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# Frontier Madagascar Environmental Research

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## REPORT 19

### Artisanal shark fishery, Toliara region, south-west Madagascar



**FRONTIER**  
FRONTIER - MADAGASCAR  
2005

# **Frontier Madagascar Environmental Research**

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### **Artisanal shark fishery, Toliara region, south-west Madagascar**

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**Society for Environmental  
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**Frontier-Madagascar**

Madagascar, the fourth largest Island on the planet is renowned for its high biological and ecological diversity, characterised by its high abundance of endemic species. Madagascar is one of the poorest nations in the world and very dependent on the resources the natural environment provides. As a result conservation and development work is of paramount importance as efforts are made to preserve an environment under increasing pressure from unsustainable exploitation. Frontier-Madagascar conducted baseline survey work in the southwest coastal region of Toliara in an effort to provide biological and resource utilisation data for the preparation of sustainable management initiatives for the region.

**Institut Halieutique et des Sciences Marines (IHSM)**

The Université de Toliara was established in 1976 as a centre for learning and research in the biological sciences. The (IH.SM) is the marine department of the Université de Toliara. The University is studying the flora and fauna of Madagascar and is conducting research into the maintenance and improvement of the environment and the sustainable use of the natural resources in the region.

**The Society for Environmental Exploration (SEE)**

The Society is a non-profit making company limited by guarantee and was formed in 1989. The Society's objectives are to advance field research into environmental issues and implement practical projects contributing to the conservation of natural resources. Projects organised by The Society are joint initiatives developed in collaboration with national research agencies in co-operating countries.

**Frontier Madagascar Marine Research Programme (FM MRP)**

The Society for Environmental Exploration (SEE) and the Institute Halieutique et des Sciences Marines (IHSM), part of the University of Toliara have been conducting collaborative research into environmental issues since 2000 under the title of Frontier-Madagascar. Frontier-Madagascar Marine Research Programme (FM MRP) conducts research into biological diversity and resource utilisation of both marine and coastal environments. FM MRP has also been working with local stakeholders within the marine environment to promote sustainable resource use through training and education.

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# EXECUTIVE SUMMARY

## Overview of results

The main findings of this study are listed below:

- 20 villages visited and 22 shark fishermen interviewed
- Fishermen
  - Occasional or occupational fishermen
  - Fish for sharks throughout the year
  - Outward travel time ranges from 30-150 minutes
  - More palangres in the South, more jarifas in the North
- Shark fin operators
  - 3-9 official shark fin operators
  - 2 were interviewed
- Shark fin collectors
  - 1-10 different collectors visit the villages of study area
  - 280 visits per month as maximum for one village
  - villages bordering Tulear have high frequency of visits, otherwise no correlation
- Sharks caught annually thought to be 14,000-28,000, other estimate states 236,250
  - \$52.80/kg for dried fins and \$37.35/kg for fresh fins, final destination Southeast Asia
  - 4-6 tonnes of dried shark fins shipped to Southeast Asia annually per shark fin operator
  - Good quality fins have high density of fibres
  - \$0.33/kg for dried meat and \$0.18/kg for fresh meat, consumed locally or sold inland
  - Jaws sold for \$3.75-300.00 per set.
  - 100m of palangre costs \$60 and 100m of jarifa costs \$135, high initial investment but low running costs
  - Shark fishermen daily wage 3x higher than average man in Southwest Madagascar
- Population Biology
  - The shark fishermen thought there are less sharks now compared to 5-15 years ago
  - The shark fin operators stated that the number of sharks has not changed
  - Casual observations recorded very few territorial reef sharks
  - River mouths within study area could possibly be nursery grounds for sharks of the *Sphyrnidae* family (hammerhead sp.)
  - Most sharks caught in Austral summer
  - Six fishermen stated that they had caught tagged sharks
- Cultural value
  - Half the fishermen used a local medicine man (ombiasy) in the shark fishery
- Shark nomenclature
  - Malagasy names are very descriptive according to morphological features
  - Very inconsistent from one village to another

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# 1. INTRODUCTION

Madagascar is the fourth largest island in the world with a length of nearly 1,600km and a width of 560km at its widest point (Brown, 2000). With a wide range of climates, ranging from the tropical rain forests in the Northeast to the spiny forest of the Southwest, the island has a huge diversity of flora and fauna comprising a number of endemic species. Furthermore, Madagascar has an estimated coral reef area of 2,230km<sup>2</sup> (Spalding et al, 2001). The study area is located in Southwest Madagascar, north and south of Tulear, and consists of an inner lagoon and a fringing reef that is 300 to 850m from the shoreline.

Sharks form a vital key in the marine environment. They are apex predators and their presence or absence has a cascading effect on the entire ecosystem. In the past 400 million years sharks have successfully roamed the world's oceans numbering more than 350 different species today. These elasmobranchs (sharks, rays and chimeras) are feared by many as a marine nuisance, whilst others greatly depend on them as they have become a valuable resource in the fishing industry.

Sharks have adapted a life strategy that makes them very susceptible to overexploitation. This strategy has been termed the "k-selected" life history strategy (Holden, 1974; Hueter, 1998; Smith et al, 1998; Stone et al, 1998; Walker, 1998; ICES, 1997; Branstetter, 1993; da Silva and Ross, 1993). The characteristics of this strategy include a late age of maturity, low fecundity, few reproductive cycles, long gestation periods and slow growth rates. With this strategy in mind, overfishing can quickly lead to a stock depletion of shark species (Heuter, 1998), with little chance of recovery. If sharks are to continue roaming the waters of the world then steps must be taken to ensure their survival. Management of the artisanal shark fishery and conservation of the shark species present in south-west Madagascar are essential for the long term survival of the local shark population.

In Southwest Madagascar, the area of this study, sharks have been fished with increasing intensity. There exists a great amount of uncertainty as to the scale and extent of this shark fishery. The people of Southwest Madagascar belong to a semi-nomadic sea faring ethnic group called the Vezo, a subgroup of the Sakalava tribe (Fitzpatrick and Greenway, 2001). Since the 1970s the Vezo have opted to settle as opposed to their nomadic way of life (Koechlin, 1975). The south-western coast of Madagascar has scattered villages ranging from 250 to 2000 inhabitants. These villages fall into the category of artisanal fisheries as they use low-tech fishing gear, but their catch is beginning to provide for more than subsistence living (pers. comm.). The traditional fishing methods involve the use of small, mainly non-motorised vessels (pirogues: hand-made, single hulled traditional sailing boats constructed from the tree *Givotia madagascariensis*, Walker and Roberts, 2003) with one or more fishermen utilising multiple fishing techniques for a broad range of targeted species. The various techniques the fishermen employ consist of line fishing, net fishing and spear fishing. Jarifas (gill nets) and palangres (suspended lines) are used in the shark fishery of Southwest Madagascar (see Appendix I for a full explanation of these fishing methods). The shark fishermen in the Southwest of Madagascar can be classed into two different groups: occasional or occupational shark fishermen.

The general fishing techniques were studied by the authors in an area 30km south of Tulear, typical of the region. Most fishermen using a pirogue employ a number of techniques over the course of the day, depending in which area they are working. The working day is dependent on sunlight (and moonlight) and usually starts just before sunrise. Many go out in small groups

past the reef to check shark lines and fish with nets, whilst others carry out line fishing within the lagoon. The pirogues usually stay out for 4-6 hrs with the return to shore determined by the wind and/or tide. Some will stop on the way back to take advantage of the shallow water and hunt reef fish, octopus, sea cucumber and shellfish with spears. A large number of women also work in the shallows, having walked out from the shore. They mainly collect seaweed, octopus, sea cucumbers and shells. The return to shore is marked by many of the community (mainly women and children) coming to the beach to help with sorting catch and boats. The rest of the day is usually occupied with mending nets and preparing the fish, the majority of which are smoked over open fires, with some being sold at markets. Within the area there is also a thriving squid industry which entails night fishing with lights (using homemade torches constructed of split small logs filled with kindling).

External factors such as the Asian market and international transportation links as well as local factors such as the attitude of the Malagasy fishermen have influenced the development of this shark fishing industry. The distribution network to the overseas market is now well developed, despite the underdeveloped internal transport infrastructure. The demand for shark fins from Asia has continued to rise and the financial rewards are high for successful fishermen, in some cases doubling or even tripling their monthly earnings.

The Frontier-Madagascar Marine Research Programme set out to map the small-scale artisanal shark fishery of Southwest Madagascar. Every village in a 140km stretch of coastline (north and south of Tulear) was visited and the shark fishermen interviewed regarding the shark fishing practices of that village. Shark fin operators working out of Tulear were also interviewed. The results of this study revealed that almost every village visited appeared to have a targeted shark fishery, as opposed to earlier assumptions of only several villages in the entire area. One conservative estimate states that approximately 300 people are involved in the shark trade within this area with at least 14,000 sharks landed annually (pers. obs). The shark fins are all destined for the Southeast Asian market whilst the meat is either consumed locally or sold inland to other villages and towns. There is a delicate balance between those sharks in the artisanal shark fishery taken and the amount of sharks needed to sustain the various shark populations residing in Madagascan waters. The fishing industry must not fish beyond this minimum if the conservation of the shark population in this area is to remain successful.

## 2. METHODS

The Frontier Madagascar Marine Research Programme conducted this study in the south-west region near Toliara, (Figure 1a). Interviews with individuals involved in the artisanal shark industry were conducted in all the main villages along the coastline within the study area. This included all villages north and south of Tulear ( $23^{\circ}35'S$ ,  $43^{\circ}44'E$ ), from Fitsitike ( $22^{\circ}58'S$ ,  $43^{\circ}28'E$ ) to Ambola ( $24^{\circ}04'S$ ,  $43^{\circ}40'E$ ), in the north and south respectively, and the shark fin collectors in Tulear (Figure 1b)

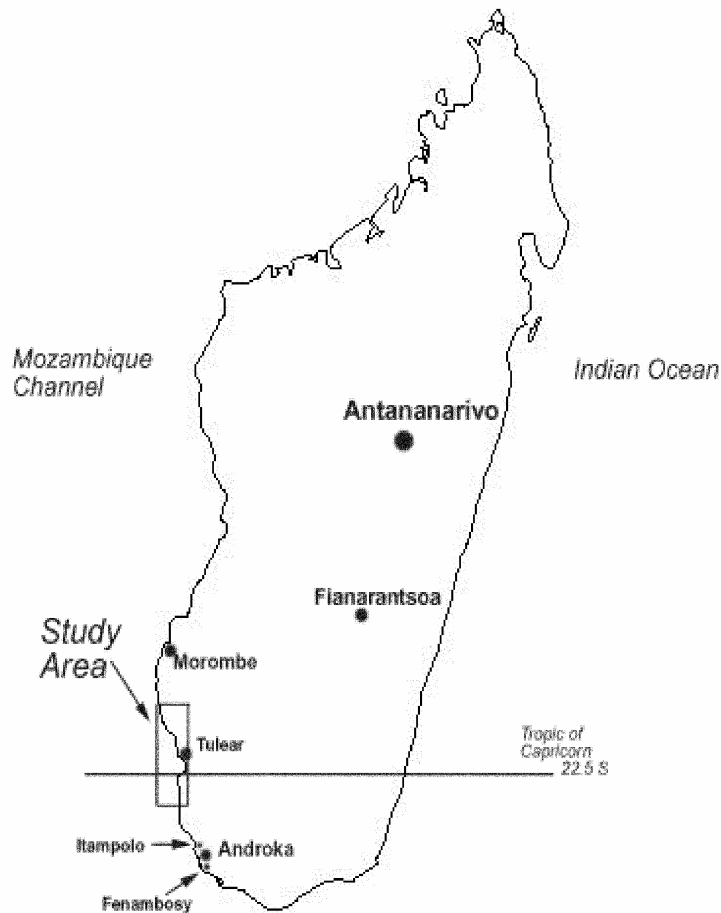
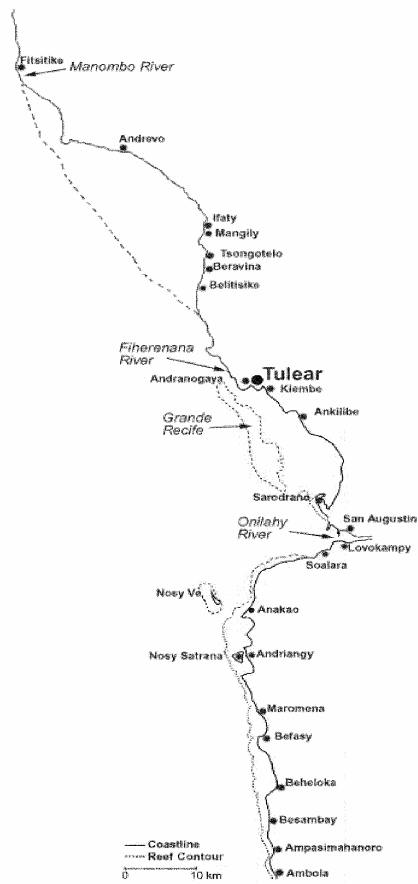


Figure 1a. The south-western coast of Madagascar, Tulear region.



**Figure 1b. Enlargement of the study area.**

Frontier-Madagascar representatives visited every village in the 140km stretch from Fitsitike to Ambola and spoke with some of the local shark fishermen of those villages. Upon arrival at each village permission was sought from the village president to interview a shark fisherman. The interviews consisted of an informal, semi-structured interview using a questionnaire (Appendix II) as a base. The Frontier-Madagascar representatives consisted of 45 people, one local Malagasy employee of Frontier-Madagascar (the translator) and 3-4 Europeans (a co-ordinator and scribes). The interviews were conducted in Malagasy, using French when possible. The co-ordinator would ask a question in French. The local employee would then translate the question to Malagasy and ask the person interviewed. This person would then answer in Malagasy and the response was translated to French by the local employee of Frontier-Madagascar. The responses were then scribed from French into English by the scribes. Throughout the duration of each interview there were a minimum of three people scribing. These notes were transcribed into a notebook directly following the interview. Once all the information had been collected, the data was analysed. It is appreciated that a small degree of error may occur in the translation process, but this was kept to a minimum by obtaining agreement with all scribes after the interview and clarifying any outstanding queries with the local employee involved in that interview. At the end of each interview the fishermen were asked to go through a list of different species of shark and indicate the Malagasy names for each species utilising pictures from Frederico and Hassall, 1998.

The interviews with the shark fin operators followed a similar format except that there were only 3 representatives of Frontier-Madagascar present, one local Malagasy employee and 2 Europeans (the two people scribing). The interviews with the shark fin operators were conducted mainly in French with minimal use of Malagasy ( the shark fin operators spoke French). In total 20 villages were visited and two shark fin operators were interviewed.

### **3. RESULTS**

#### **3.1 Fishermen**

Twenty villages were visited and in each one, a shark fisherman was interviewed (in Anakao and Andriangy two shark fishermen were interviewed as those villages were visited twice by different groups of researchers). The second set of interviews for the villages of Anakao and Andriangy will be referred to as Anakao2 and Andriangy2. Andriangy2 refers to a fisherman from the village of Soalara who occasionally fishes in Andriangy. As there were no shark fishermen in the village of Mangily no interview could be conducted for that village. The village of Maromena was also visited but the interview had to be aborted due to weather conditions.

A wide variety of data was collected from these interviews. All of the villages, with the exception of two, had a targeted shark fishery. The two exceptions were the villages of Lovokampy and Andriangy, both of which caught sharks as by-catch in their day-to-day fishing practices using seine nets. The majority of the fishermen interviewed were occupational shark fishermen whilst several were occasional, benefiting from the by-catch of sharks in their daily fishing activities. Most of the fishermen admitted to fishing throughout the year but stopped shark fishing if other activities of more importance occurred (such as pirogue building and seasonal sardine fishing). Other fishermen only fished for sharks when there were numerous sharks to be caught or during certain months when the weather was known to be calm.

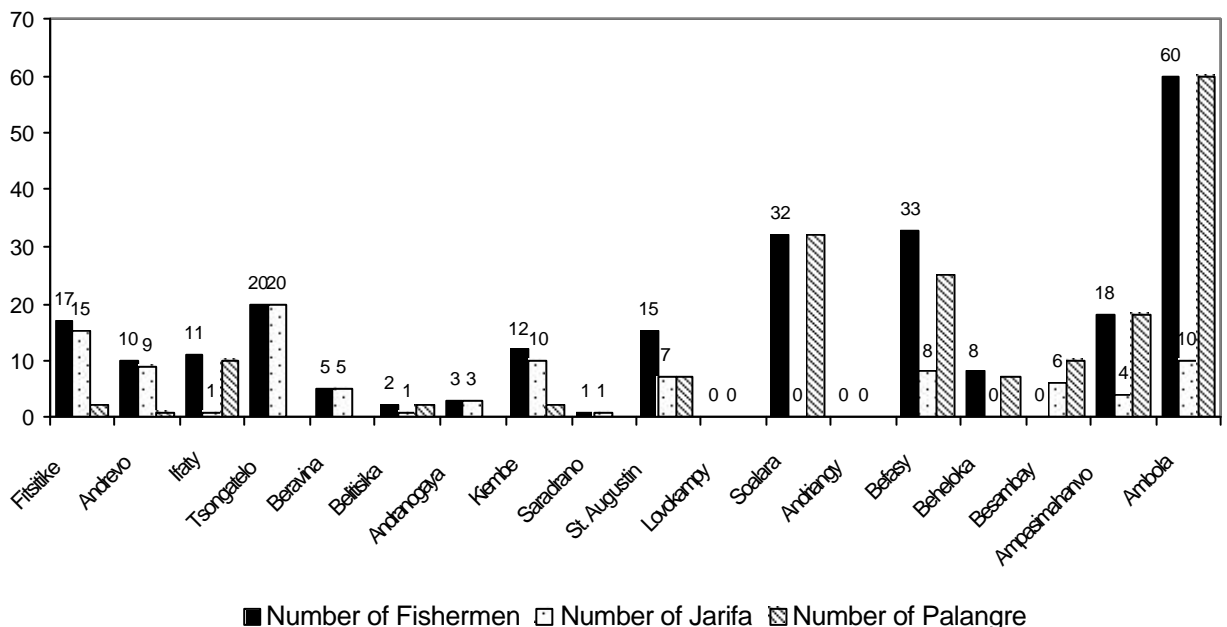
The fishermen were found to use either a jarifa or palangre in the shark fishery. These methods of fishing were presented to the bigger villages (in excess of ~1000 people, such as Maromena and Beheloka) by the FAO (Food and Agriculture Organisation) and subsequently spread to the remaining smaller villages (Mr. Francois, President of Beheloka, pers comms). The fishermen usually departed for their fishing activities around sunrise and returned 6-7 hours later, the return time was tide and wind dependant. The travel time varied between 30 and 150 minutes (outward) on average to get to the fishing grounds, as the wind could be variable and light (Table 1). The return journey was usually considerably faster, being determined by the onset of the brisk onshore wind.

Village	Min journey time (min)	Max journey time (min)	Average journey time (min)
Fitsitike	5	30	15
Andrevo	120	180	150
Tsongatelo	5	60	30
Belitsika	15	30	22.50
Andranogaya	30	60	45
Kiembe	60	120	90
Ankilibe	90	120	105
Soalara	5	300	150
Befasy	30	60	45
Beheloka	90	240	165
Besambay	90	180	135
Ampasimahanvo	30	60	45
<i>Average time</i>	<i>46.25</i>	<i>120</i>	<i>83</i>

**Table 1. Outward journey time in minutes for the fishermen in each village.**

For the villages of Ifaty, Beravina, Saradrano, St. Augustin, Andriangy, Andriangy2, Anakao, Anakao2 and Ambola no data was collected. The village of Lovokampy was not included as they did not have a targeted shark fishery.

Upon arrival at the jarifa or palangre, the fishermen checked the nets/lines and pulled the caught shark into the pirogue, tied it down and towed it back to the village. If the shark was too big to tow or land on the pirogue the fins would be cut off and the rest discarded. Figure 2 depicts the number of jarifa and palangre per village, in comparison to the number of fishermen present in the village. It is evident that most villages in the South prefer palangres whilst the opposite holds true for the North.



**Figure 2. The number of Fishermen, and number of Palangre and Jarifa in each village.**

For the villages of Ankilibe, Andriangy2, Anakao, Anakao2 no data was collected.

Most shark fishermen in each village (Figure 3) used either a palangre or jarifa and thus the numbers of gears per village often equates to the number of fishermen per village, as seen in Figure 2. The village of Maromena was not interviewed due to logistical restrictions but according to Walker and Roberts (2002) the village operated 30 jarifa directed towards a shark fishery at the time of their study.

### 3.1.1 Shark Fin Operators

For the purpose of this report a distinction was made between shark fin operators and collectors. The shark fin operators are those people that have a business in Tulear and coordinate the collecting (either by themselves or by other people) of the shark fins and arrange for the further sale of the shark fins. Two shark fin operators, operating out of Tulear, were interviewed. In order to become a registered fin collector it is necessary to obtain a permit from the fisheries department located in Tulear, but the permits are not always issued, which leads to many collectors operating illegally. The gathered data suggests there were between 3 and 9 official shark fin operators, operating out of Tulear, however, numerous unregistered fin collectors also existed. The two operators that were interviewed had a fin collecting range that extended from Fanambosy in the South, to Morombe in the North (however, one of the fin collectors only collected from Itampolo in the South to the villages north of Ifaty in the North, Figure 1). The former operator began collecting in Tulear in 1994 (before that time he had worked for the other interviewed operator) whilst the latter had been operating in Madagascar since 1992 and only moved to Tulear in 1999. The frequency of visits to the villages depended mostly on the weather, which dictates the amount of fishing activity and thus the number of sharks caught. One of the shark fin operators had various fin collectors in his employment who travelled to the villages north and south of Tulear to collect shark fins, whilst the other operator conducted all of his own collecting. Both shark fin operators also bought shark fins from individuals selling fins who did not work for them (either unregistered fin collectors or fishermen who had travelled to Tulear).

### 3.1.2 Shark Fin Collectors

The shark fin collectors are those people that visit the villages and sell the fins they have purchased to the shark fin operators in Tulear. When asked how many different shark fin collectors visited the villages, the numbers ranged from one in the villages of Saradrano and Lovokampy to ten in the villages of Fitsitike and Kiembe.

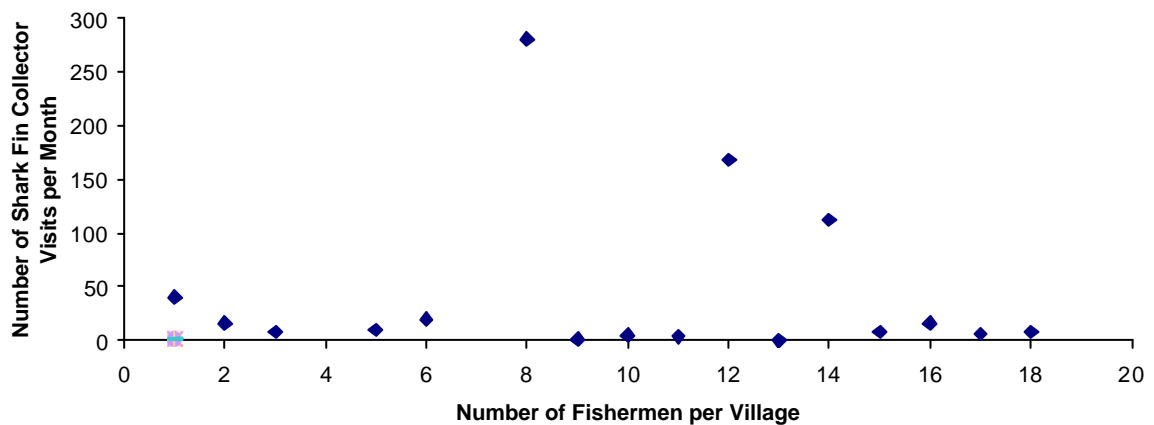
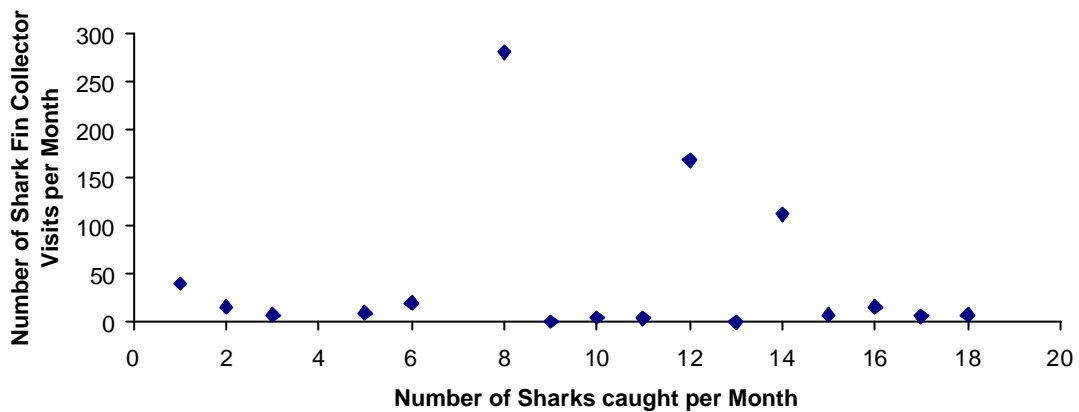


Figure 3. The number of shark fin collector visits per month compared to the number of shark

**fishermen in each village.** No data exists for the fin collector visits for the villages of Andriangy, Andriangy2, Anakao, Anakao2, Andranogaya and Tsongatelo. No data exists for the number of shark fishermen for the villages of Ankilibe, Anakao, Anakao2, Andriangy and Andriangy2. For the villages of Kiembe, Ankilibe, Soalara and Befasy the actual numbers of shark fin collector visits per month are 280, 126, 168 and 112 respectively.

These shark fin collectors would visit the villages on either a daily, weekly, fortnightly or monthly basis. Even Lovokampy, with a non-targeted shark fishery, was frequented on a weekly basis by 1 collector. When the shark fin collector visits (calculated per week) were compared to the number of shark fishermen (Figure 3) it became evident that no correlation existed. The same appeared to hold true when the number of shark fin collector visits (calculated per month) were compared to the number of sharks caught per month (Figure 4). From the interviews it became apparent that the shark fin collector visits largely depended on the weather conditions as the shark fin collectors visited the villages by means of sailing or motor pirogue.



**Figure 4. Number of shark fin collector visits per month compared to the number of sharks caught per month in each village.** No data exists for the fin collector visits for the villages of Andriangy, Andriangy2, Anakao, Anakao2, Andranogaya and Tsongatelo. No data exists for the number of sharks caught per village for the villages of Ankilibe and Ampasimahavo. For the villages of Ifaty and Tsongatelo the actual number of sharks caught per month are 495 and 400.

### 3.1.3 Outputs of the Shark Fishery

Using the gathered data from the interviews a conservative estimate of 14,000 to 28,000 sharks are landed annually in the 140km stretch from Fitsitike to Ambola. This figure was calculated using the number of sharks caught per fishermen per month (see Figure 4) and multiplying that by the number of fishermen in the village (see Figure 2). This number was then multiplied by 12 and all the totals of the villages added up (28,000). An assumption was also made that not all the fishermen fished throughout the year and to correct for that the total number was halved (14,000). Table 2 shows that the annual conservative estimate for sharks caught per village is significantly higher than the value obtained by McVean and Walker (2003) for 2 of the villages included in their study area (Soalara and Beheloka).

Village	Annual number of sharks caught	
	McVean and Walker	den Haring et al.
Soalara	462	2304
Beheloka	104	192

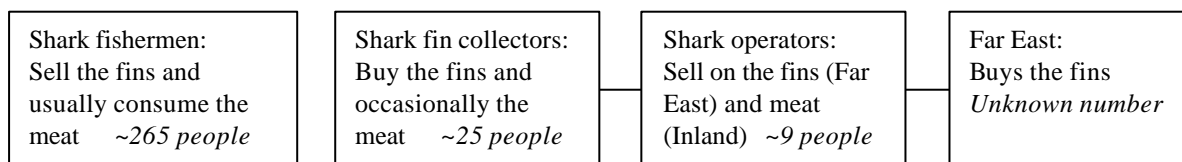
**Table 2. The annual shark capture for the villages of Soalara and Beheloka as found by McVean and Walker (2003) and this study (den Haring et al, 2004).**

## 3.2 The Economic Value of the Shark Fishery

### 3.2.1. Shark Fins

The average price of dried shark fins of all the villages was 352,000 Malagasy Francs (FMG) (\$52.80)/kg (range n=15): FMG 150,000-500,000 (\$22.50-75)/kg) for good quality fins. The fresh fins were sold for slightly less at FMG 249,000 (\$37.35)/kg (range n=16): FMG 75,000-400,000 (\$11.25-60)/kg). Most of the shark fishermen interviewed stated that if several fin collectors were present at the same time the price of the fins would increase as the fin collectors attempted to outbid each other. The prices the villages sold the shark fins for to the fin collectors can be found in Appendix I.

This information is consistent with the price the shark fin collectors paid for the fins. The price that the shark fin collectors paid for good quality dried shark fins was FMG 300,000-400,000 (\$45-60)/kg and was sold on for about FMG 450,000-500,000 (\$67.5-75)/kg in the Far East. If the shark fins were poor quality then they were bought for as little as FMG 25,000-50,000 (\$3.75-7.50)/kg. The shark fishermen therefore made the main profits (price/kg) with the shark operators only making FMG 100,000-150,000 (\$15-22.50) profit per kg of shark fins. Section 3.3.3 provides an explanation of the costs incurred in the shark fishery by the fishermen. One of the interviewed fin operators sold his products to the other interviewed fin operator who organised for transport to Hong Kong. Before the products were shipped to Hong Kong they were cleaned, trimmed and dried. Approximately 1-1.5 tonnes of dried fins accompany the shark fin operator every two to three months to Hong Kong. Upon arrival in Hong Kong the shipment of shark fins was transferred to the local dealer. Apparently there was a lot of interest in shark fins in Hong Kong as numerous dealers approached the Tulear-based fin operator upon arrival at the airport, even to the extent of specifically targeting males of an African origin on flights originating from Madagascar, the Comores and Mauritius. Figure 6 depicts the trade network of the shark fishery in southwest Madagascar.



**Figure 6. The trade network of the shark fishery in Southwest Madagascar.**

### 3.2.2 Good vs. Bad Quality Fins

Shark fin prices varied considerably between species and the fishermen used two different criteria to classify good and bad quality fins. Different species of shark have a different physical make up and their fins have a different density of “fibres” as well as a different shape. These fibres constitute the valuable part of the fin, the most flavoursome component which is ultimately used in Asian cooking. Seventeen of the interviewees described the good quality fins by species i.e. a high density of fibres, whilst two in Ifaty and Fitsitike judged fin quality by size irrespective of species (the remaining three interviewees did not mention the difference between good and bad quality fins). This was confirmed by one of the fin operators who determined poor, medium and good quality fins by length (<10cm, 10 to 25cm and >25cm respectively), but also backed this up by specifying the shark species with good quality fins were those whose fins were large or numerous. On a species determination of good and bad quality, the fishermen were all of the opinion that the best quality species were most of the species caught apart from those that were classed as “poor quality”. Nearly all of the fishermen stated that tiger sharks, nurse sharks and bottom dwellers had a “poor quality” fin

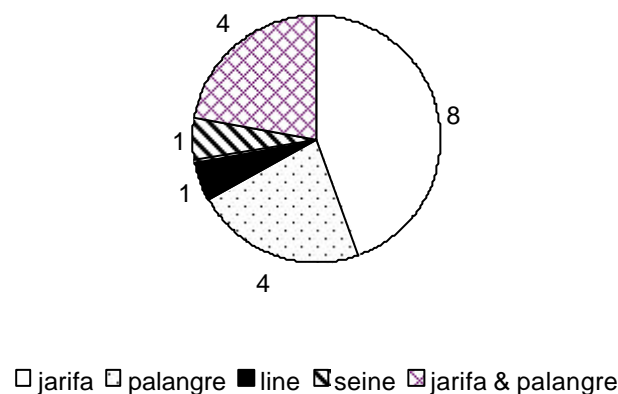
which was due to the lack of fibres within the fins rather than size. Hammerhead sharks were unanimously regarded as having good quality fins.

### 3.2.3 Shark Meat

The shark fishermen sold meat in a dried state for approximately FMG 2,200 (\$0.33)/kg (range (n=7): FMG 1,000-3,500 (\$0.15-0.53)/kg) whilst fresh meat was sold for FMG 1,200 (\$0.18)/kg (range (n=7): FMG 1,000-2,000 (\$0.15-0.30)/kg). Several of the shark fishermen stated that they did not sell the shark meat but instead consumed it locally. The reasoning behind this was that it was not worth their efforts to sell it. Shark meat was usually not collected by the shark fin collectors. However, when it was, it was bought for FMG 1,000 and 2,500 (\$0.15-0.38) /kg (fresh and dried respectively) and sold on for FMG 4,000-15,000 (\$0.60-2.25)/kg as dried meat to the villages inland. This depended on how far inland it was sold; the further inland the higher the price, particularly so in high-density areas such as Antananarivo and Fianaransoa (see Figure 1).

### 3.2.4 Costs for the Shark Fishermen

Data was collected concerning the costs of the gear used by the shark fishermen (Figure 7 depicts which gear the villages predominantly uses). All of the fishermen interviewed stated that the various items needed to fabricate either the palangre or jarifa were bought in Tulear and then assembled in their village. The average price for 100m of palangre was FMG 400,000 (\$60) (range n=9): FMG 50,000-1,400,000 (\$7.50-210.00)/100m) and the average price for 100m of jarifa was FMG 900,000 (\$135; range (n=15): FMG 100,000-3,000,000 (\$15-450)/100m) (Table 4). The gear was a substantial cost but once bought the ongoing maintenance was fairly cost-free. For floats plastic containers/bottles were salvaged, and for weights either shells or rocks were used, all of which incurred no additional cost. No data was collected concerning the costs of the shark fin operators and collectors.



**Figure 7. The fishing gear employed by the villages.** There was no data collected for Anakao2 and Lovokampy.

Village	Cost of Jarifa (100m)	Cost of Palangre (100m)
Fitsitike	1,500,000	*
Andrevo	100,000	100,000
Ifaty	2,000,000	350,000
Beravina	750,000	No data
Tsongatelo	No data	No data
Belitsika	375,000	187,500
Andranogaya	277,778	*
Kiembe	400,000	500,000
Ankilibe	666,667	No data
Saradrano	150,000	*
St. Augustin	375,000	175,000
Lovokampy	*	*
Soalara	No data	No data
Anakao	No data	No data
Anakao2	No data	No data
Andriangy	*	*
Andriangy2	1,100,000	No data
Befasy	3,000,000	350,000
Beheloka	No data	No data
Besambay	1,600,000	1,400,000
Ampasimahanvo	150,000	50,000
Ambola	1,000,000	500,000

**Table 4. The price of a 100m section of jarifa and palangre in each village.** No data refers to data that was not collected and \* refers to the questions not applicable to the villages (either because they do not have a targeted shark fishery or because they do not use one of the two methods).

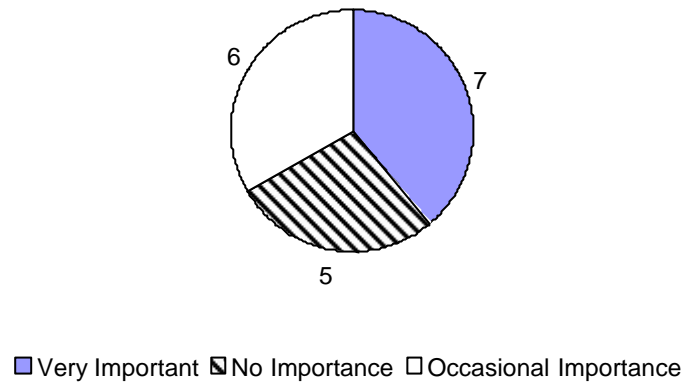
### 3.2.5 Other Shark Products

Apart from the fins and meat the only other shark product sold was the set of jaws from certain sharks. The jaws were only sold if the specimen was a shark in excess of 3-4m and only of certain species (usually sharks of the *Lamnidae* family). Nine of the twenty two shark fishermen interviewed stated that they would sell the teeth if they met the above description. The price ranged from FMG 25,000 to 2,000,000 (\$3.75-300.00)/set of jaws. One fisherman admitted that a good quality set of jaws could be sold to tourists for FMG 10,000,000 (\$1500). One of the shark fin operators stated that he has bought jaws from the shark fishermen to sell on to a Frenchman from Reunion that visits every three months. There was no data concerning the price of these transactions. A dive operator in Mangily was interviewed and he stated that the jaw of a 6-7 metre Tiger shark (weighing 800kg) was sold for FMG 3,000,000 (\$450) to a local hotel.

### 3.2.6 Economic Importance

McVean and Walker state that the average monthly wage for the region to be FMG 274,000 (\$41.10), whilst the shark fishermen have a monthly wage of  $\pm$  FMG 850,000 (\$127.50). The shark fishermen, as do the turtle fishermen (Walker and Roberts, 2003), make the most of the profit involved in the product trade. The dealers (shark and turtle) end up with a seemingly small profit, FMG 100,000-150,000 (\$15-22.50) compared to FMG 300,000-450,000 (\$45-60)

for the shark fishermen per kg of shark fins. Figure 8 depicts that overall there existed mixed feelings regarding the importance of the shark fishery to the shark fishermen interviewed. Regardless of whether the fishermen thought of the shark fishery as economically important, most of the fishermen were of the opinion that if the shark fishery should cease to exist (e.g. if there were no more sharks) they could find an alternate source of income.

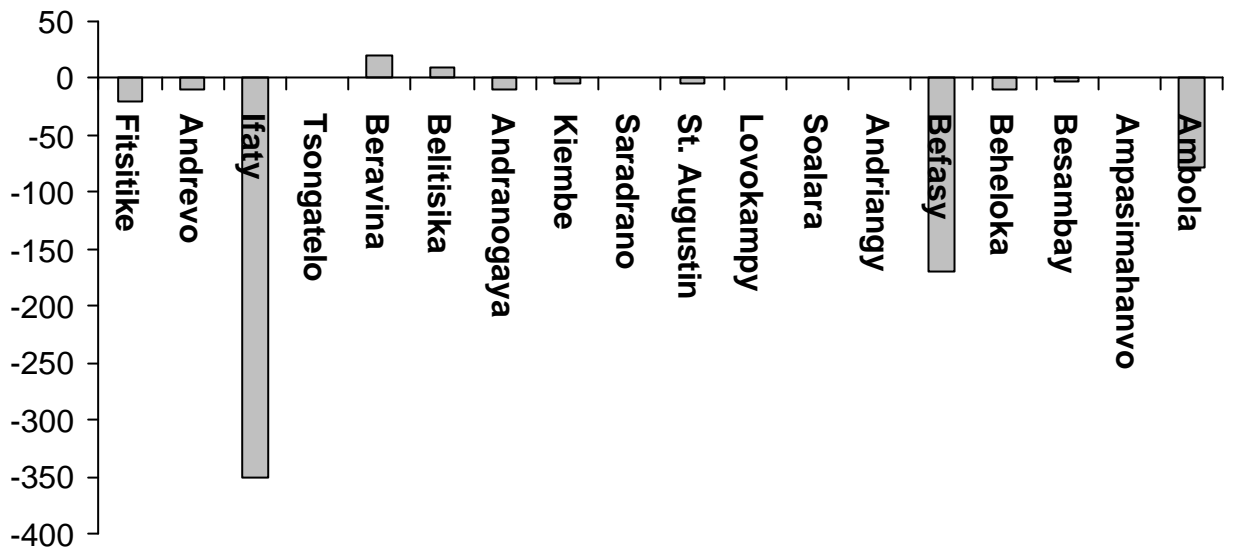


**Figure 8. The Economic importance of the shark fishery to each shark fishermen interviewed.** No data was collected for the village of Andriangy.

### 3.3 Population Biology

#### 3.3.1. The Past and Present: Changes over Time

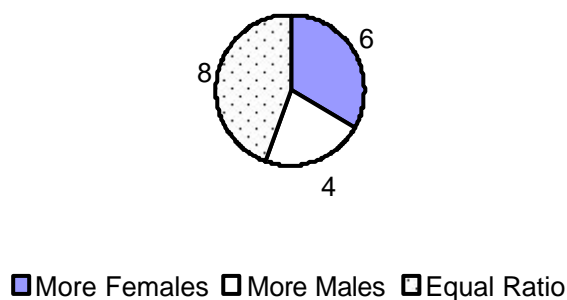
One of the questions asked during the interviews was: “Have the catch levels changed over the last 5-15 years?” Eighteen of the shark fishermen interviewed stated that there were more sharks 5-15 years ago, one fishermen thought that there were more sharks now compared to 5-15 years ago and 2 of the interviewed fishermen did not know if there was a difference. Both of the shark operators in Tulear thought that the number of sharks had not changed in the last 10-15 years (only the price has increased). It is not known if the number of shark fishermen has changed in the last 10-15 years but the impression received from the interviews seemed to suggest that there are presently more shark fishermen than before. One of the shark operators stated that 5-15 years ago there were less fin collectors/operators compared to now. Figure 9 shows the number of sharks caught per month per village at present compared to 5-15 years ago. Using this data a conservative estimation of the annual shark catch in all the villages from Fitsitike to Ambola (a 140km stretch of coast line) was made to exceed 14,000 sharks per year (see section 3.1.3). It was not possible to estimate the annual catch rate 15 years ago, as there is no data concerning the number of fishermen then. Casual observations by Frontier-Madagascar researchers undertaking underwater visual censuses on the reefs of Anakao yielded 5 sightings of elasmobranchs in roughly 1750 dives over a 12-month period. Two of these sightings were of a zebra shark (*Stegostoma fasciatum*) whilst the remaining three were of guitarfish (*Rhynchobatus djiddensis*: all three observed simultaneously). Similar casual observations were made on the reef of Beheloka in 500 dives over a period of 8 months and yielded no shark sightings. These observations confirmed that there existed practically no territorial reef sharks inhabiting the fringing reef at those two locations.



**Figure 9. The change in number of sharks caught presently in comparison to 15-20 years ago.** No data concerning numbers at present was collected for the villages of Anakao, Anakao2, Andriangy and Ampasimahavo. No data concerning numbers 5-15 years ago was collected for the villages of Tsongatelo, Saradrano, Anakao, Anakao2, Andriangy and Andriangy2.

### 3.3.2. Nursery Grounds

The study area included three major rivers (see Figure 1) and these included the Manombo River north of Fitsitike, the Fiherenana River in between Belitsika and Andranogaya and the Onilahy River in between St. Augustin and Soalara (note that Lovokampy is actually several hundred meters inland along the south bank of the river). The data gathered during the interviews in the various villages and from the shark fin operators in Tulear appeared to indicate that the river mouths might be a nursery ground for some species of shark in that area. One of the questions put forth to the fishermen was whether they caught more male or female sharks (data from the interviews indicated that the fishermen were all able to distinguish between male and female sharks).



**Figure 10. The number of villages that caught more males or females, or equal amounts of both male and female sharks.** No data was collected for the village of Andriangy2.

Figure 10 depicts which village caught more male or female sharks, or if they caught equal numbers of sharks. Villages just north and south of the rivers appeared to catch more female species of shark (for the villages of Belitsika, Saradrano, Lovokampy and Soalara) or equal numbers of male and female sharks (villages of Fitsitike, Andranogaya and St. Augustin). What all of these villages have in common is that they catch more hammerhead sharks (“viko” in Malagasy) in the months of November to March (August to December for the village of Soalara), the Austral summer period. As the members of the family *Sphyrnidae* (hammerhead sharks) are easy to recognise due to their shape, it can be assumed that the separate villages did not mistake this species.

Tables 5 and 6 portray the female sharks with foetuses caught by the shark fishermen. Again, due to the physical appearance of the species of hammerhead sharks in the family *Sphyrnidae*, it can be assumed that no mistakes were incurred in naming these species. However, for the remaining species listed in the table it is evident that the Malagasy names do not always agree with each other. The village of Soalara and Ambola both refer to a shark known as “tomany manente” in Malagasy. At the end of the interview, the interviewees were asked to look through the photo-book of sharks and state the Malagasy names for the various sharks. The Malagasy names did not always have a similar English equivalent. For example, two different sharks were found to exist for “tomany manenty”: Silvertip shark in Soalara and Oceanic Whitetip in Ambola. Although these sharks are of a different species, they have similar morphological marks (white tips on fins) that could place them under one name in Malagasy (most of the sharks are named according to descriptive characteristics). However, it is of interest to note the number of foetuses each female carried upon capture.

Village	Shark name in Malagasy	Shark name in English	Number of foetuses found in the shark	Time of year when shark was caught
<b>Tsongatelo</b>	Voti	*	6	Feb-April
<b>Soalara</b>	Tomany manente	Silvertip	8	Aug-Dec
	Viko	Hammerhead sp.	60-70	Aug-Dec
<b>Befasy</b>	Fesotse	Spinner	8-12	Sept-Oct
	Palapalandoa	possibly Hammerhead sp.	30	Sept-Oct
<b>Beheloka</b>	Vorotse	Tiger	30	Dec-Jan
	Fesotse	Great white	24	Dec-Jan
<b>Ampasimahanvo</b>	Viko	Hammerhead sp.	28	Nov-Feb
<b>Ambola</b>	Viko	Hammerhead sp.	30	Nov-Dec
	Tomany manente	Oceanic whitetip	10-12	Nov-Dec

**Table 5. A summary of the data concerning female sharks caught with foetuses. When possible an attempt has been made to correspond the Malagasy names with their English equivalents (\* refers to when it has not been possible for the interviewee to identify that species of shark from a book, see section 3.5).**

The species of hammerhead shark (family *Sphyrnidae*) that frequent southwest Madagascan waters include the Smooth Hammerhead shark (*Sphyrna zygaena*), the Scalloped Hammerhead shark (*Sphyrna lewini*) and the Great Hammerhead shark (*Sphyrna mokarran*), the latter being the most likely. These three species of sharks have 29-37, 15-31 and 13-42 number of young respectively (Compagno, 1984). This is very similar to the data collected from the various villages that have witnessed female hammerhead sharks with foetuses (with the exception of Soalara). Furthermore, these species of hammerhead are known to give birth in the Austral summer period (and *S. mokarran* has a gestation period of approximately 7 months; Compagno, 1984) which corresponds to the dates given by the shark

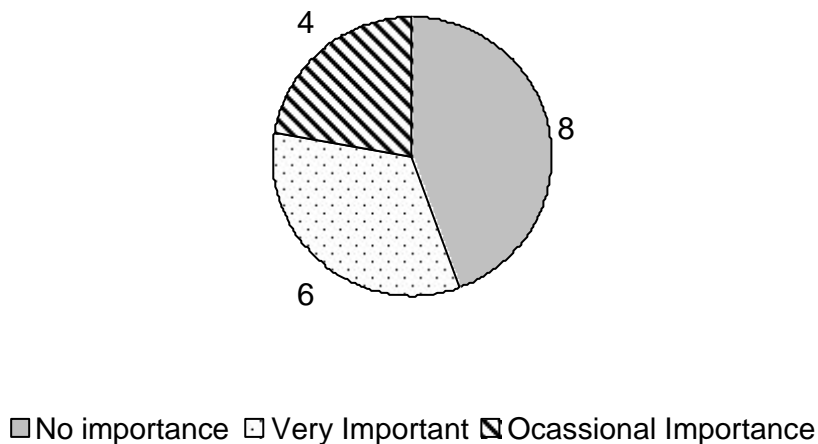


### 3.3.3. Tagged Sharks

Of the 22 shark fishermen that were interviewed only 6 had ever caught a shark with a tag on it. The descriptions of the tags varied. Three of the fishermen described the tag as a “bridal harness” (taken from a French translation). This “bridal harness” resembled a belt around the shark located behind the pectoral fins and in front of the dorsal fin. A fisherman in the village of Ambola had caught a Great White Shark (*Carcharodon carcharias*) with such a harness—although this is most likely a mis-identification, since Great White sharks have litters of 7-9 (Compagno, 1984) and are not known to frequent Madagascan waters. Great White sharks could easily be mistaken for other members of the *Lamnidae* family: Mako shark (*Isurus oxyrinchus*) and Porbeagle shark (*Lamna nasus*). However, this too seems unlikely as both these species have litters of 2-16 and 1-15 young respectively (Compagno, 1989) and not 24 as stated during the interview. A fisherman in Ampasimahanvo caught a shark he identified as either a Silvertip shark (*Carcharhinus albimarginatus*) or Oceanic Whitetip shark (*Carcharhinus longimanus*) with a similar tag. An Anakao fisherman caught an unidentified shark with a “bridal harness” in 1998. This tag was wrapped around the body of the shark beyond the pectoral fins and in front of the dorsal fin. In the village of Besambay a fisherman caught two unidentified sharks with such harnesses in 1997. A Tiger shark (*Galeocerdo cuvier*) with a white plastic tag (with no markings) on its dorsal fin was caught in 1980 in Itampolo by a fisherman in Beheloka. In 1988 a fisherman from Andrevo captured an unidentified (“valuvombotse” in Malagasy) tagged shark. The tag was silver and attached with a wire cord, and had a South African address on it. The tag has since become lost.

### 3.4 Cultural Value

The cultural value associated with the shark fishery is portrayed in Figure 11. Again, there was a mixed feeling towards the cultural value associated with the shark fishery. Of the fishermen that expressed a cultural value it usually consisted of consulting the ombiasy (local medicine man) whether it was an auspicious day to set the nets, go out to sea, or for catching fish. One fisherman in Soalara described how the heart of a shark and the meat from the neck were taken to the ombiasy who then proceeded to put a spell on it. The pieces were then attached to the palangre when it was deployed to act as “good luck” bait.



**Figure 11. The cultural importance associated with the shark fishery in the villages..** No data was collected for the villages of Anakao, Anakao2, and Andriangy

Several of the remaining fishermen admitted to performing their own personal blessing of the nets before deployment, whilst others stated that they believed in God to aid them in their fishing activities. Some of the shark fishermen scorned the idea of an ombiasy and others admitted that they lacked the funds to use the ombiasy.

### **3.5 Shark Names**

The shark names used by the individual shark fishermen were inconsistent when all the villages were compared to each other (see Appendix IV). Even neighbouring villages had various inconsistencies. Another complication with the names relates to the size of the sharks. Sharks can have a very descriptive name when small but as soon as the shark becomes bigger it can be referred to by another name. An example is as follows: the Spot-tail shark is called “akio mainty paty” (shark with black tips) when small, but when it becomes bigger the name given it is “akio meso” (dangerous shark; McVean and Walker, 2003). As most of the shark names are derived from morphological features of the shark it is possible that a specific shark name can refer to a group (possibly family or order) of sharks who share similar morphological features. One example is the Malagasy shark name “mainty paty”. A translation of this name literally means “black tip” and is used to describe any shark with black fin tips. Where possible the Malagasy shark names were paired with the common/species name using the shark name data gathered at the end of each interview.

## 4. DISCUSSION

The shark fishery in Southwest Madagascar appears to be exerting a considerable amount of pressure on the existing shark population. With more than 14,000 to 28,000 (conservative estimate) sharks being removed from a 140km stretch of coastline, and interviews showing declining catches compared to only 5-15 years ago, the local elasmobranch population could be in a state of decline. Interviews with Fishermen along the coastline helped to shed more light on the current shark fishery practices, and how this has changed in 15 years.

The general impression the villages have is that the numbers of sharks have decreased dramatically over the past 5-15 years. Even though this may appear obvious, it need not necessarily be accurate. A possible explanation is that there exist more shark fishermen now than 5-15 years ago. This was confirmed by several of the shark fishermen interviewed. The two shark fin operators interviewed both stated that no change in the number of sharks caught was evident in the last 5-15 years. This implies that there exist more shark fishermen now, each catching fewer sharks than before, but all together landing the same amount of sharks as 5-15 years ago. If this was true then 5-15 years ago there could have been around one tenth of the number of shark fishermen as now (catching ten times the number of sharks), something considered very plausible by the authors. From the interviews it also became apparent that territorial reef sharks no longer inhabited the fringing reefs and coastal waters of the study area. The fishermen stated that they have continually kept increasing the distance they fish offshore resulting in further travel times to obtain the same catches. With this in mind, the shark target species are also beginning to include the pelagic sharks inhabiting that area. These practices may lead territorial reef shark populations to recover; this seems unlikely because as soon as they begin to return to the territorial reef waters nearer shore, the shark fishermen will discontinue their long travel times and opt for the shorter travel times to catch any sharks they can.

There was a significant difference in the estimated number of sharks caught by each village in this study and in the comparative study by McVean and Walker (2003), where McVean and Walker find a much lower number of sharks caught. This could be due to the difference in methodology; McVean and Walker based the results of shark capture per month on a database using data the shark fishermen returned to the authors on a continual basis. It is possible that not all of the shark fishermen were willing to cooperate with this data collection resulting in inaccurate shark capture data. On the other hand, the shark fishermen interviewed in this study, could have exaggerated their results thus leading to an overestimate of the total number of sharks caught.

One complication for fishermen wanting to enter the shark fishery is being able to acquire the resources necessary for the initial cost. A palangre or jarifa will cost FMG 400,000 and FMG 900,000 respectively, around two to three times the average monthly wage. This would appear to make shark fishing very economically important. However, the overall attitude of the shark fishermen indicated that the fishery was not *that* important economically. If the shark fishery should cease to exist they were of the opinion that other forms of income would be available. Mr. Justin (president of Andrevo) pointed out that there exists a preference for the use of a jarifa over a palangre, as a jarifa (gill net) is multi-use. Being a gill net it can trap more organisms of economic importance to the fishermen. These organisms include turtles, dolphins

and various large pelagic fish. Selling these additional catches would help to re-imburse the cost of the more expensive jarifa, making it more economically viable.

An underlying thought behind the shark fishery that potentially stimulates its unrestricted nature is that should the shark fishery cease, due to a population collapse; there exists numerous other forms of income available to the fishermen. This would seem to agree with the local culture of Madagascar as experienced by the authors whilst living in Madagascar. The local population of Madagascar live very much so for the present and tend not to plan ahead or prepare for the future. Fishing is the mainstay of these communities. There are few crops grown by the Vezo, with a large part of the diet consisting of manioc (cassava) and maize bought to the coast by the inland producers. The rest comprises seafood and occasionally rice. The Vezo tend not to store or save a great amount, a fact which may be attributed to the days in which they were much more transient. In view of this, the attitude of the shark fishermen is to continue with their current fishing methods until a collapse of the shark population becomes inevitable. The “fast money” idea behind the fishery makes it very attractive to a broad range of fishermen. There is a high initial cost of the gear but the profits that the shark fins bring in would make this a lucrative venture.

Enough data appears to have been collected to state that nursery grounds exist in or near the river mouths, especially concerning the hammerhead species (family *Sphyrnidae*). The river mouths within the study area are an easy and predictable place to fish for the shark fishermen. Furthermore, sharks caught in this area are at a very vulnerable stage of the population's lifecycle. Given the very slow gestation period, low fecundity and slow growth rates of sharks (Holden, 1974; Hueter, 1998; Smith et al, 1998; Stone et al, 1998; Walker, 1998; ICES, 1997; Branstetter, 1993; da Silva and Ross, 1993) this could result in disastrous effects for the population, resulting in a stock depletion of that population. In teleost fish a strong year class can allow for a rapid recovery of a collapsed population, however, with sharks this would not be applicable as low numbers of young in a year class are produced (Fogarty et al, 1989).

The tagged sharks caught by the fishermen are of interest as one of the tags was reported to have come from South Africa. The conservation and management of sharks is greatly hindered when it concerns sharks visiting territorial waters of several nations as one nation would not necessarily have similar conservation/management ideas as the other. Most of the tagged sharks caught by the fishermen interviewed had a tag best described as a “bridal harness”. These “tags” were wrapped around the body of the shark beyond the pectoral fins and in front of the dorsal fin. This “tag” could easily have been a piece of gill net mistaken by the fishermen for a tag.

## 5. CONCLUSIONS

One very important note that must be considered when examining the results of this study is that due to the nature of the methods used to gather the data (informal discussions/interviews) there exists a great degree of subjectivity. One shark fisherman in each village (two for two of the villages) was interviewed and the data gathered from that specific interview need not necessarily apply to all the shark fishermen in that village. However, it has been assumed that the information provided by the interviewed shark fishermen is descriptive of the shark fishermen in the entire study area. The cultural differences between the Malagasy culture and that of the Western world, and the three-stage translation process used, will inevitably also lead to various discrepancies. During our informal interviews with the shark fishermen a translator was used who also aided in the post interview scribing of the interview and explained any queries that appeared. With this in mind it was hoped that the cultural or translation discrepancies were kept to a minimum. A majority of the shark fishermen were not able to provide accurate data concerning time (dates, months, years) as they do not base their time scale in terms of years or months, but rather in terms of tides or seasons (something more directly applicable to fishing). Due to the nature of the interviews, namely informal discussions led by a Frontier-Madagascar representative, gaps in the data were present. This meant that not all the data was obtained from each village. The informal interviews were attempted to be unobtrusive yet that was not always possible. In such situations a choice was made to gather the most important data and depart on friendly terms with the shark fishermen. For the village of Anakao the informal interview was conducted by researchers not completely familiar with the shark project and this resulted in a lack of information for those two interviews.

At the moment very little, if any, data exists quantifying the elasmobranch catches of the remaining coastline of Southwest Madagascar and this lack of information paired with the data from this study suggest that the implementation of an elasmobranch management system is crucial. Currently there are approximately 300 people involved in the shark trade within this area with at least 14,000 sharks being landed annually.

Stock recruitment of any species is limited in size. Whether these limitations are caused by fishing or natural pressures, they are limited (Walker, 1998). And therefore one must be extremely cautious when creating management plans that allow a fishing industry. The stock will not grow indefinitely and more importantly, the stock also has a lower limit. This lower limit is the bare minimum required for the stock to survive. The fishing industry must not fish beyond this minimum if the conservation of the species is to remain successful.

In conclusion, the elasmobranch fishery must proceed with caution (Fogarty et al, 1989). The removal of an apex predator in an ecosystem can have a very large domino or cascade effect changing the entire system. One should not ask if the fishing industry is sustainable, but rather, what proportion of the biomass can be taken to permit the population to survive (Walker, 1998; Smith et al, 1998). The question of maximum yield must be put aside and one must focus on the reproductive capability of the species. This reproductive capability will ensure the survival of individuals to maturity and adulthood and therefore the survival of the species. In 1973 Holden answered "yes" to the question of long-term elasmobranch fisheries being sustainable. Holden continued to state that they should proceed with caution due to the lack of knowledge of the biology of these elasmobranchs. This lack of knowledge has proven itself vital in the development of management plans by numerous authors (Holden, 1973, Walker 1998, Fogarty et al 1989).

## 6. IMPROVEMENTS

Of the improvements that could have been made most will relate back to the actual questionnaire. The questionnaire is the basis for acquiring information and looking back it has become evident that certain questions should have been asked to obtain a better understanding of the shark fishery in Southwest Madagascar. Below are listed several questions that should have been covered in the original questionnaire:

1. How many shark fishermen were there 5-15 years ago? *Data from this question could have been used to determine the number of sharks caught in the past.*
2. Questions concerning family ties in the shark fishery. *From a socio-economic viewpoint this could have been of interest to gain an insight into family fishing practises.*
3. More detailed questions concerning the population dynamics of the sharks (e.g. mating, times of year, certain species, babies in sharks, tags etc...). *This data is essential if a valid picture of the population dynamics is to be formed.*

One must bear in mind that due to the logistical restraints the questionnaire could not always be covered as thoroughly as desired. Some of the villagers had no time, at other times the tides dictated that the interview be cut short. These are consequences one must allow when recording data in this manner, however, they can be kept to a minimum. Other improvements that could have been made but were unfortunately not feasible (mostly due to time shortages and weather restrictions) within the period of this study include:

- The village of Maromena could have been visited again
- More shark fin operators could have been interviewed
- Shark fin collectors could have been interviewed
- Data from the Ministerie du Peche could have been collected to see how many sharks were actually declared

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## **APPENDICES**

- I. The palangre and jarifa fishing method (Pascal and Randria, pers comm. 2002)
- II. Shark fishermen Interview
- III. Shark fin collector Interview
- IV. Shark names per village

**Appendix I: The price the fin collectors pay for dried or fresh shark fins in each village (from North to South). “No data” refers to data that was not collected.**

<b>Villages: North to South</b>	<b>Price of Dried Fins in FMG</b>	<b>Price of Fresh Fins in FMG</b>
Fitsitike	425000	No data
Andrevo	350000	250000
Ifaty	500000	No data
Tsongatelo	225000	No data
Beravina	No data	400000
Belitsika	500000	300000
Andranogaya	500000	No data
Kiembe	350000	300000
Ankilibe	No data	250000
Saradrano	225000	250000
St.Augustin	No data	300000
Lovokampy	150000	No data
Soalara	No data	375000
Anakao	400000	No data
Anakao2	300000	150000
Andriangy	No data	75000
Andriangy2	No data	250000
Befasy	400000	137500
Beheloka	No data	300000
Besambay	250000	200000
Ampasimahanvo	350000	250000
Ambola	350000	200000

## **Appendix II: The palangre and jarifa fishing method (Pascal and Randria, pers comm. 2002)**

**Jarifa:** The jarifa comprises a long and narrow net of mesh size approximately 20cm. The net may be between 100m and 200m long and of height 3-8m. It works by ensnaring sharks, which drawn by the scent of baited fish become entangled in the net. The jarifa is a labour intensive fishing method requiring about 3 or 4 people to set the net. A suitable site is found in water depth of 100-150m with a sandy bottom (a lead weight is towed for approximately 1km behind the pirogue to see if catches on any protrusions, if not, the bottom is suitable). The net sits vertically in the water supported on each of the short ends by a line, with the long upper sides held up by wooden floats and lower sides held down by shell weights. Therefore the net will sit upright at depth, this being determined by the fisherman but usually at about 100m or 2/3 of the water depth (the deeper the better but the net needing sufficient height from the seabed to avoid snagging and so that sharks can not escape). One of the short end lines will run from surface (attached to a buoy) down to the seabed, anchored in place with a large rock. This will act as the swivel line. The other short end line will also be held at the surface by a buoy and have a smaller rock attached at the lower end of the line (not touching the seabed) so that whilst the net is held upright, it is also free to move with the current. This is essential due to the length of the net as it would not be strong enough to withstand any current from side on. The end cords may be made of steel cable if this can be found and afforded. The net is baited with large chunks of fish at various points along the net. When checking the jarifa (usually done on a daily basis), the net will usually have to be lifted out of the water. However, if there are quite a few sharks entrapped they may have skewed the net (from the light end) or the buoys may be closer together or changed distance so it could be possible to tell from the surface. It is necessary to take the jarifa out of the water every 5 to 10 weeks in order to dry out the wooden floats which become saturated over time and lose their buoyancy. Diagram/drawing would help here. WILL TRY TO FIND OR SKETCH ONE

**Palangre:** The palangres are much easier to use as there is much less material involved. They work in much the same way as a jarifa in terms of being a structure anchored at one end and turning in the current. However, rather than a suspended net, there are a number of baited hooks which hang down from a cross line of about 100m length between the 2 surface buoys. Each line (the number of which is dependent on money available for materials may be about 5) is also held up by it's own buoy and will usually be set at a water depth of about 50m These individual buoys also make it fairly easy to check if there is a shark on the line as the buoy will usually be pulled under the water surface. Each line is baited with large chunks of fish. The jarifas will also be checked on a daily basis if the weather allows.

### Appendix III: Shark fishermen Interview

Interview:

General introductions

Questions to be asked

1. Do you catch sharks?
  - 1.1 By-catch or targeted?
  - 1.2 How many people or families catch sharks in the village?
2. What species do you catch?
3. What gear do you employ (palangres or gill nets (jarifa))?
  - 3.1 Number of gear per family/community?
  - 3.2 Number of fishermen per gear?
    - 3.2.1 How often do you check/rebait the gear (palangres/jarifa)
  - 3.3 Where does the gear come from (FAO?)?
  - 3.4 Costs of the gear?
4. What happens to the caught sharks?
  - 4.1 Is it sold or consumed?
  - 4.2 Locally?
5. Who buys it? (fin collectors from Tulear, other villages, locally...)
  - 5.1 What parts are sold (fins, meat, all of it)
  - 5.2 What price are they sold for?
  - 5.3 Which sharks bring in the most \$? least \$?
6. How many sharks have you caught in the last 4 weeks?
  - 6.1 What happened to the catch?
7. How long have you fished sharks?
8. Are there certain times of year when you catch more big or small sharks?
  - 8.1 What time of year
  - 8.2 Are there months when you catch many, few?
9. Any species caught only certain times of year?
10. Do you catch more male or female sharks?
  - 10.1 How do you know which is male/female?
11. Which species do you catch the most?
12. How important are sharks to you?
  - 12.1 Do you rely on them economically?
  - 12.2 Cultural importance?
13. Have the catch levels changed over the last 10-15 years?
  - 13.1 Example of how many caught 10-15 years ago?
  - 13.2 Use different methods back then?
14. Where do you fish for sharks?
  - 14.1 Has this changed in the last 10-15 years (new areas)?
15. Have you ever seen any sharks with tags (plastic, colors, letters, numbers...) on them?
16. Have you ever found any babies in the sharks?
17. Have you ever seen any sharks mating?
  - 17.1 Where, what time of year, species?
18. Do you have any questions for us?

## **Appendix IV: Shark fin collector Interview**

### Interview

#### General introductions

#### Questions to be asked

1. Are you the only company who buy shark fins in Tulear?
2. How many fin collectors work for you?
3. Where do they collect/ how often?
4. Which species do you collect?
5. How many kg/day or week?
6. Do you have any yearly figures?
7. Do they ever buy meat (whole sharks)?
8. Prices (fins and meat)?
9. How many kg for a 1m shark fin for example
10. Which species are most/least expensive?
11. Any other shark products (jaws)?
12. What happens to the shark products (national/ international)?
13. Do they process the products?
14. Which species do they see the most/ least?
15. Times when more/ less/ bigger/ smaller sharks?
16. Do they ever encounter sharks with babies in them?
17. What do they do with the baby sharks?
18. Have they ever seen any tagged sharks?
19. How long have they been collecting for?
20. Have they noticed a change in number/ species of sharks over last 10-15 years?
21. How many fin collectors were there then?
22. How many kg did you collect then (eg. per week)?

## Appendix V: A summary of the Malagasy shark names per village

Latin name	order	Fisitike	Tsongatelo	Andranogaja	Belitsika	Kiembe	Ankilibe	Lovokampy	Soalara	Soalara	Anakao	Befasy	Beheloka	Ambola
<i>Carcharhinus falciiformes</i>	Carcharhiniformes	mainty paty	?	?	?	?						?(tseka mentioned)	mainty paty	?
<i>Loxoda macrohinus</i>	Carcharhiniformes	?	?	?	garagaranoro	lavavombotse						?	?	?
<i>Carcharhinus brevipinna</i>	Carcharhiniformes	?	?	mainty paty	mainty paty	?						fesotse	fotivonto	?
<i>Carcharhinus albimarginatus</i>	Carcharhiniformes	fesotse	?	fotivonto	fesotse	?	fotirambo	bevombotse	bevombotse	mainty paty	fotirambo	fotirambo	?	?
<i>Carcharhinus amblyrhynchos</i>	Carcharhiniformes	fesotse	?	mainty paty	?	fotivonto	maintyrambo	mainty rambo	tomany manenty	tomany manenty	mainty paty	mainty lamboussy	?	?
<i>Carcharhinus sorrah</i>	Carcharhiniformes	?	?	?	mainty paty	?						mainty paty	fotivonto	?
<i>Carcharhinus leucas</i>	Carcharhiniformes	foti	fotivonto	mainty paty	?	same family as fesotse	?	mainty rambo	valuvombotse	gofu	boriloaha	?	?	?
<i>Carcharhinus longimanus</i>	Carcharhiniformes	foti	?	fotipaty	fotirambo	same family as fesotse	fotirambo	fotirambo	m-bato	bevombotse		?	bevombotse	tomany manenty
<i>Triakonodon obesus</i>	Carcharhiniformes	?	?	sinike	valuvombotse	same family as mainty paty		tsaka	fotirambo	valuvombotse		valuvombotse	?	fotirambo
<i>Carcharhinus melanopterus</i>	Carcharhiniformes	fotivonto	mainty paty	?	?	mainty paty	mainty paty	mainty paty	mainty paty	mainty paty	meso	foti	?	mainty paty
<i>Carcharhinus limbatus</i>	Carcharhiniformes	?	mainty paty	mainty paty	?	fesotse						?	?	?
<i>Carcharhinus wheeleri</i>	Carcharhiniformes	?	?	mainty paty	?	fesotse						?	?	?
<i>Negaprion brevirostris</i>	Carcharhiniformes	?	meso	foti/valu	?	foti	?	?	valuvombotse		vombotse	bevombotse	?	foti
<i>Galeocerdo cuvier</i>	Carcharhiniformes	fesotse	?	?	?	?	?	tsaka	tsaka	vorotse/tigre	vorotsy	vorotse	vorotse	?
<i>Prionace glauca</i>	Carcharhiniformes	?	?	?	?	garagaranoro	menamaso	garagaranoro	garagaranoro			?	?	santra
<i>Carcharhinus galapagensis</i>	Carcharhiniformes	fesotse	?	?	?	?	meso	?	?	?	?	?	?	?
<i>Pseudotriakis microdon</i>	Carcharhiniformes	?	?	?	?	?	?					?	?	?
<i>Rhynchobatus djeddensis</i>	Carcharhiniformes	sorobois	sorobois	valusoro	leja leja	leja leja				sorobois	sorobois/valosoro	sorobois	sorobois	?
<i>Sphyrna lewini</i>	Carcharhiniformes	viko	viko	viko	viko	viko	viko	viko mainty rambo	viko	viko	viko lavavombotsy	viko mainty	viko	viko mainty
<i>Sphyrna mokarran</i>	Carcharhiniformes	viko	viko	viko	viko	viko valuvombotse	viko	viko valuvombotse	viko ranomany	viko	viko befofy	viko foti	viko	viko foti
<i>Chlamydoselachus anguineus</i>	Hexanchiformes	?	tandaly	?	linta	hiya hiya	?					?	?	?
<i>Hexanchus vitulus</i>	Hexanchiformes	?	mainty paty	?	tsaka	fesotse						hiya hiya	?	bevombotse
<i>Hexanchus griseus</i>	Hexanchiformes	besofi	hiya hiya	belidak	hiya hiya	bevombotse (black and white photo)						tomany manenty	?	?
<i>Heptanchias perlo</i>	Hexanchiformes	?	?	?	hiya hiya	fotivonto						lavaoro	?	?
<i>Notorynchus cepedianus</i>	Hexanchiformes	?	?	?	?	meso	?					tigre	?	tigre
<i>Hexanchidae sp.</i>	Hexanchiformes						?	fihilatse	belidak		matso			
<i>Alopius vulpinus</i>	Lamniformes	sabonto	?	?	santra	marofatike	?	santra (much dispute)	santra		santra	santra	berambo	?
<i>Carcharodon carcharias</i>	Lamniformes	bevombotse	bevombotse	?	gofu	foti	?	tomany manenty	jinganify		sabonto/ombilahy	tseka (mintseka)	fesotse	fesotse
<i>Isurus oxyrinchus</i>	Lamniformes	fesotse	?	?	tigre	?	sabonto	tomany manenty	jinganify		jinganify/mintseka	sabonto	tomany manenty	sabonto
<i>Lamna nasus</i>	Lamniformes	fesotse	?	?	bevombotse	same family as foti	fotivonto					anjevan	?	sabonto
<i>Carcharias taurus</i>	Lamniformes	magaraganoro	?	?	mintseka	same family as farao	?					jinganifyXXXX	?	?
<i>Pseudocarcharias kamoharai</i>	Lamniformes	bemaso	?	?	?	same family as bemaso but different	?					?	bemasu	?
<i>Ginglymostoma cirratum</i>	Orectolobiformes	hiya hiya	hiya hiya	sinike	?	meso	?	hiya hiya	belidak		tsaka/valompiso	hiya hiya	hiya hiya	hiya hiya
<i>Rhincodo typus</i>	Orectolobiformes	vorotse	tjouso	?	?	bemasu	?					sabonto	sabonto	?
<i>Stegostoma fasciatum</i>	Orectolobiformes	tomango	tigre	?	tigre	tsaka	tigre	santra	tigre		valoso	tigre	tigre	tigre
<i>Pristinidae (sp)</i>	Pristiophoriformes	vavay	vavay	vavay	vavay	vavay	vavay	vavay	vavay		vavay	vavay	vavay	?
<i>Centrophorus moluccensis</i>	Squaliformes	?	?	?	?	?	?					?	ranu	?
<i>Isistius brailliensis</i>	Squaliformes	?	?	?	?	?	?					?	?	?
<i>Etmopterus lucifer</i>	Squaliformes	belidak	?	?	belidak	farao	belidak					tsaka	bemasu	?

Soalara1 refers to an interview conducted 11-2001 outside of this specific project.

Soalara2 refers to an interview conducted 2-2002 outside of this specific project.

Soalara3 refers to an interview conducted 13-11-2002 during this specific project.

Anakao refers to an interview conducted 2-2002 outside of this specific project.

“?” refer to shark species not identified by the shark fishermen interviewed.

Blank spaces refer to no photographic material available at the time to show the shark fishermen during the interview.