



**Shark Research Institute – Operation Whale Shark
Mafia Island, Tanzania, Nov. 2007 – March 2008
Report of Field Research & Supplemental Work**



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SRI - Mafia Island, Tanzania Fieldwork Nov. 2007-Mar.2008

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Abstract

Whale sharks have been observed to aggregate in the waters west of Mafia Island, off the coast of Tanzania. A research project was proposed and initiated by the Shark Research Institute (SRI) with support provided by The Kairos Company, Ltd, The Wave Foundation of the Newport Aquarium, and WWF-Tanzania. The first year of the study was a success and warranted further studies of the whale sharks at Mafia. The principal investigator, Matthew Potenski, conducted field surveys and tagged whale sharks for the period of November 2007 through March 2008. The tagging program was successful, as 21 ID tags were deployed. Thirty-five different individuals were differentiated using spot-pattern recognition software applied to digital images taken for each shark encountered. The author worked closely with the Mafia Island Whale Shark Conservation Society (WHASCOS) to aid them in achieving their year 1 initiatives. Additionally, a survey team was trained by Matthew D Potenski so that whale shark monitoring may be undertaken year-round in Mafia. This is a preliminary report of the data collected from the tagging and survey efforts during the above mentioned interval.

Introduction

Mafia Island is the southernmost island of the Zanzibar Archipelago off the coast of Tanzania. Over the past few years, whale sharks (*Rhincodon typus*) have been observed aggregating off the western side of the island, particularly in Kilindoni bay (Fig. 1- whale shark photographed off Mafia Island).

Figure 1 – Whale shark (*R. typus*) with snorkellers in Mafia Island waters

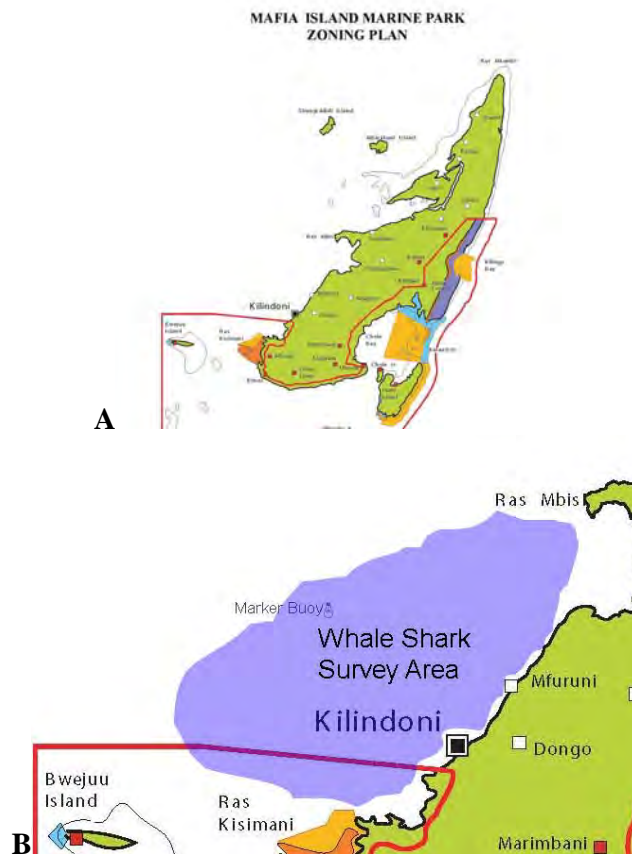


The status of the whale shark worldwide is not concretely known but there is some evidence that its numbers are very low. Whale sharks were added to the Appendix II list of CITES in 2002 and are currently on the ICUN red list for threatened species. Whale shark ecotourism has also become a major attraction in many areas where the

sharks can be found. Despite the high profile that whale sharks have in the media, we still know very little about them and need to understand many things about them to effectively manage and protect their populations. Research projects are beginning to illuminate the world of the whale shark, but years of effort are still ahead. Mafia Island presents us with a unique opportunity, as it has a reliable population of whale sharks with only a light ecotourism impact. To try and determine parameters of whale shark population structure, behaviors, and movements, a research project on the whale sharks of Mafia Island was conceived. A proposal was approved by COSTECH in November 2006 and a Research Permit was granted. The author of this proposal was a shark biologist from the Shark Research Institute (USA). The first year of the project was a success and the research permit was renewed for a second field season. The research will continue to be supported and in cooperation with the WWF-Tanzania office, the Mafia Island Whale Shark Conservation Society (WHASCOS), and the M/V Kairos. The program of ID tagging, direct observation, and improving photographic records will be expanded for year two. In addition to the field research, other initiatives of WHASCOS were overseen by the author. The purpose of this report is to disseminate the field research activities and explain the accomplishments of supplementary work completed to achieve WHASCOS initiatives. These initiatives work towards the goals of learning more about the whale sharks in Mafia waters, and work with the local community in Mafia to raise awareness and stewardship for whale sharks as a sustainable natural resource.

Map

Figure 2 – Mafia Island (A) and the whale shark primary sampling area (high season) – Kilindoni Bay (B)



The majority of the fieldwork conducted during the author's field season (Nov 2007-March 2008) was contained in this area. On certain days when sharks were not observed, the surveys may have ranged farther North, West, or South in search of whale sharks.

Fieldwork - Tagging

The primary goals of this research project were to deploy visual ID tags on as many whale sharks as possible, and to take photos of as many sharks as possible for photo-identification analysis and database records. During the time period from November 2007-March 2008, a total of 35 days in the field were recorded. Whale sharks were observed on 24 of those days, while no sharks were observed on 11 of those days (see Table 1).

Table 1: Dates of field work with observance of whale sharks

Month	Whale Sharks Observed	No Sharks Observed
November	05, 07	06, 15, 16, 17
December 2007	05	
January 2008	14, 15, 16, 17, 18, 19, 20	
February	03, 15, 16, 17, 21, 22, 23, 24, 26, 27,28	08, 10, 11, 18
March	07, 11, 15	09, 21, 22

During November 2007 and January 2008, the research was conducted using the M/V Kairos as a platform. The vessel has RIB-style zodiac boats that allowed the investigator to approach and observe the whale sharks. During the months of February and March 2008, the research was done from Mafia Island using boats from Kilindoni. The research was carried out as per the methodologies and parameters set forth in the project proposal submitted to and approved by COSTECH (see Potenski 2006). All fieldwork was done in-situ on snorkel from several small boats, including the RIB tenders for the M/V Kairos, and a fiberglass v-hulled vessel with outboard engine arranged for by WHASCOS, as well as traditional wooden boats used for whale shark ecotourism. All sharks were approached from the left side (off the starboard side of the vessels). The water visibility was sometimes less than two meters, and required the observer to get fairly close to the sharks for tagging and photography purposes. Sharks were found on the surface and were encountered in the water from 0-5m depth. Typically, three separate encounters were needed to get data on an individual shark. The first dive was to observe the sharks, denote and markings, determine sex, and get ID pictures. The second dive was to place a tag in the shark. Finally, a third dive was taken to verify and inspect the tag attachment and take additional pictures. The author was supplied with twenty-one placard style ID tags from SRI (see Figure 3A). He was able to successfully deploy the tags on whale sharks during the course of the field season (see Figure 3B).

Figure 3 – The author with placard tag and spear gun (A) and a whale shark with ID tag attached (B)

A)



B)



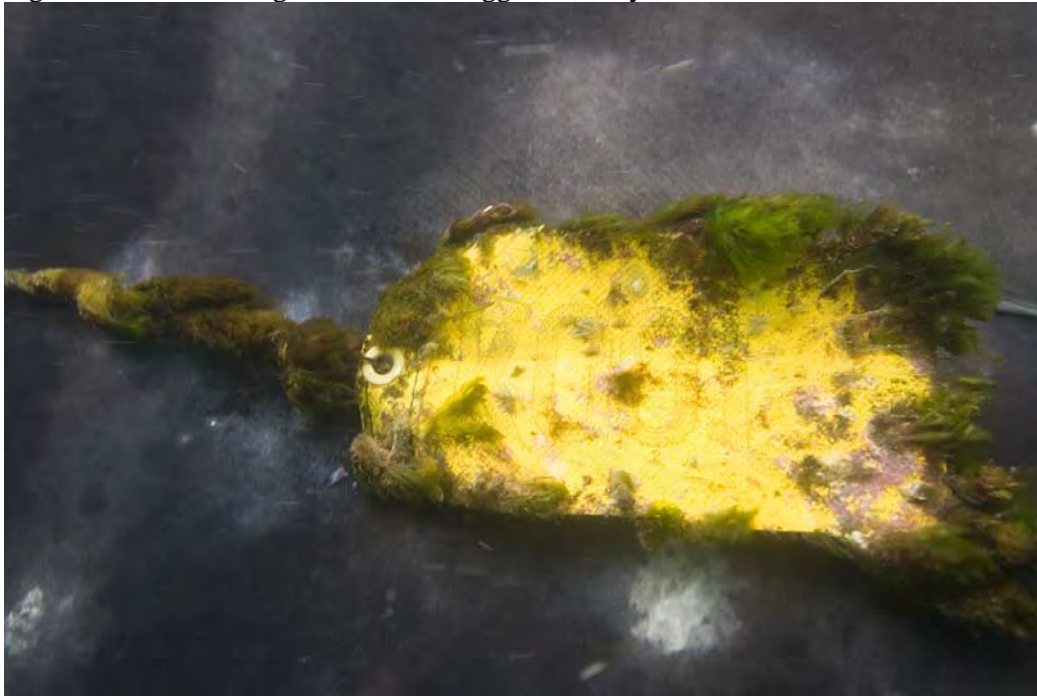
Preliminary Results

Tagging

A total of twenty-one whale sharks were marked with visual ID tags during the period of Nov. 2007-March 2008 (Refer to Appendix 1 – Field tagging data summary). In

addition, one foreign tag (K001) was sited and identified as a tag deployed by a group of whale shark researchers from Kenya (East Africa Whale Shark Trust). Four tag deployments were confirmed as retaggings by the existence of old tag stringers hanging out of the sharks and/or distinguishing features recognized from the previous season. Therefore seventeen of the tags deployed could be considered to be original taggings on animals missed the previous season. There were twenty five sharks tagged last season, so with the additional seventeen marked this year and the single Kenyan shark; there are potentially forty-three animals that can be identified by tag number in the Mafia Island area. Similar to the first season's findings, significant sexual bias was exhibited in the population. Male sharks outnumbered female sharks in a ratio of roughly 6:1. Only three females were tagged, and the sex ratio shows an even stronger bias than last year. Male sharks comprised the remaining fourteen new taggings, the four retagged sharks, and shark K001 for a total of nineteen recorded males. See Figure 4 for an illustration of the non-SRI tag attached to a whale shark.

Figure 4 – Non-SRI tag, Identified as tagged in Kenya – shark # K001



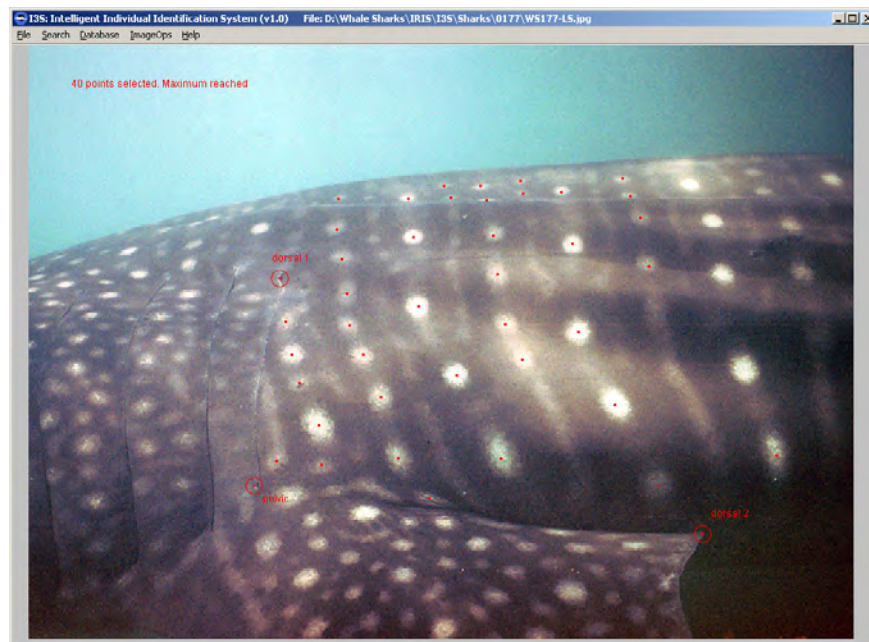
The Kenyan tag was completely covered in a dense mat of algae and it took three separate encounters to dive and clean the algae from the tag to the point where any markings were discernable.

The author observed and tagged the sharks pretty consistently over the course of the field season. The most tags deployed in a single day were five on February 03, 2008. The whale sharks were observed feeding on the surface, and many did shallow dives when approached or tagged. However, the sharks would almost invariably resurface somewhere between 50-100m away and resume normal feeding behaviors. The general lack of reaction to the tagging event coupled with the quick resumption of normal feeding behaviors tend to point to the success of this methodology to effectively mark individuals in the population with little to no effects on their behavioral patterns.

Photo-Identification Database

The author took approximately 400 images of whale sharks during the course of the research in Tanzania in the 2007-2008 field season. The images of the whale sharks were taken via a Canon 20D digital SLR Camera utilizing a Canon 10-22mm lens. The camera and lens were put in an Aquatica A20 housing with 8 inch acrylic dome port. All images were taken using ambient light and shot in the RAW format, for maximum image quality and ability to extract contrast. Despite the high resolution, sometimes the underwater visibility and/or existence of shoals of small fish did not allow for a clean spot-pattern image. Once converted to jpegs, the photos must be cropped, straightened, and the contrast boosted. The image is then “mapped”. In order to accomplish this you have to set static or comparable anchor points in all the photos, to provided scale and spatial reference to a two dimensional matrix. For whale sharks, the area that is mapped is directly behind the gill slits. The last gill slit is used as the first two points – as the top and bottom edges serve as anchors. Lastly, the trailing margin of the pectoral fin serves as a third anchor point. Once the anchors are in place the spots are marked out in a distinctive “map” (see figure 8). At this point, spot maps can be compared via algorithms that look for overlap. You will get the most probable matches from a database with a ranked score for fit. The operator will always have to visually recheck the matches, but the software packages have a high accuracy rate. The algorithms for this software were originally developed for star-recognition and were applied to the spot patterns of whale sharks (see Arzoumanian et al 2005).

Figure 5 – Spot pattern map in I3S software (from Pierce 2007)



The images were mapped using both the I3S and Ecocean software packages and have been uploaded to a central database through the www.whaleshark.org website.

WHASCOS Surveys

According to the WHASCOS list of activities, a monitoring program was to be set up and weekly surveys conducted. WHASCOS asked the author to oversee and conduct the surveys starting in February 2008. Funds were allocated to allow the author to procure a boat and crew for conducting surveys for whale sharks off the west side of Mafia Island. In the nine days of surveys made, sharks were observed on seven of the nine total days of surveys. The surveys allowed for the deployment of eight visual placard-style shark tags. In addition, the surveys were able to record twenty-seven resightings of tagged whale sharks in the area. Finally, there was one sighting and record of a shark with a foreign tag, labeled K001. Through email follow-up the author was able to determine the origin of this tagged shark, as part of a study currently being conducted in Kenya. In all, the survey days allowed the author to tag and make observations on whale shark behavior, and were considered a resounding success.

Survey Team Training

The goal of this WHASCOS initiative was to select and train a team of Mafia Island residents to conduct visual surveys via boat for whale sharks in the waters to the west of Mafia Island. The training was to encompass all the methodologies employed by the author, Matthew D. Potenski, in his current research program, as well as going over proper boat-handling around whale sharks, and tag cleaning in-situ by monitors on snorkel. The author, along with Liberatus Mokoki, sought to train a team of six individuals. Three monitors (Polu Slakoindemori, Ally Chande, & Mohammed Bakari) and three boatmen (Idd Salum, Gregory Joseph, & Daudi Kimbite) were identified and accepted as trainees (see Figure 6).

Figure 6. – WHASCOS Monitoring Survey Team



Day one consisted of a classroom presentation in the morning. The author gave a PowerPoint presentation that was translated by co-trainer Liberatus Mokoki. This presentation included an orientation to whale sharks and a description of the research methods employed in the survey program. The lecture went in depth to explain the

exact details of how and why the data is collected. The trainees showed great enthusiasm, and asked many questions. After lunch, the training moved to a field session on the water. The swimming and diving prowess of the trainees was assessed and found to be more than satisfactory. In water observations for tag numbers and sex identification were started. Practice getting position fixes with a GPS unit, and recording data were also introduced. Day 2 began with another field session on the water. The drills of the previous day were again covered – entailing number reading and sex determination. Before lunch, a short classroom session was commenced to go over the process so far and start to perfect and refine techniques. Of note was a review of the role and execution of the boatmen in placing the boat where the monitor would have the best chance to observe the shark. The afternoon included another field session in which boat driving was emphasized, as well as the monitoring skills and GPS use were reviewed. At this point, all the trainees seemed to be showing competence in all tasks required of them. The author moved on to the final skill with the monitors – in water tag cleaning. The morning session on Day 3 was another field session where the monitors again went over tag reading, sex determination, and tag cleaning. After lunch, the trainers and trainees had a short discussion session, where the author received feedback from the trainees on their opinions of the training and sense of confidence in their mastery of the skills. The afternoon of day 3 was spent on the water, with the team going over drills yet again, though in a somewhat leisurely atmosphere. The training went very well and the author believes that the six trainees are prepared to begin to carry out surveys independently in the near future. The author has every confidence that the team will be able to not only do the task at hand, but to successfully take data at the same level as the whale shark surveys conducted personally by the author. Three sets of new snorkel gear were purchased by the author in early March and transferred to Mr. Liberatus Mokoki's care for use by the whale shark monitors. The team is now well equipped to conduct the whale shark surveys. The author let the survey team do several surveys independently and then went out to check the data and observe them in the field. The team did well in the field but the author suggests continued personal supervision by Mr. Liberatus Mokoki until the team is comfortable enough with data recording to be completely independent. Upon further talks with Mr. Mokoki the author updated the data sheets to include both English and Kiswahili which may aid the monitors in data recording. Surveys are planned to occur with the frequency of approximately two per week for the remainder of the year.

Supplemental Work – WHASCOS Initiatives

In addition to the actual field work that was conducted, the author pledged his time and efforts to fulfill several WHASCOS initiatives. A six-panel informative pamphlet was designed by the author. He composed all the text, which included information on whale shark biology, their existence in Mafia Island and research efforts, encounter guidelines, and discussion of WHASCOS. The author also did the layout and used images from his library to create an attractive design. The pamphlets were translated into Kiswahili by SeaSense and subsequently printed in both Kiswahili and English for distribution on the island. The author then did the graphic design for WHASCOS T-shirts. Upon consultation with Dr. DeVilliers, a two-sided design was brainstormed. The T-shirt includes a whale shark image taken by the author on the front with English text on the front, and a spot-pattern graphic with Kiswahili text on the back, and the WHASCOS logo on the sleeve. This design was used to print T-shirts for distribution across Mafia to raise whale shark awareness in the villages, as well as to market to tourists as souvenirs. The author also designed the three panels

for the permanent display to be erected in Kilindoni, the main town of Mafia Island. The three panels included one panel each in English and Kiswahili that covered whale shark biology and one center bi-lingual panel with information about WHASCOS.

Further Research

As part of the original research program from year one of this study, eight PAT-style satellite telemetry tags were attached to whale sharks off of Mafia Island. The tags had intervals of up to 12 months. Seven of the eight tags successfully transmitted data via the ARGOS satellite system. Satellite tags 67452, 67453, 73242, 73243, 73244, 73245, and 73246 all transmitted data to the Argos system. Only tag 73241 was not heard from. The data gained from these tags – geolocation, temperature profiles, and temperature profiles will be presented, analyzed, and submitted for review in a separate and complimentary report. Preliminary analysis of the tags shows the whale sharks staying in the general area of the Tanzania coast maybe as far as southern Kenya.

Year three of the project is being planned with continued ID tagging and photo-identification, monitoring surveys, and possibly more satellite tag deployment. Cooperation with concurrent research in Kenya with potential for data sharing may be looked at in the next year. It is highly likely that individuals in this area may migrate from Kenya to Mafia and back. Initial contact has been made and data from the observation of shark # K001 submitted to the East African Whale Shark Trust. Further initiatives such as plankton tows and water quality analysis may be added to the WHASCOS monitoring surveys.

Conclusions

Building on the success of the first year of the project, the year two field season achieved all its goals. The continued deployment of ID tags and photo-identification of individuals progressed as planned. The author was able to work towards the goals of SRI's Operation Whale Shark, as well as complete initiatives of the Mafia Island Whale Shark Conservation Society. In most instances this was easy, as both organizations share very similar goals. The support of both SRI and WHASCOS/WWF-Tanzania was essential to the progress made in this project during the 2007-2008 field season. The results of this year's tagging and observations support observations from the first year of the study. Many sharks tagged last year were resighted, so there is evidence the sharks are either resident or partial residents in Mafia. An estimate of over fifty individuals utilizing the area can be made through tagging and photo-identification of over forty animals with confirmed identities. The population is still composed of juvenile to subadult sharks, with males easily dominating the sex ratio. All these findings have been duplicated by researchers working in Kenya and Mozambique, respectively the countries to the immediate North and South of Tanzania. It appears that the whale sharks in Mafia are exhibiting behavioral and life history patterns that are typical for the species in the Western Indian Ocean. Further study should cement the conclusions made for this aggregation of whale sharks.

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Appendix 1 – Summary of field tagging conducted during study period

ID TAG #	SEX	SIZE	Date Tagged	Comments
0556	6.5m	M	15-Jan-08	No markings observed
0560	6m	M	16-Jan-08	Cut in top of UC
0561	5.5m	F	18-Jan-08	Scar on back behind D1 "Robin"
0587	6.5m	F	18-Jan-08	No markings observed, "Khriissy"
0588	4.5m	M	19-Jan-08	Half of UC missing
0630	6m	M	19-Jan-08	Damaged D1 - horizontal cut and curled over "Curly"
0632	5.5m	M	20-Jan-08	"Christopher" 0846 - RETAGGED as 0632 . Horizontal cut in dorsal
0633	5.5m	M	3-Feb-08	Scalloped D1 (old prop wound), RETAGGED as #0633
0634	7m	M	3-Feb-08	No markings observed
0643	4.5m	M	3-Feb-08	No markings observed
0644	7m	M	3-Feb-08	No markings observed "Abe"
0645	5m	M	3-Feb-08	No markings observed
0646	5m	M	15-Feb-08	Had old tag stringer hanging out of it RETAGGING
0647	6m	M	15-Feb-08	Has badly damaged D1 - missing large portion and cuts in trailing edge
0648	4m	M	16-Feb-08	No markings observed "Liam"
0649	5m	M	16-Feb-08	No markings observed
0677	4m	F	17-Feb-08	No markings observed "Jana"
0679	6.5m	M	17-Feb-08	No markings observed
0680	4m	M	22-Feb-08	Two cuts in D1
0682	4.5m	M	24-Feb-08	Had old tag stringer - RETAGGED as #0682 Cut in back of UC
0683	7.5m	M	27-Feb-08	No markings observed