- Tursiopstruncatus* *- Stenellalongirostris* *- Stenellaattenuata* *- Stenobredanensis* *- Lagenodelphishosei* *- Grampusgriseus* *- Globicephalamacrorhynchus* *- Peponocephalaelectra* *-Pseudorcacrassidens* *- Kogia sima*	*- Sousa plumbea* *- Tursiopsaduncus* *- Stenellalongirostris* *- Stanellaattenuata* *- Lagenodelphishosei* *- Grampusgriseus* *- Globicephalamacrorhynchus* *- Peponocephalaelectra* *-Pseudorcacrassidens* *- Kogia sima* *- Orcinus orca*

2.1.2. Southeast Region (Fort Dauphin):

Initial interviews by Oninanahary Vatosoa Velo Tantely (O.V.V.T) with 90 fishermen from the village of Amparihy, Libanona and Sainte Luce in Taolagnaro/Fort Dauphin were conducted from December 2018 to 22 February 2019. The results indicated that 14 species of cetaceans were observed by the fishermen in the waters of Taolagnaro (Table 2).
The boat survey study of Vahoavy Retenany in 2003 reported the presence of 4 species of cetacean (*Megaptera novaeangliae*, *Eubalaena australis*, *Tursiops truncatus* and *Stenella longirostris*) in the waters of Fort Dauphin (Vahoavy, 2003).

Table 2: Cetacean species observed in sea waters of Fort Dauphin, South East of Madagascar

PERIOD		**2018-2019**
CETACEAN SPECIES	**Large cetacean**	*-Megapteranovaeangliae* *- Eubalaena australis* *- Balaenoptera musculus* *- Balaenoptera edeni* *- Balaenoptera physalus* *- Physetermacrocephalus*
	Small Cetacean	*- Sousa plumbea* *- Tursiopsaduncus* *- Tursiopstruncatus* *- Stenellalongirostris* *- Orcinus orca* *- Stenellacoeleoalba* *- Delphinus delphis* *- Delphinus delphistropicalis*

2.2.Direct takes, incidental by-catch and stranding

2.2.1. Southwest Region (Toliara)

Prior to the year 2000, we interviewed in total 475 fishermen in seven villages including 237 fishermen interviewed in the village of Anakao. These data were reported in Andrianarivelo (2001) and Cerchio *et al.* (2009) and amounted to an estimated 4859 individuals killed in directed hunts, and an additional 1718 individuals reported as "strandings" (Table 3), although we believe most of these were likely intentional strandings (i.e., drive hunts). During the periodfrom 2000 to 2018, 238 fishers including womenwere interviewed in all villages in southwest coast. Those more recent interviews revealed an additional 2753 mortalities, amounting to an estimated 9330 cetaceans killed from direct hunting, stranding and by-catch in seven villages (Table 3). Of these, 70.54% of them have been reported hunted in the village of Anakao prior to 2000 (Andrianarivelo 2001, Cerchio et *al*, 2009),and 29.51% were killed during 18 passed years.

- **Fishing material and technique of the hunting**

The traditional Vezo sailing pirogue was the main vessel used by local fishermen in the area. Prior to 1985, harpoons called locally 'samondra' or 'teza' were used to catch and kill dolphins. The harpoon was three meters long and formed in two parts, a wooden shaft and a metal end which detached itself when it penetrated to the body of the targeted animal, whilst remaining attached to the wooden part by a nylon rope of 15 to 30 meters. Historically, fishermen used two harpoons to kill dolphin: one was thrown first to wound the animal. Thereafter, it was chased during three to four hours until exhaustion. The second harpoon was used to finally kill the animal. The intensive effort required per individual acted to limit the total number of directed take mortalities prior to 1985.
Since 1985, large meshed net locally named 'haratobe' or 'haratolahy' specifically used to catch pelagic fishes was used to catch dolphins. The net was made of heavy nylon ropes and the mesh size ranged from 3 to 4 cm. Local fishermen adopted a drive fishery technique to catch dolphins. The fishing season for the Bonefish *Albula vulpes* (varilava) and the Indian anchovy, *Stolephorus indicus* (tove), typically occurs between August and December. During this period, dozens of pirogues aggregate for collective fishing, thus facilitating the cooperative drive hunt of small cetaceans, likely on an opportunistic basis. Several pirogues

would circle a group of dolphins and at the same time, the fishermen would strike the hull of the pirogues to drive the dolphins towards and up into an inshore fringing reef at high tide. The fishermen then deploy nets to encircle and prevent the animals from escaping and catch them easily after the tide recedes. In large part due to this technique to take large numbers of individuals at once over 6500 small cetaceans were reported killed by Andrianarivelo(2001). Eye witness accounts of a hunt on approximately 150 spinner dolphins during 2007 were reported as validation of these data (Cerchio *et al.* 2009, 2014).

In general, throughout the southwest region the technique of the hunting is generally the same by using both harpoon and nets. However in Bevohitsy village, while the technique is the same as in Anakao village, the fishermen of this village do not wait for the occasion of collective fishing on bonefish or anchovy to opportunistically cooperate to hunt dolphins. During the year, when one pirogue has seen a group of dolphin, the fishermen call other fishermen by raising the paddle of pirogue permitting the others to approach and to gather around of the group of dolphin so that they can catch them. The interviews estimated that over 2500 dolphins were killed between 2000 and 2018, primarily in this manner (Table 3).

We collected interview data asking fishermen to recount activities both before and after the year 2000 in the village of Bevohitsy, but only the more recent data on hunting after 2000 are presented in order to have greater veracity of data collected at this site. We did not report data prior to 2000 in detail, because of the confusion for this period and uncertainty on the number of the individuals caught. For this period, the interviewees estimated that over 8000 dolphins were killed in the single village of Bevohitsy by using drive hunt, so although this number may be exaggerated due to concerns with recollection and memory, it is likely that it was a substantial number.

Dolphin species most often taken in the southwest region were spinner dolphins (*Stenellalongirostris*), Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) and Indian Ocean humpback dolphins (*Sousa plumbea*), each having a strong coastal distribution and thus vulnerable to traditional hunting (Razafindrakoto et *al*, 2009).

- **Strandings**

Hunting mortalities reported by 237 fishermen are here noted as Direct Takes, whereas mortalities described as “stranding” events prior to 2000 are noted separately (Table 3). We place “Stranding ”in quotations marks because we do not believe these to be natural stranding events of small cetaceans, but rather forced strandings in a drive hunt (Andrianarivelo 2001, Cerchio *et al*. 2009, 2015).

Considering large cetaceans, after the year 2000, two humpback whales (an adult and a calf) stranded naturally respectively in 2014 in Bevohitse, and 2016 in Belavenoke, both in the municipality of Befandefa north of Toliara. In 2014 one sperm whale stranded on Nosy Ve island off Anakao village.

Table.3: Results of the interviews on direct takes, stranding and by-catch

Cetacean species	**1975 -1999 (Andrianarivelo 2001)**		**2000 – 2018**			**Total**
	Direct takes	“Stranding”	Direct takes	Stranding	Bycatch	
Stenellalongirostris	2289	1286	1180		39	**4794**

Tursiopssp	2134	287	1231		54	**3706**
Sousa plumbea	26	35	24			**85**
Unidentified dolphin	410	110	153		49	**722**
Globicephalasp			2			**2**
Grampus griseus			4		1	**5**
Megapteranovaeangliae			1	2	12	**15**
Pysetermacrocephalus				1		**1**
TOTAL	**4859**	**1718**	**2595**	**3**	**155**	**9330**

- **By catch**

The use of gill net (called locally jarifa) and longline targeting sharks can lead to incidental by-catch of cetaceans in all villages in the southwest region. The interviews allowed us to estimate 155 cetaceans incidentally taken between 2000-2018. Interviewees indicated that spinner dolphins and bottlenose dolphins are frequently by-caught. During the humpback whale season (winter), mostly humpback calves were by-caught, and frequently gillnet and longline of the fishermen were lost due to the passage of whales. In total, 12 humpback whales were by-caught from 2000 to 2018. In 2012, in response to the passage of local traditional laws (Dina) by the local community-based conservation group, the FMTF association, one humpback whale calf that was incidentally entangled alive was released by fishermen in the village of Maromena close to Anakao village.

- **Conservation Efforts**

A concerted effort was made to engage the Anakao community and launch a strategic conservation program starting in 2006 (Cerchio *et al.* 2014, 2015). This effort included the creation of the community-based Association for the Protection of Whales and Dolphins (FMTF, Malagasy acronym), the creation of local traditional laws (DINA) governing protection of marine mammals, community education and outreach programs, and development of alternative livelihoods through local ecotourism (whale watching by village operators). Dolphin hunting continued in the village of Anakao until 2008. As from 2008, dolphin hunting decreased dramatically after the creation of the FMTF and ratification of the local DINA laws. This successful conservation effort became self-sustaining with the independence of the locally run FMTF and local ecotourism operators, and continues as of 2018 with low level support from IHSM and Norbert Andrianarivelo (NA)

A similar effort was initiated in 2012 in the commune of Befandefa, including the hunting village of Bevohitse. This effort progressed until 2014 and reached the point to which four separate community-based associations for the protection of marine mammals were formed representing 32 villages, individual DINA were ratified separately by each community association and awaited conglomeration and ratification by regional government, and a well-received education and outreach program had been launched and pursued in all engaged communities. However, the effort stalled in 2015 with complete cessation of Befandefa work mid-way through the planned engagement process, as a result of reprioritization by the NGO originally overseeing the project and the cutting of funding for the work. Recent interviews conducted in 2017 in the same communities indicated that the village of Bevohitse had reengaged in well-organized dolphin hunting campaigns, and drive hunts on spinner dolphins and Risso dolphins were documented in 2016 and 2018, respectively (T. Collins, unpublished data).

2.2.2. Southeast Region (Fort Dauphin)

The interviews surveys by O.V.V.T. revealed that 22 cetaceans including the species humpback whale, sperm whale and bottlenose dolphin were reported stranded around Fort Dauphin, with the majority being humpback whales (Table 4). Between 2000 and 2018, 17 humpback whales stranded in different locations, on the beach of the Libanona, the plage de Monseigneur, Hôvatraha, Tafandava, Ambatobe, Ehoala and Sainte Luce. One sperm whale stranded on the beach of Spirita in 2012 and one bottlenose stranded in Manantenina in 2015. Two bottlenose dolphins stranded dead in the beach of Tafandava village in 2012. In addition, one humpback whale stranded in the beach of Libanona in 1999 (Vahoavy, 2003).

The interview survey indicated that due to the lack of necessary materials, the fishermen of Antanosy do not intentionally catch cetaceans and the by-catch events are very low. However, the cetaceans that do strande or are by-caught can be consumed.

Table.4: Results of the interviews on stranding around Fort Dauphin

Cetacean species	**Prior 2000**	**2000 - 2018**
Megapteranovaeangliae	1	17
Physetermacrocephalus		1
Tursiopssp	1	2
TOTAL	**2**	**20**

2.3.**Utilization of cetaceans**

In the southwest region, the animals hunted, bycaught or stranded in the area are used for local consumption and local sale. When the number of captured dolphins caught was low (1-2), the meat was shared among family members. When the number of the individuals caught was high, as in drive hunts, the meat was sold at the local market and/or other surrounding villages with price of approximately 3000 MGA (ca. US $0.92) per kilogram in 2018.

CONCLUSION

Marine resources are the principal source of income and sustenance for the coastal communities in the southwest of Madagascar. Different types of fishing gear have been used to collect marine resources. The information collected through our interviews indicate that coastal cetacean species have been directly hunted and bycaught in artisanal fisheries. Bottlenose, spinner and Indian Ocean humpback dolphins were the common species reported hunted and incidentally caught in artisanal fisheries in the southwestern waters. Hunting and by-catch likely exists in almost all of the coastal villages of Madagascar. Gill nets and harpoon are two types of fishing gear used to catch sharks and dolphins. In general, there is a lack of conservation strategy in Madagascar, especially on the west coast. Community engagement in Anakao during 2006-2014 led to a successful conservation outcome, with the apparent near-cessation of hunting in the participating communities. However, failure of a similar effort in the Befandefa community due to abandonment of the community engagement midway through the process, highlighted the critical importance of follow-through on the parts of conservation organizations until the resulting local associations and programs become self-sustaining. The conservation of marine mammals needs to be reinforced not only in southwest region and but in all coast of Madagascar

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