Regional Tuna Tagging Project-Indian Ocean: A Report on the Activities of the 4th Tuna Tagging Cruise in Tanzanian Waters.

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Acknowledgments

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To all who made cruise 504 successful and enjoyable, may you live to see and enjoy the fruits of your labour.

Background

The Regional Tuna Tagging Project (RTTP) is a 5 year, 14 M€ project funded by the European Development Fund (EDF). It is a scientific project of the Indian Ocean Commission (IOC), implemented by the Indian Ocean Tuna Commission (IOTC). The general objective of the project is to reinforce the regional management capacity, leading to sustainable exploitation of tuna resources in the Indian Ocean. Specifically, the project aims to reinforce the scientific knowledge of tropical tuna stocks and the rate of exploitation in the Indian Ocean by obtaining crucial parameters for stock assessment.

The project has chartered two pole-and-line vessels for 2.5 years, with 34 seamen and 6 tagging technicians. It is also collaborating with countries within the Indian Ocean by encouraging participation of personnel from these countries as Regional Tagging Technicians (RTTs). The project management unit (PMU) comprises of a Chief Coordinator (Jean Pierre Hallier), a Publicity and Tag Recovery Officer (Michael Stockwell) and an Administrative and Financial Officer (T. Athayde). The PMU is based in Victoria, Seychelles.

Rationale for Indian Ocean Tuna Tagging

The last two decades have seen a rapid increase in tropical tuna catches (Yellowfin, Bigeye and Skipjack), as well as growth of the two main industrial fisheries (purse seine and longline). The artisanal fisheries have also grown significantly. While the main fisheries are spread over the entire tropical oceans, they are particularly concentrated in the Indian Ocean.

Despite the tremendous development of the Indian Ocean tuna fishery, there is a growing lack of knowledge on the status of this fishery. Data on stock assessments are lacking or doubtful while some biological parameters essential for stock assessment models are still unknown or imprecise. For Yellowfin and Bigeye tunas, these parameters are still unknown. In addition, the interactions between the two main industrial fisheries (purse seining and longlining) are poorly understood.

One of the ways of obtaining information on the tuna fisheries is through a large scale tagging program on the tuna stocks of the Indian Ocean. Through such a program, the RTTP aims to achieve the following technical outputs: 1) to tag a minimum of 80, 000 tuna in 2.5 years; 2) to recover atleast 15% of the tagged fish; 3) to process and interpret the recovered data, and to design scientific models for tuna stock assessment and 4) to reinforce the capacity of the Regional Fisheries Organizations (RFO) and participating institutions in stock assessment and management. Ultimately, the project will achieve a better understanding of the following parameters: 1) stock structure and migration patterns; 2) growth; 3) natural mortality as a function of age and sex; 4) size of stock and fishing mortality; 5) interactions between the two main tuna fisheries; 6) behaviour of tunas as a function of their environment and 7) the impact of FADs on the resource.

1.0 Introduction

The Regional Tuna Tagging Project (RTTP) started its activities in February 2005, with actual tagging starting in May, the same year. The RTTP has chartered two pole and line vessels for the 2.5 years during which actual tagging will take place. Pole and line vessels catch tuna in good condition, thus enhancing the survival of the fish after tagging. It is worth noting that the survival of tuna after tagging is critical to the success of this project. To date (November, 2005), the project has conducted 4 cruises.

One of the project's objectives is to involve personnel (Regional Tagging Technicians-RTTs) from the Indian Ocean countries in tuna tagging and data analyses components of the project. So far, the project has involved RTTs from Seychelles, Madagascar, Mauritius, Mozambique, Tanzania and Kenya. This report outlines the activities of the fourth 45-day cruise, from the 19th of September to the 1st of November 2005, by Mr. Robinson Mugo. Mr. Mugo, a research scientist from Kenya Marine and Fisheries Research Institute (KMFRI), was aboard one of the sister vessels chartered by the project, known as Kemantxo.

The spatial coverage of the fourth cruise (cruise 504) was entirely within Tanzanian waters. The cruise began on the 19th of September, off Zanzibar where the vessels had anchored to change personnel after the third cruise. After Zanzibar, the vessels sailed to Dar es salaam harbour to refuel, after which they proceeded with the usual tagging and bait fishing operations. Tuna tagging operations for the fourth cruise were confined in Tanzanian waters, while bait fishing mainly took place around Mafia Island, which is also within the Tanzanian EEZ.

The personnel in each of the two vessels comprise of the captain, chief engineer, cruise leader (CL), chief tagging technician (CTT), regional tagging technicians (RTT) and fishing crew. The captain is responsible for the safety of the vessel, the crew and the tagging team, as well as ensuring that compliance with access requirements in different countries' waters are adhered to. The CL and the CTT are charged with administrative and technical responsibilities of the project within the

vessel. The RTTs, after training, support the duties of the CL and the CTT while the fishing crew's main duty is to fish for bait and tuna and perform any other duties as may be called upon by the CL, the CTT or the captain.

1.1 Project Organization and Infrastructure

The RTTP-IO is being implemented through a three tier organizational structure involving the European Union (EU), the Indian Ocean Commission (IOC) and the Indian Ocean Tuna Commission (IOTC). The EU delegation in Mauritius provides the project funds and controls their utilisation while the IOC in Mauritius implements the contracts and budgets of the project. The IOTC in Seychelles is carrying out a supervisory role in the technical aspects of the project and is the recipient of the project's results. The RTTP-IO implements the project.

The RTTP has sub-contracted different components of the project to facilitate its smooth implementation. There are about 3 levels of sub-contracting, mainly for the vessels, the project coordinator, the tagging team and IOTC for logistical support. The vessels (Aita Fraxku and Kemantxo) are contracted through AZTI (a Spanish company). The project coordinator mainly operates from the IOTC offices in Victoria, Seychelles and reports to the Indian Ocean Commission.

2.0 Materials

2.1 The Fishing Vessels

The project has chartered two pole and line fishing vessels (Kermaxto and Aita Fraxku). One of the vessels is shown in Plate 1. The vessels are fitted with bait holding tanks, which are normally used for storing frozen fish in normal fishing operations. The bait tanks are continuously pumped with sea water to ensure the survival of the bait.

Plate 1: One of the pole and line fishing vessels in the project –Kemarntxo. (Photo: R. Mugo).

2.2 The Crew

On board each ship are twelve crew members (Plate 2) mainly for fishing (pole and line), general engine maintenance and other onboard logistics. The ship is manned by one captain, assisted by a technical engineer. The scientific crew comprises of three personnel in each ship, the cruise leader (Mr. Jan Hoogesteger), the chief tagging technician (Mr. Keith Paterson) and one regional tagging technician (Robinson Mugo). Specific duties for each of these personnel (for this particular cruise) are listed in a tagging manual by Hallier (2005).

Plate 2: Members of the fishing crew aboard Kemantxo (Photo: R. Mugo).

2.3 Fishing gear

2.3.1 Boats

2.3.2 Bait attraction boats

Two small boats for bait attraction, about 6 ft long and 3 ft wide (Plate 3). On each side, the boats are fitted with two filament lights at an angle of approximately 60 ^{o} to the water. The lights are about 250-400 watts in power, and are powered by a generator carried on board the boat. They are usually manned by one person using oars.

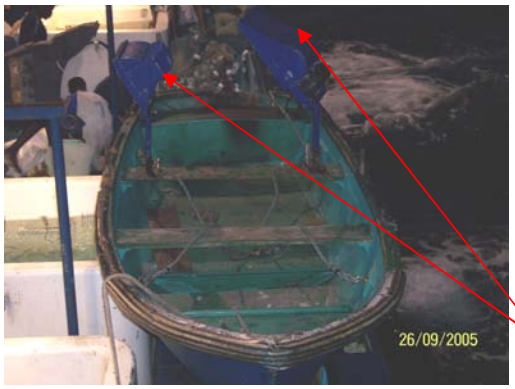

Plate 3: Bait attraction boat fitted with lights (Photo: R. Mugo).

2.3.3 General purpose boat

One boat about 20 ft long and 5 ft wide. It's fitted with an outboard engine and usually used for setting nets (Plate 4).

Plate 4: General purpose boat (Photo: R. Mugo).

Plate 5: A seine net hauled by a hydraulic crane using a power block (Photo: R. Mugo).

2.3.4 Nets

Seine nets of varying sizes were used for bait fishing (Plate 5). One seine net was about 400 m in length and about 20 m in depth.

2.3.5 Scoop nets

Basket shaped scoop nets made of non knotted material. Used for transferring fish from the seine net to the holding tanks, as well as from one holding tank to another.

2.3.6 Hook and Line

Fishing for tuna is done with pole and line fitted with hooks. Poles are made of bamboo stick while lines are made of nylon. The hooks are semi circle shaped, of varying sizes.

2.3.7 Laboratory Facilities

A small on board laboratory mainly for entering data comprised of 3 laptop computers, all networked, with one of them used as a server and the other two as data entry points (Plate 6). Data are fed into an access database. A small shelve for books, computer accessories and paper files. The laptops had the following specifications: Dell, Latitude D610, Pentium IV, RAM 512, and 1.6 GHz.

Plate 6: Simple laboratory on board the ship (Photo: R. Mugo).

2.3.8 Buckets

General purpose plastic buckets for transferring fish from point A to B, mainly handling by catch.

2.3.9 Measuring boards

For taking fork lengths of sub-sampled fish from the bait haul.

2.3.10 Hit Counters

For counting number of scoop nets hauled into the holding tanks. They have a range of 0 to 9999 and are made of stainless steel.

2.3.11 Underwater writing board

For recording measurements and tallies of bait hauls.

2.3.12 Tagging cradle

The tagging cradle is made of a stainless tripod stand that is wedge shaped (Plate 7). The front part has a holding box for the applicator block. The cradle is covered with a vinyl material which is labelled with measurements on a scale of 1 to 150 cm. The measurements are frequently checked to ensure that they are not misleading.

Plate 7: A tagging cradle (Photo: R. Mugo).

2.3.13 Sound recorder

A small gadget used to record audio data during tagging. The model used in this program is the Olympus Digital Voice Recorder VN 480 PC (Plate 8).

Plate 8: A voice recorder for recording audio data while tagging (Photo: R. Mugo).

2.3.14 Gloves

Hand knit gloves are worn by the TTs when handling the tuna fish. They also protect the tagger from any injury either from jerking by the fish or from hooks and applicators on the tagging cradle.

2.3.15 Blinding Cloth

A dark coloured cloth is used to cover the fish's eye during the short span it is placed on the tagging cradle to make it calm down and avoid jerking up and down.

2.3.16 Tags and Tag Organization

Each of the tags is numbered to facilitate its identification. This number is usually done by the manufacturer and normally creates a series of tags, say for every 100 tags. The series is made up of a combination of alpha numeric characters. e.g. AA01500 which refers to tags in the AA series, tag number 00, on batch 015. The alpha characters usually indicate the size of the tag, for example, the AA series could be 14.5 cm in length.

2.3.17 Tag Holding Blocks

A wooden block measuring about 12x4x40 cm, with 100 holes drilled in it on the larger surface area facet (Plate 9). The holes which hold the applicators are numbered

from 0 to 99. The block is usually placed at the front end of the cradle during tagging where it is held tightly to prevent it from falling off.

Plate 9: A tag holding block with dart tags already in applicators (Photo: R. Mugo).

2.3.18 Applicators

An applicator is a device that is used to apply the tag to the fish. The device is a tube, about 8 inches long and is made of stainless steel. One end is sharply tapered to make it lodge easily into the fish's muscle. The dart tag is slotted into the applicator, from the sharp end.

2.3.19 Taxonomic/Identification Manuals

Differentiating between Yellowfin and Bigeye tunas is a critical step in the data recording process. Prior training on identifying these fishes by use of colour and morphometric traits ought to have been done before tagging. A technical manual by Itano (2003) is very useful in this process. FAO fish identification manuals, preferably by region are also being used to help in the identification of bait fish and any other fish caught besides tunas.

2.3.20 Vernier Callipers

One meter long vernier callipers for taking fish fork lengths.

2.3.21 Global Positioning System Unit (GPS)

A GPS connected to one of the laptops in the laboratory is useful for reading out coordinates and navigation routes for scientists when not on the bridge. The GPS is connected to CMAPS (charts for marine navigation) program, a software capable of showing the velocity, course and position of the fishing vessel. At the bridge, latitude and longitude readings could also be taken from either the bird radar, or the sonar.

3.0 Project Design and Data Structure

3.1 Bait Fishing Data

Pole and line fishing for tunas is almost entirely dependent on availability of live bait. The variables obtained under bait fishing include: the date, country, cruise number area and recorder. Further, data is recorded on the haul number, Time, Latitude (N or S), Longitude (W), Depth, Cloud, Current, Fishing Method Average weight, the mean range and the number of buckets caught for each species. Appendix 1a is a sample bait fishing data collection table.

To better understand the rate of bait utilisation while fishing for tuna, bait fish utilisation is recorded as number of buckets used by the bait fish master. The number of buckets used during chumming is recorded in the bait fish utilisation log. Appendix 1b is a sample of the bait fish utilisation log.

3.2 Daily Activities

The daily activities of each vessel are recorded in a "daily activities log". The purpose of this log is to indicate the different times spent by the vessel in different activities. There are about 14 different activities in the cruise, which are coded as shown in the Table 1. A sample Daily Activities data entry sheet is presented in Appendix 1c.

Table 1: Codes for daily activities.

CODE	ACTIVITY
PO	*In port (for refuelling, loading goods, dropping or taking crew & scientists)*
BA	*Anchor for bait fishing (at night or during the day)*
BF	*Bait fishing at night or during the day*
SD	*Steaming during the day*
SN	*Steaming at night*
SS	*Searching with a school associated to the vessel*
SE	*Searching for tuna schools, log or Fish Aggregating Device (FAD)*
CH	*Chasing a tuna schoolFIFishing (tagging) tuna*
DS	*Drifting or steaming at a low pace with a tuna school*
DL	*Drifting during the day near a log or a FAD*
DG	*Drifting at night with lights to gather tuna or with an associated school*
DW	*Drifting because of bad weather*
DT	*Drifting or at anchor or in port because of engine or other mechanical problems*

3.3 School and FAD Sighting Log

Fish Aggregating Devices (FADs), form a significant component of the tuna fishery. FADs can either be natural or man-made. Natural FADs are mainly drifting logs while man-made FADs range from simple objects such as drifting rafts to sophisticated gadgets that are fitted with GPS systems for positioning.

The purpose of school and FAD sighting log is to record schools sighted and their associations. There is a general distinction made in tropical tuna fishery between tuna schools associated or not associated to non-living objects. There is a well marked difference in species and size composition between these two types of schools. Type one schools are those not associated to non-living objects but may be associated to other marine fauna such as birds, whales and whale sharks. Type two schools are those associated to non-living objects such as natural logs or man-made fish aggregating devices (FADs). Generally, skipjack are the most abundant species under log schools and they usually swim close to small yellow fin and bigeye tuna. Large yellow fin and bigeye usually swim in free schools. Appendix 1d is a sample template for school and FAD sightings data entry.

There are two important numbers in the school and FAD sighting log. The first one is the school number which is a sequential entry of each school sighted in each day, whether fished or not fished. The tag school number is a sequential number of all the schools from which fish are tagged. The tag school number starts at 1 from the first cruise and continues increasing for each vessel till the end of the project. Unlike the school number which starts with every new cruise, the tag school number does not start with every new cruise.

3.4 Tag Release Data

Tag release data are usually recorded into the voice recorder during tagging and later transcribed into data sheets and fed into the database. The tags used for the different size of fish in this project are coded by colour, size and type. Generally the size of the tag is proportional to the size of the fish being tagged. The method used also depends

on the purpose. Table 2 shows the different sizes of tags in use in the project and the sizes of fish expected to be tagged by these tags. Appendix 1e is a sample tag release data entry form.

Table 2: List of tag series, corresponding lengths, color codes and their functions (Hallier, 2005).

Tag Series	Overall Length (mm)	Color	Use
CC 00000 – CC 99999	110 - 115	Yellow	Ordinary single & double tagging small tuna
DD 00000 – DD 99999	110 - 115	Yellow	Ordinary single & double tagging small tuna
EE 00000 – EE 99999	145 – 150	Yellow	Ordinary single & double tagging medium-large tuna
FF 00000 – FF 99999	145 - 150	Yellow	Ordinary single & double tagging medium-large tuna
ET 00000 – ET 00299	145 - 150	Orange	Electronic tagging
OT 00000 – OT 00499	110 - 115	White	Chemical tagging small tuna
OT 10000 – OT 11499	145 - 150	White	Chemical tagging medium-large tuna

Tag release data also includes a measure of confidence or reliability that the tagger has on the fork length measurements, fish condition and tag reliability. The different levels of confidence for each of these parameters are coded on a numeric scale of "good to bad".

3.5 Catch on Deck / Fishing Log

The purpose of this form is to record all fish caught during the tagging operations but are not tagged. They are recorded by numbers, species, morphometric measurements (forklengths, FDL) and biological data such as stomach contents, liver weight, gonad weight and whole fish weights. Appendix 1f is a sample data entry form for catch on deck data.

3.6 Length Frequency Data

All measurements of the main tuna species left on the deck after tagging are recorded in this log. Forklengths are taken for all fish less than 100 cm and lengths to the first dorsal fin (FDL) are taken if the fish is greater than 100 cm fork length.

3.7 Tagging Strategies

The project has adopted about six tagging strategies inorder to improve the efficiency of tagging and the overall survival of fish tagged.

I) Overall vessel tagging

The overall vessel tagging strategy is aimed at optimizing estimation of the exploitation rate, interaction levels between fisheries, migration rates between areas (stock structure), and estimation of growth rates.

II) Purse seine fleet seasonality

The seasonal movement of the purse seine fleet can generally give an indication of where large stocks of tuna are. The project vessels can take advantage of this pattern and tag fish slightly behind the tuna fleet in order to avoid the tagged fish getting captured immediately.

III) Technical aspects

Tagging technicians must be well trained to tag fish in order to avoid or minimise tagging related mortalities. The TTs must also be well trained in data recording and entry into the RTTP database.

IV) Tagging methods

The project employs more than one method of tagging to optimize information gathering through the different methods of tagging (chemical, archival and dart).

Chemical tagging with oxy-tetracycline provides information on the growth of the fish by analysing growth rings on the otoliths. Archival tagging provides information on the movement of the fish, as well as some environmental parameters such as temperature, and depth. The application of each of these methods is described in detail in the project manual (Hallier, 2005). Double tagging with dart tags provides some information on the tag shedding rate of dart tags by species.

V) Priority species for tagging

The project gives priority to tagging yellow fin and big eye tuna. Consequently, whenever the vessels are in an area where many skipjack have been tagged, searching is intensified in other areas.

4.0 A Typical Tuna Tagging Day

4.1 Planning in Advance

Planning in advance for the tagging day ahead is the key to a successful tagging exercise. Some of the issues that call for planning in advance include preparation of the tags and tagging blocks, ensuring that the voice recorders are working properly and that their batteries are fully charged as well as a clear understanding of division of labour amongst crew members. It is important that all instruments and materials are returned to their usual places after use.

4.2 Bait Fishing

There various methods of bait fishing include Boka ami net used with above water lights, Boka ami net used with under water lights, night purse seining with lights, night purse seining in the dark and day purse seining. Purchase of bait either caught in the dark or during the day is also considered as a bait acquisition method in the project.

Night purse seining with lights is the main method of fishing for bait in the project. Bait fishing usually starts at 4 am, but is largely dependent on the weather conditions and the location. At first, a small boat with lights powered by a generator is set overnight in the water to attract bait fish. Then the captain locates areas with high bait concentration with the help of the sonar. He then guides the fishing crew while setting the seine net in the water. Once the entire net is set, hauling begins immediately. Hauling is usually done by three winches (for the purse and floater lines), the crew and two hydraulic cranes fitted with a hydraulic power block (Plate 10). The net is hauled close to the boat to facilitate transfer of the bait fish to the holding tanks.

The bait fish are transferred to the holding tanks with scoop nets fitted with a bamboo handle (about 3m long) and a short hauling line to pull the scoop net out of the seine net (Plate 11). The fishermen form a loop within which the scoop net with bait fish is

passed as fast as possible to the person close to the holding tank, who releases the fish into the tank and passes the scoop net on the next person, ready for the next scoop.

Each scoop released into the holding tanks is counted using a hit counter. A sample of the bait fish caught is taken and sorted by species. The number and fork lengths for each species are taken and recorded into the bait fish haul data sheet.

Plate 10: Hauling a seine net while bait fishing (Photo: R. Mugo).

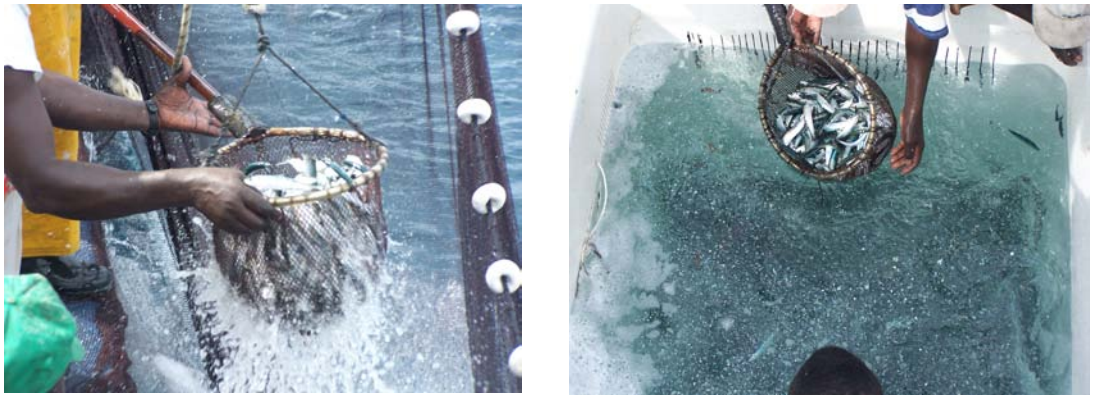

Plate 11: Transferring the bait fish from the seine net to the re-circulatory holding tanks.

4.3 Tuna Tagging Process

There are three methods of tagging in use in the project; namely dart tagging, archival tagging and chemical tagging. Dart tagging is the most commonly used method. The tuna tagging exercise in a day falls under three main activities, searching, chasing and fishing and tagging. Amongst these three, searching usually takes the highest percentage of time. However, this depends on the area and the season and to some extent the time of the day.

4.3.1 Searching and Chasing

Tuna schools are more often associated with birds that congregate around the schools to feed, non-living drifting objects (logs, FADs) or living things such as whales, sharks and dolphins. This is a phenomenon that fishermen have used for a long time to locate schools. Searching for tuna schools is done with bird radar and or a pair of binoculars (Plate 12) to locate the birds. The crew also use the naked eye at the same time to monitor the movement of birds from a close range. The binoculars are also useful in sighting logs and FADs from a distance. Once a school (birds, logs) is sighted (Plate 13), the time, location and nature of the school are recorded in the school sighting data sheet and chasing after the school starts. The captain continues to monitor the birds with the radar, with the help of the crew, but also uses the sonar to estimate the size of the school.

Plate 12: Searching for birds associated with tuna schools (Photo: K.P.).

Plate 13: Birds associated with tuna schools (Photo: K.P.).

Once the ship has closed in on the school, the captain signals the crew to chum the school. Chumming refers to the process of throwing bait fish to the tuna fish to attract them towards the ship. The captain also switches on the water spray which makes the tuna fish want to come closer to the ship for shelter. During this process, the fishermen are ready with baited hooks, set to fish. On the other hand, the tagging technician switches on his/her voice recorder and records the date, time, tag series number, tag school number and the first tag number on the block.

4.3.2 Dart Tagging Process

Once a fish is caught, the fisherman has to bring it to the tagging cradle as fast as possible (Plate 14) and as carefully as possible, after which three steps of the tagging process follow, some of them simultaneously. The first step is to unhook the fish. Unhooking the fish is done by the tagging assistant with the help of the fisherman. Unhooking should be done as carefully as possible to avoid further injury to the fish. While unhooking the fish, the fisherman should take control of his fishing line and hook to avoid hurting either himself, the tagging assistant or the tagging technician. As soon as the fish is brought on the tagging cradle, the tagging technician is required to identify the fish by species and record this into the voice recorder. The tagging technician must have his gloves on and frequently check that the voice recorder is running.

Plate 14: Tagging tuna on a tagging cradle (Photo: K.P.).

The second step is to examine the fish for injuries, take its fork length and tag the fish. Based on the condition of the fish, the tagging technician should make a decision whether to tag the fish or not. The condition of the fish is then recorded into the recorder (bleeding, jaw injury etc). The fish is then turned on its right side, with the tip of the mouth touching the zero mark of the tagging cradle, after which the fork length of the fish is taken and recorded. If the fish is restless on the cradle during this process, the tagging technician should place a wet black cloth on the fishes' eye. Just before tagging, the tag number in use should be loudly shouted into the voice recorder. With the tag applicator on the right hand, the applicator is inserted into the fishes' muscle, at the base of the second dorsal fin, at an angle of 45 ^{o} to the flesh. The applicator is then pushed right into the fishes' muscle sending it past the bones supporting the second dorsal fin. This lodges the barb of the dart tag past the bones

making it difficult for the fish to shed off the tag. If the barb of the dart tag just lodges into the fish flesh, there is a high likelihood that the fish will shed it off. Ordinary dart tags are yellow in colour, and bear the projects contact address.

After successful tagging, the third step is to release the fish (Plate 15). This should be done as carefully as possible to avoid hurting the already tagged fish. The fish should be released headfast into the water. The left hand should support the fish by the belly while the right hand holds the fish by the caudal peduncle. Every time a fish is released, any blood or slime left on the cradle should be washed off with sea water.

Plate 15: Releasing a tagged tuna back to the sea (Photo: K.P.).

4.3.4 Other tagging methods under use in the project

4.3.4.1 Archival tagging

Archival tags (Plate 16) are electronic devices implanted into the abdominal cavity of the fish by surgical means. These tags are capable of recording more information than the dart tags. They usually record the water temperature, depth, pressure and light intensity. However, they are by far more expensive than the dart tags. Hallier (2005) outlines the procedure for implanting archival tags in the project. Fish tagged with

archival tags are also tagged with orange/red dart tags to indicate that there is an archival tag in the belly of the fish. In cruise 504, archival tags were not used.

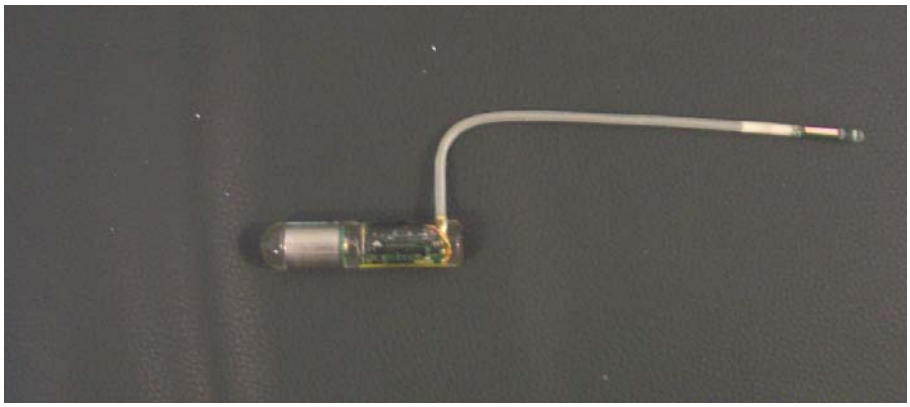

Plate 16: An archival tag (Photo: R. Mugo).

4.3.4.2 Chemical Tagging

Chemical tagging is one of the methods of ageing fish. In chemical tagging, the fish is injected with a known amount of oxy-tetracycline (OTC), which leaves a mark on the fishes' otoliths (growth rings) on the day the fish are injected with the chemical. The amount of OTC injected into the tuna is usually 50mg per kilogram of fish weight (Hallier 2005). Injecting OTC is best achieved with auto injectors. A fish injected with OTC is also tagged with a white dart tag, to distinguish it from others tagged with ordinary dart tags or archival tags. The project aims to tag a minimum of 2000 fish with chemical tags. Chemical tagging was not used in cruise 504.

4.3.4.3 Catch on Deck

Catch on deck refers to all fish (either tuna or other species) that are fished and are not tagged, and therefore end up on the ships deck (Plate 17). For all these fish, length and weight data are obtained, as well as weight of stomachs, liver and gonads (Plate 18). The stomach contents are also described where the stomachs are dissected.

Plate 17: Catch on deck (Dolphin fish) from which length frequency data are obtained (Photo: R. Mugo).

Plate 18: Scientists, Jan (left) and Keith (right) weighing tuna gonads onboard the Kemanxto vessel. Inset: Female Tuna gonads (Photo: R. Mugo).

5.0 Tag Recovery

The project hopes to recover a minimum of 15% of the tags released. To achieve this, a strategy has been laid down on tag recovery and publicity. First, the PMU is publicising (Plate 19) the project and the tag recovery programme to fishermen (artisanal, purse seiners and longliners) and fish processing factories in the region. Incentives in form of rewards are being offered to those who send in recovered tags with the details of the recovered fish. Rewards include t-shirts, caps etc. The project is also organising a grand lottery for the tags that will have been recovered at the end of the project.

Plate 19: A poster for publicising the tuna tagging project in the Indian Ocean region.

6.0 Project Findings in Cruise 504 (Vessel: Kermantxo)

6.1 Spatial and temporal coverage

Cruise 504 operated entirely within Tanzanian waters for 45 days. Areas covered for bait fishing and tagging include waters off Zanzibar, Mafia Island, and Dar es salaam. Precise times and positions for bait fishing and tuna tagging for cruise 504 are stored in the RTTP database.

6.2 Bait fishing

In cruise 504, five areas were fished for bait. Table 3 summarises bait fishing activity by area fished, number of hauls made, the number of buckets obtained and the approximate weight for all buckets fished. Each bucket is approximately 6 kilograms of live weight fish.

Table 3: Area fished, fishing hauls made and the amount of bait fish obtained.

Area fished	No. of hauls	Buckets fished	Approximate wgt
Mafia Island-Monitor anchorage	11	241	1446
Mafia Island-Monitor anchorage, north	23	689	4134
Mafia Island-Mbili pass	1	7	42
Nungwe-Zanzibar	2	8	48
Yacht Club bay-Dar es salaam	1	3	18
Total	**38**	**948**	**5688**

6.3 Tuna Tagging

In cruise 504, a total of 802 fish were tagged from 46 schools. Of the 802, 184 were Bigeye, 317 were Skipjack and 301 were Yellowfin. Table 4 presents fish tagging

results by tagger and species. Table 5 is a summary of number of fish tagged by gear and species. The size frequencies of fish tagged in cruise 504 are shown in figure 1 by species.

Table 4: Number of fish tagged by each tagger per species.

Recorder	Bigeye	Skipjack	Yellowfin	Grand Total
JNH	84	118	210	412
KAP	88	149	60	297
RM	12	50	31	93
Grand Total	**184**	**317**	**301**	**802**

Table 5: Number of fish tagged by gear type and species.

Gear Type	Bigeye	Skipjack	Yellowfin	Grand Total
PL	164	317	236	717
TR	20		65	85
Grand Total	**184**	**317**	**301**	**802**

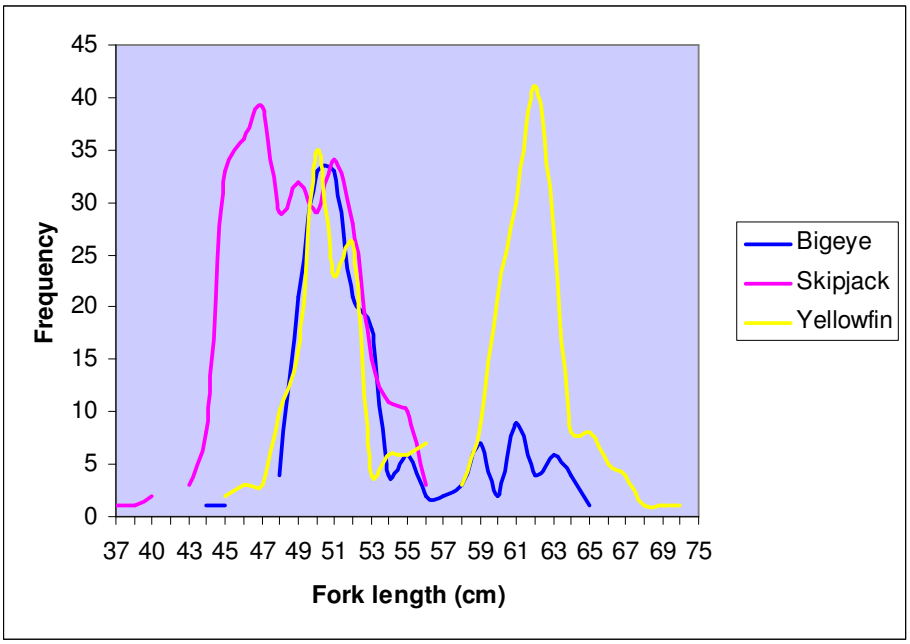

Figure 1: Size frequencies of fish tagged in cruise 504 by species.

6.4 Preliminary Data Analyses

Preliminary analyses for all fish tagged from all cruises were performed with an aim of bringing out the following comparisons:

Number of fish tagged:

- By species
- By species and vessel
- By species, cruise and vessel
- By gear and species

Size Frequencies:

- All sizes
- By species and vessel
- By species and cruise
- By species, vessel and cruise
- By species and tag series

Number of fish tagged:

- By recorder and species
- By cradle and species

Reliability codes-fish:

- All species
- By species
- By cradle and species
- By tagger and species

Reliability codes-species:

- All species
- By species
- By cradle and species
- By tagger and species

Reliability codes-Forklengths:

- All species
- By species
- By cradle and species
- By tagger and species

Reliability codes-Tags:

- All species
- By species
- By cradle and species
- By tagger and species

Preliminary analyses were also done to compare associations of tuna schools with FADs, in all cruises and for both vessels. The results of these analyses are not presented in this report because the report confines itself to activities within cruise 504.

7.0 Conclusions and Recommendations

The primary objective of participating, getting trained and assisting in tagging and data analyses operations in the RTTP-IO was achieved. Further collaboration between the Western Indian Ocean country institutions and the project is strongly recommended as a way of enhancing the understanding and management of tuna stocks in the Indian Ocean.

8.0 References

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Suggested Further Reading

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Appendices

Appendix 1a: Sample baitfish catch data entry table.

BAITFISH CATCH LOG (RTTP - IO)

DATE: D D M M Y Y

COUNTRY:

Page n°:

CRUISE N°:

AREA:

RECORDER:

Haul	Time				Latitude						N	Longitude							Depth	Cloud	Current		Fishing	Catch (buckets or scoops)		
#	h	h	m	m	d	d	m	m	•	m	S	d	d	d	m	m	•	m	(metres)	cover %	Direction	1/10 knots	method	Avg. Wt	Loaded	Discard
1									•								•									
2									•								•									
3									•								•									

FAMILY / GENUS SPECIES	HAUL 1			HAUL 2			HAUL 3		
	Number fish	Mean (cm)	Range Min / Max	Number fish	Mean (cm)	Range Min / Max	Number fish	Mean (cm)	Range Min / Max

COMMENTS:

Appendix 1b: Sample bait utilisation data entry table.

BAIT UTILISATION LOG (RTTP - IO)

COUNTRY: | | | |

Page N°: | | | |

RECORDER: | | | |

CRUISE N°: | | | | | |

DATE						Bait carried at				Bait catch				Bait catch				Total bait catch				Bait used				Bait dead			
DAY		MONTH		YEAR		the start of the day				during the day				during the night				day & night				during the day				day & night			

Appendix 1c: Daily activities data entry table.

DETAILED DAILY ACTIVITIES LOG (RTTP - IO)

COUNTRY:

Page N°:

RECORDER:

CRUISE N°:

DATE			TIME		POSITION			Activity code	If no bait fishing operation: why?	Sea Surface Temperature (1/10 °C)	Sea condition	WIND		CURRENT	
DAY	MONTH	YEAR	Hour	Minutes	LATITUDE (° & mn)	N/S	LONGITUDE (° & mn)					Direction	Speed (knots)	Direction	Speed (1/10 knots)

Appendix 1e: Tag release data entry table.

TAG RELEASE LOG (RTTP - IO)

Page N°

DATE: D D / M M / Y Y

CRUISE N°:

TAGGER CODE:

COUNTRY:

TAG SERIES:

TAG SCHOOL N°:

CRADLE CODE:

GEAR TYPE:

TAG #	SP	SP reliabi	FL	FL reliabi	Reliability Tag	Reliability Fish	DD tag	TAG #	SP	SP reliabi	FL	FL reliabi	Reliability Tag	Reliability Fish	DD tag	TAG #	SP	SP reliabi	FL	FL reliabi	Reliability Tag	Reliability Fish	DD tag	TAG #	SP	SP reliabi	FL	FL reliabi	Reliability Tag	Reliability Fish	DD tag
0								25								50								75							
1								26								51								76							
2								27								52								77							
3								28								53								78							
4								29								54								79							
5								30								55								80							
6								31								56								81							
7								32								57								82							
8								33								58								83							
9								34								59								84							

Appendix 1f: Catch on deck data entry form.

CATCH ON DECK / FISHING LOG (RTTP - IO)

Page N°: | | | |

COUNTRY: | | | | RECORDER: | | | | CRUISE N°: | | | | | |

Day	Mont	Year	Sch. N°	Tag School N°	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Sp	N° Fish	Total N° Fish