Ecological observations from a portion of the Lugenda valley, Niassa Reserve: resource utilization and densities of key animal species

Plate 1: Traders returning to Tanzania to sell their full baskets of smoked fish bought at the Lugenda River fishing camps

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Summary

The Niassa Reserve Biodiversity Workshop (Maputo 2004) highlighted a number of concerns regarding the extent of resource utilization, particularly fishing pressure along the Lugenda River. In addition more detailed information was requested on fish catches and the densities of crocodile, hippo, impala and African skimmer. This report hopes to contribute to a better understanding of the dynamic between people and the environment in Niassa Reserve, particularly the reliance of people on the Lugenda River. Our study area is situated in the south-eastern section of the Niassa Reserve core area and incorporates 25 km of the Lugenda River bounded by the Mbamba River in the west and the Msangezi river in the east, extending approximately 10 km inland (to the north). Data were collected opportunistically and through measurement of fish catches, transect counts and conversations with local resource users during the dry season (May – Nov) 2004.

Fish are the most important natural resource utilized in the study area although honey, meat and plant products, particularly bamboo and palm fronds are also extensively used. In total 36 fishing camps (30 active) were identified. An estimated 250 fishermen utilized this area during the peak fishing period (Oct - Nov) predominantly from local villages within Niassa Reserve (76 %), but also from Cabo del Gado (23 %) and Tanzania (1 %). In addition a minimum of 50 traders (from Cabo del Gado and Tanzania) were based at the fishing camps during the peak season. At present the fishery can be considered an open access system and, at current levels of exploitation, it appears to be moving from subsistence to a commercial enterprise as it includes trading for luxury items in addition to basic goods. Nine fishing methods were identified (standard valve and insevila traps, gill nets, throw nets, chingombo nets, chingundenje nets, rod & line, static lines and poisoning) and 203 individual fish catches were measured (11 385 fish). More than 90 % of the catch was made up of only four fish species (two *Labeo sp* and two species of bream). Rocky channel habitat was the focus of most fishing activities with the exception of insevila trap fishing. On average chingundenje fishing (conducted primarily at the end of the season) yielded the largest catch per device (12 kg / net) with insevila traps also yielding relatively large catches (7 kg / trap) of primarily juvenile fish. Standard valve traps and gill nets yielded similar catches per device (3kg / device) but on overage gill nets (63 mm gill nets were the most common) caught significantly larger fish than standard valve traps. Conflicts between fishermen and other animals were minimal and largely confined to damage to traps by African

clawless otter and to gill nets by crocodiles. Both young (caught in gill nets) and adult crocodiles are killed on occasion and fishermen habitually destroy crocodile nests. Crocodiles injure several fishermen each year but fatalities are rare. There is currently insufficient evidence to suggest that fish stocks are declining and we believe the current system might be self-regulating limited by transport, onset of rains and market forces. Collection of data from other areas and seasons is needed to assess this further and establishment of an effective monitoring system should be a priority. Management of the fishery should be based on actual data so that reasonable limits can be set for no fishing zones, the number of licenses issued and fishing camps established.

Baseline information (abundance, distribution and habitat use) on key species in the study area was also collected. The crocodile survey indicated that crocodiles of all ages are present in the study area with adult crocodiles preferring the rocky channel habitat and juveniles more commonly found in the sandy channels. Yearlings (0-18 months) and large adults (>3 m) appear rare. Spotlight counts of all size classes suggested a density of 18.5 crocodiles / km in sandy channel habitat and 5 crocodiles / km in rocky channel habitat. However, accurate surveying in rocky channel habitat is difficult, and given that this is the preferred habitat of the adult crocodiles, it is likely that their numbers have been underestimated in this survey and previous aerial surveys. The reasons for the relatively low numbers of adult crocodiles and breeding records are unclear. At least 80-85 hippos were counted at three main pools within rocky channel habitat and their numbers appear to be increasing. Impala (15 / km^2), waterbuck (3 / km^2) and kudu (2 / km^2) were regularly seen and appear to be increasing in numbers with few old males but large numbers of juveniles and subadults. Sable, zebra, eland and hartebeest were uncommon but fairly large herds were seen near the river during the late dry season. Niassa wildebeest were never recorded in the study area. A flock of African skimmer (maximum 12) was regularly seen in sandy channel habitat and they were believed to be breeding in this area.

This small section of the Lugenda Valley is of particular interest as it is not only intensively utilized for fishing, honey gathering and plant collection, but is also scenically beautiful and has relatively good concentrations of game. While traditional eco-tourism or hunting activities might be difficult given the large amount of pedestrian and bicycle traffic, eco-tourism ventures that include aspects of cultural tourism are likely to be successful here. This could provide visitors with a unique experience whilst providing alternative income generating opportunities for the local people by using their local knowledge.

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Introduction and justification

The Biodiversity Workshop (Maputo, April 2004) highlighted a number of concerns regarding the extent of resource utilization particularly fishing pressure and activities along the Lugenda River (Bills 2004) and the need for ground truthing of GIS, and aerial census data (ungulates: Gibson & Craig 2002, 2000). In addition more detailed information was requested on fish catches and the densities of a number of key animal species, crocodile, hippo, African skimmer and impala. Whilst our primary research focus remains carnivores (honey badger, lion and wild dog), one of our objectives during the 2004 dry season (May to November) was to collect information to address these issues.

With this in mind, a narrowly defined study area along the Lugenda River (between the Mbamba and Msangezi rivers; Fig. 1) in the southeastern section of Niassa Reserve was chosen for further investigation. This relatively small area lies within our broader carnivore study area where we have temporary vehicle based camps. We were therefore able to collect information on a regular basis and establish a long-term working relationship with the people utilizing this area, whilst still continuing with our primary research objectives.

One of the distinguishing characteristics of this Reserve is the large population of people who reside within the core area. The study area is of particular interest as it is heavily utilized by residents of Mbamba village (one of the largest villages within the Reserve along the Lugenda River), as well as by Cabo del Gado and Tanzanian traders and fishermen. It is also scenically beautiful with significant eco-tourism potential and supports relatively high populations of game.

The report is divided into two main sections: resource utilization with an emphasis on the measurement of fish catches and fishing activities, and densities of key animal species. Each section can be read independently to facilitate different interests but together they provide a more detailed assessment of this area. On a small scale we hope these results will contribute towards future management, monitoring and zoning plans for this particular area. More widely, we believe these preliminary data can be extrapolated to other areas of similar habitat within the Niassa Reserve and we hope will provide a more detailed understanding of the dynamics of

resource utilization particularly fishing pressure on areas of the Lugenda River. In addition, the data sets (fish catches, number of fishing camps, crocodile densities, ungulate and hippo group sizes etc.) provide a baseline for future comparisons. Based on our findings we have provided preliminary recommendations for research priorities and management where appropriate and a brief assessment of the eco-tourism potential of this area (Section C). Given that the carnivore research is ongoing and will only be completed in late 2006, we (K & C Begg) will continue to collect information on resource use in the study area. As requested by SGDRN a final edition of this report, reflecting the additional and updated information will be provided to SGDRN during 2007.

Study area and study period

The Niassa Reserve, located in northern Mozambique, encompasses an area of approximately 42 000 km^2 with a core area of 22 000 km^2 and a buffer area of 20 000 km^2 that is divided into five management concessions. It is located within the Eastern Miombo Woodland eco-region (WWF 2001). For the purposes of this study, our efforts were concentrated in the south-eastern section of the core area of the reserve along the northern bank of the Lugenda River. The southern bank of this section of the Lugenda River borders portions of both Kambaku (Block B) and Luwire (Block C) hunting concessions.

The specific study area (Fig. 1) incorporates 25 km of the Lugenda River bounded by the Mbamba River in the west, the Msangezi River in the east and extends approximately 10 km inland (northwards) encompassing an area of approximately 250 km^2 in total. Extending between the confluence of the Mbamba and Msangezi rivers the river falls approximately 40 m (from an elevation of approximately 248m asl. at the Mbamba confluence to 207m asl. at the Msangezi confluence). To provide access to the study area an old track originally cut by Mark Jenkins was opened from Mbamba Village to the disused Chipaputa aistrip. This is one of the roads that has been proposed for construction by SGDRN management.

Recent land class mapping indicates the study area falls into the "Lugenda Valley" region (Desmet 2004). The broad scale "vegetation map" produced suggests that the area comprises two riverine classes (rapids and sandbanks) and four terrestrial land classes (plains woodland incised, small and large granite domes and eastern lowland riverine forest and woodland; Desmet

2004). However, ground truthing revealed a more complex situation (Table 1). For our purposes it was also more useful to identify easily recognizable habitats within these land classes that related to specific plant communities and land forms as these had direct relevance to animal and human distributions. With this in mind we therefore identified a mosaic of ten specific habitat types (3 riverine, 5 terrestrial) and 13 vegetation types within these land classes using the guidelines provided by Timberlake *et al*. (2004) and Desmet (2004) and our own observations (Table 1; Plates 2 - 15). As accessibility is a major constraint in the Reserve during the rainy season (December – April), the study was confined to the period May – November 2004. One of the river's most outstanding characteristics, in contrast to its tributary streams, is the fact that it flows throughout the year. The steady base flow, as well as the clear nature of the water, suggests that groundwater sources could be responsible. At the same time, judging from indicators such as flood debris caught in the branches of trees and watermarks on tree trunks, the river level appears to be capable of rising by 4 m or more during high flow periods. River levels were receding throughout the study period and reached their lowest level during the study at the beginning of November. The first light rains occurred in the study area on 11th October with heavier falls, marking the advent of the proper rainy season falling in the last week of November. In response to rains higher up in the catchments of the Lugenda the river level rose and fell over a range of approx.10 cm throughout the month of November. During this period there were also times when the turbidity of the river water increased for a short while.

Overall methods

Throughout this period data were collected both opportunistically through visual observation and conversations with local inhabitants (resource utilization, sightings of key species) and more rigorously through the measurement of fish catches, and daylight and spotlight counts along defined transects (ungulates, crocodiles). Specific methods are detailed in the each section. During the study period Oscar Muemedi (Mecula resident) was trained to measure individual fish catches and collect fisheries information in a systematic manner. In addition, during the peak fishing period (October – November), Dr George Begg assisted in the collection of further information on utilization of the fishery (number of fishing camps, barriers, ovens, fishermen), and undertook a systematic survey of crocodiles.

Fig. 1 The study area (satellite image from http://zulu.sssc.nasa.gov/mrsid)

Table 1: Descriptions of broad habitat and vegetation types found within the study area, modified from Desmet (2004) and Timberlake *et al*. (2004)

Land –classes (Desmet 2004)	Habitat category	Vegetation Type	Vegetation type and description	Main plant species
Riverine land classes				
River Lugenda rapids	Rocky channels	Rocky channels	Rocky channels with numerous small rapids created by rock sills lying across the flow path of river; complex braided channels with localised deep pools (6 –7 m) and thickly vegetated islands. PLATE 2	Island vegetation: *Phragmites mauritianus.* *Syzygium sp.*
River Lugenda sandbanks	Sandy channels	Sandy channels	Slow flowing water with unconsolidated sandy sediments in sandy channels; main channel meanders between north and south bank; shallow backwaters with some blind channels; low unvegetated sandbanks form islands between channels. PLATE 3	Island vegetation: *P. mauritianus.* *Syzygium sp.* Variety of pioneer plants
Not represented	Seasonally dry river beds with isolated pools	Dry river beds	Seasonally dry, sandy riverbeds with isolated pools and a narrow band of riparian thicket and forest. PLATE 4	
Terrestrial land classes				
Eastern lowland river forest and woodland	Riparian open woodland	Albida woodland	Localised areas of open *F. albida* woodland on alluvial soils on Lugenda River floodplain PLATE 5	*Faidherbia albida*
	Riparian thicket & forest	Riparian forest	Narrow bands of dense riparian thicket and forest on alluvial soils; Lugenda river bank and bank of Mbamba, Mpopo, Msangezi rivers PLATE 6	*Sterculia appendiculata* *Kigelia africana* *Syzygium sp.*

Table 1. cont…

Flat, heterogenous, plains woodland	Dry Thicket	Combretum thicket	Extensive patches of dense thicket with *Combretum sp*; sandy soils, interspersed with mixed open woodland and wooded grassland. PLATE 7	*Combretum sp.*
	Wooded grassland / plains	Acacia / palm wooded grassland	Localized patches of Acacia / palm wooded grassland with clay pans; becoming open bare plains at the end of the dry season. PLATE 8 & 9	*Acacia welwitschii* *Hyphaene coriacea*
	Deciduous woodland	Euphorbia / Acacia woodland	Localized patches of Euphorbia /Acacia woodland on cemented soils; interspersed with patches of Acacia / palm wooded grassland and plains; particularly in Mbamba River region. PLATE 10	*Euphorbia cooperii* *Acacia nigrescens*
Undulating, incised, plains woodland	Deciduous woodland	Open dry woodland	Open dry woodland on deeply incised (eroded) colluvial pebble soils; frequently in close proximity to large inselbergs. PLATE 11	*Milletia Stulhmannii?*
Undulating plains woodland with wooded streams	Deciduous woodland	Mixed open woodland	Mixed open woodland with some clay pans and wooded streams; interspersed with patches of Acacia / palm wooded grassland. PLATE 12	*Adansonia digitata* *Sterculia sp,*
	Deciduous woodland	Miombo woodland	Extensive stands of Miombo woodland extending inland; some transition types with mixed woodland. In some areas extends to Lugenda riverbank. PLATE 13	*Brachystegia sp* *Julbernadia sp*
	Bamboo thickets	Bamboo thickets	Dense stands of bamboo thickets, frequently at base of granite inselbergs and along streams PLATE 14	
Large & small granite domes	Inselberg slopes and domes	Inselberg vegetation	Inselberg vegetation consisting of xerophytic plants on granite slopes and domes with more wooded vegetation in gullies. PLATE 15	*Coleochloa setifera* *Aloe mawii* *Myrothamnus flabellifolius*

Plate 2:Rocky channels

Plate 3: Sandy channels

Plate 4: Seasonally dry riverbeds

Plate 5: Riverine *F. albida* woodland

Plate 6: Riverine forest and thicket

Plate 7: Dry *Combretum* thicket

Plate 8: Acacia /palm wooded grassland-early dry

Plate 9: Acacia / palm wooded grassland, late dry

Plate 10: Euphorbia / Acacia woodland

Plate 11: Open dry woodland, colluvial soils

Plate 12: Mixed open woodland with clay pans

Plate 13: Miombo woodland

Plate 14:Bamboo thickets

Plate 15: Inselberg domes and slopes

Section A: Resource Utilization

1. Introduction and Objectives

Our aim was to obtain an insight into the use being made of natural resources such as fish, honey, plants and animals in the study area. It was not our intention to repeat the in-depth utilization studies that have already been done by the WWF community officers and other researchers in villages throughout the Niassa Reserve (e.g. Wiinblad 2003). Rather our aim was to complement these studies with information on resources used by people living seasonally in the fishing camps along the Lugenda River, away from their home villages.

It is important to recognise that no practical distinction can be made between fishermen and traders, and others who are hunters, honey gatherers or craftsmen. All the men living away from their home villages in the study area are engaged in all these activities although either fishing or trading is usually their primary activity. While the information presented is separated into the different resource types for clarity, the resource users are frequently the same. Since fishing was the primary activity in the area, this forms the focus of this section. Bills (2004) identified the need for a ground truthing exercise to count the number of fishermen, canoes, nets, barriers and traps downstream from Mussoma bridge and the collection of fish catch data. Bearing this in mind, we set the following objectives:

a) To establish an estimate of the number of people and fishing camps in the study area
b) To gain a better understand of the dynamics of the fishery
c) To provide detailed descriptions of the fishing methods and type of gear being used
d) To monitor fish catches in a systematic manner
e) To identify any areas of conflict between fishermen and wildlife
f) To identify and examine other plant and animal resources used in the study area
g) To offer preliminary recommendations based on the conclusions drawn.

2. Methods

Emphasis was given to establishing the co-operation and trust of the local hunting and fishing communities operating in the area. To this end, few attempts were made to enforce the law or manage activities although management information was passed on to the warden and SGDRN when it was deemed immediately important to do so (e.g. instances of poisoning, licensing irregularities, snares). In this way we were able to collect information on the use of poisons and animal traps, prices for plant and animal products and the persecution of animals causing conflicts (crocodiles; otters). By regular conversations with the communities we were also able to gain a preliminary understanding of the concerns of the local communities, which would have otherwise been difficult.

Information on the utilization of plant and animal products and the persecution of particular animals (otters, crocodiles, antelope) was collected opportunistically. To obtain a better understanding of honey gathering and fishing activities and to document the activities in detail, several honey gatherers and fishermen were accompanied on their honey collecting and fishing trips. The fishermen cooperated fully and allowed catches to be measured and weighed before processing, photographs to be taken, the mesh size of nets to be measured and fishing licenses to be examined. Many fishermen voluntarily brought their catches to our camp for measurement. Fishermen also provided us with information on poisoning and lead us to animal carcasses found in the area.

All fishing camps within the study area were visited at least once during October and November with two camps (Milola 1 and Nakatopi 1) visited regularly throughout the season. For each camp, the camp name, GPS position and number of ovens were recorded. Where possible the number of canoes, traps and nets owned by each fisherman, the origin (village & province) of the people present, the type of licenses and the names of the local fishermen were also recorded. In addition a number of fishermen were asked to provide information on the average number of nets and traps owned.

Catch data were obtained throughout the season from a variety of fishing techniques. For each fisherman's catch, the length of each individual fish (before staking) was measured (to the

nearest cm) using a measuring board provided by R. Bills. In most cases the entire catch was measured and weighed. It was considered impractical to identify all fish to species level given our inexperience in this regard and given that some species are still being described. Instead local Cyao names of the fish were used, these having been drawn from the field-book provided by R. Bills (2003). As a result some names reflect individual species while others reflect groups of similar species (e.g. all the *Barbus* species are locally known as *Mbojojo*). It was not possible to accurately determine catch effort as fishermen seldom remembered the number of times nets were set during the night, the number of days between checking traps. Data were initially recorded into a notebook. Later, catches were recorded onto fish monitoring forms provided by WWF community officer, Joao Manuel (adapted from the original forms provided by R. Bills and translated into Portuguese). Updated forms are provided as Appendix 3. All data were entered into a Microsoft Access database. A copy of this database will be given to SGDRN to ensure the consistency of future data collection.

Plate 16: O. Muemedi measuring fish at Nacatope 1 fishing camp

3. Results

3.1. Description of resource users

3.1.1. Overview

The people utilizing the study area for resource collection are almost exclusively men and boys. The only women observed were traveling with their families through Niassa Reserve en-route to Tanzania or Cabo del Gado or in a few rare cases the wives of local fishermen camped on the islands with their husbands temporarily.

The majority of people utilizing the study area are from villages within the Niassa Reserve (Mbamba, Nkuti, Mecula, Mussoma, Macalange and Naulala). For the purposes of the report these have been termed "local" resource users. Their predominant activity is fishing and fish trading, however people also visit the area to collect honey (section A3.6.1), plants (section A3.6.2), meat (section A3.6.3.) and to visit ancestral grave sites (section A3.1.2). Since Mbamba village lies in close proximity to the study area (within a day's walk) the majority of people utilizing the area are from Mbamba. However, a significant number of people whose home villages lie in Cabo del Gado and Tanzania outside of the reserve boundaries also utilize the area, primarily for fishing and fish trading. Many of these people travel in the region of 100 km to reach these camps. For the purposes of this report these people have been collectively termed "outsiders".

Aside from fishing, local fishermen also reported that Tanzanian honey gatherers and poachers regularly use the area inland between the Msangezi and Chipaputa rivers during the wet season. In one instance in 2003, Mbamba honey gatherers surprised a Tanzanian group in the Msangezi area; the Tanzanian fled leaving behind 20 kg of maize meal and other belongings. On several occasions we also encountered families walking through the reserve en-route to Tanzania from Cabo del Gado to visit family members and on one occasion encountered two general traders (not fish traders) moving through the reserve on their way back to Tanzania after a season of trading in Cabo del Gado. Much of the movement through the study area, particularly by fishermen and traders, occurs on pedestrian/elephant paths along well-defined routes either on foot or by bicycle.

3.1.2. Cultural sites

Several people visited gravesites during the study period. While these people are not necessarily fishermen or traders they do form part of the regular pedestrian traffic through the study area and they do utilize resources opportunistically. Through our conversations with local people, we understand that the entire study area used to be settled and there were small homesteads all the way along the Lugenda floodplain. Due to colonialism and subsequent wars these people were encouraged to move to Mbamba village or elsewhere. As a result Mbamba village has three traditional chiefs: Chief Ncolange, Chief Namanya and Chief Ngongo. Chief Ngongo spends much of his time fishing on the river (Ntumbula camp) and is well respected by many of the local people utilizing the study area.

Given this history, it is not unexpected that several gravesites are located in the study site. To date we have located four personal gravesites. In addition there is the grave site of Chief Nantusi, which is of particular importance to many people in Mbamba Village since the graves of all ancient chiefs are considered spiritual sites connected with the ancestors (Chonde-Chonde ancestral sites; Wiinblad 2003; Anstey 2004). It is considered respectful to visit this site with a local Chief or elder and make an offering (money, food) at the beginning of a season of work in this area (GPS: 12.18274S / 38.17497E). The four other sites are also graves situated on old homesteads but appear to be visited by family members only. One is a site called Nalikunye, visited by Chief Ngongo's family, another is Likonde near the Msangezi River confluence. At one site near the Lugenda River an old pestle & mortar (*Litule*) stands on the gravesite and family members regularly take small chips of wood from the mortar for special ceremonies.

Two additional sites, one on top of Mantidano inselberg on the bank of the Lugenda River and one at Mapili cave on the Msangezi River are also of cultural interest and may be of future archaeological interest. Mapili cave is currently utilised for shelter both during the wet season (fishermen) and dry season (honey gatherers; Plate 17) and there are signs of an old smelting site below including pottery, slag and the remains of tuyeres (the hollow clay pipes used to direct air into a furnace). This cave appears to have been regularly used over many generations. The site on top of Mantidano Inselberg also has signs of an old smelting site as well as the remains of three stone circles of unknown significance (Plate 18).

Plate 17: Mpili cave on the Msangezi River with evidence of an old smelting site

Plate 18: Smelting site and stone circles on top of Mantidano Inselberg, Lugenda River

3.1.3. Fishing camps

A fishing camp was defined as a base camp situated on the river (away from the villages) where fishermen process their fish on smoking ovens, often sleep and keep their belongings and canoes (Plate 20; Plate 21). All the camps function as cohesive communities with individual smoking ovens, but communal cooking fires and sometimes shelters. Within the large fishing camps, smaller groups of family members or friends may fish together but still use individually owned gill nets or traps. Temporary campsites used during overnight fishing activities (e.g. gill netting) are not called fishing camps, as there are no smoking ovens present. In total 36 fishing camps were identified within the study area along the Lugenda River (Table 2; Fig. 2). Of these, thirty camps were active during the peak fishing period (Oct –Nov), three camps were used only during the wet season and three were old abandoned camps that were not re-used during 2004.

Whilst 11 of the active camps (marked in bold on Table 2) were permanent fishing camps active throughout the dry season with recognised names and stable positions from one year to the next, 19 were satellite camps that were established during the season. Many of the satellite camps were not individually named and for the purposes of this report we named these camps sequentially depending on the nearest permanent camp. For example Nakatope 1 was the permanent camp, and Nakatope 2, 3, & 4 were considered to be satellite camps.

The fishing camps varied in size from 2 – 24 ovens (mean = 8 ovens; Table 2; Fig. 2), with three camps (Grestina 1, Milola 1, Gwimbi 1) supporting more than 16 ovens. The largest of the fishing camps was Grestina 1, which was situated on the south bank of the river and was utilized by mainly Cabo del Gado fishermen. The camp contained at least 24 active ovens and at times more than 38 people (both fishermen and traders) could be found there.

Key to fishing camps

1 = Gwimbi 1	10 = Ndambalale 2	19 = Milola 2	28 = Nacatope 3
2 = Gwimbi 2	11= Ndambalale 3	20 = Milola 1	29 = Nacatope 2
3 = Chiyangwasi	12 = Nsalangwe 3	21 = Grestina 2	30 = Nacatope 4
4 = Mpaleta 3	13 = Nsalangwe 1	22 = Masigulu 1	31 = Nacatope 1
5 = Mpaleta 1	14 = Nsalangwe 2	23 = Masigulu 2	32 = Luambezi
6 = Mpaleta 2	15 = Nsalangwe 4	24 = Grestina 1	33 = Nanyimbu 1
7 = Chipuya	16 = Lititi	25 = Ntumbula 1	34 = Msangezi 1
8 = Licjanje	17 = Mpopo 1	26 = Grestina 3	35 = Nanyimbu 3
9 = Ndambalale 1	18 = Mpopo 2	27 = Ntumbula 2	36 = Nanyimbu 2

Fig. 2: Position and relative size of fishing camps identified in the study area in 2004

Table 2: Characteristics of fishing camps identified within the study area during the 2004 dry season. The number of ovens in each camp provides an index of the maximum number of experienced fishermen using each camp as ovens are individually used. Fishing camps in bold are permanent camps active throughout the season. Numbers in brackets reflect ovens that were not in use during the 2004 dry season. The identification numbers refer to Fig. 2

Id. No.	Name	Season Active[1]	Origin of fishermen	Number. of Ovens	GPS South	GPS East
3	**Chiyangwasi**	**Dry**	**Macalange**	**15**	**12.17983**	**38.10273**
7	Chipuya	Dry	?	8	12.19787	38.11879
21	Grestina 2	Dry	Cabo del Gado	8	12.20256	38.17542
24	**Grestina 1**	**Dry**	**Cabo del Gado**	**24**	**12.20096**	**38.17870**
26	Grestina 3	Dry	Mbamba	5	12.19953	38.18817
2	Gwimbi 2	Dry	Mbamba	2	12.17827	38.09945
1	**Gwimbi 1**	**Dry**	**Mbamba; Macalange**	**15**	**12.18186**	**38.09073**
8	Licjanje	Abandoned	?	(9)	12.19733	38.12000
16	Lititi	Dry	Mecula	14	12.20718	38.15104
32	Luambezi	Dry	Mecula	5	12.18451	38.22775
22	**Masigulu 1**	**Abandoned**	**Mbamba**	**(10)**	**12.19616**	**38.17590**
23	Masigulu 2	Dry	Cabo del Gado	5	12.19809	38.17762
20	**Milola 1**	**Dry**	**Mbamba, Macalange**	**20**	**12.19227**	**38.16390**
19	Milola 2	Dry	Mbamba	8	12.19423	38.16202
5	**Mpaleta 1**	**Dry**	**Mbamba**	**10**	**12.18802**	**38.11530**
6	**Mpaleta 2**	Dry	Mbamba	1	12.18551	38.10892
4	Mpaleta 3	Dry	Mbamba	3	12.19152	38.11085
17	**Mpopo 1**	**Dry**	**Mbamba**	**3**	**12.19520**	**38.15138**
18	Mpopo 2	Abandoned	Mbamba	(4)	12.19344	38.15727
34	Msangezi 1	Wet	Mbamba	(5)	12.16990	38.24291
31	**Nacatope 1**	**Dry**	**Mbamba**	**12**	**12.19647**	**38.20308**
29	Nacatope 2	Dry	Mbamba	5	12.19793	38.19670
28	Nacatope 3	Dry	Mbamba	9	12.19869	38.19504
30	Nacatope 4	Dry	Mbamba, Tanzania	4	12.19373	38.19918
33	Nanyimbu 1	Wet	Mbamba	(5)	12.17340	38.24234
36	Nanyimbu 2	Wet	Cabo Del Gado	(6)	12.17250	38.24455
35	Nanyimbu 3	Dry	**Mecula**	2	12.17216	38.24304
9	**Ndambalale 1**	**Dry**	**Mbamba**	**8**	**12.20447**	**38.12727**
10	**Ndambalale 2**	**Dry**	**Mecula, Nkuti**	**9**	**12.20510**	**38.12777**
11	Ndambalale 3	Dry	Mbamba	7	12.21161	38.13108
13	Nsalangwe 1	Dry	Mecula, Nkuti	13	12.21319	38.13675
14	Nsalangwe 2	Dry	Mecula, Nkuti	12	12.20989	38.13691
12	Nsalangwe 3	Dry	Mecula, Nkuti	8	12.20796	38.13577
15	Nsalangwe 4	Dry	Mecula, Nkuti	12	12.21188	38.13897
25	**Ntumbula 1**	**Dry**	**Mbamba**	**6**	**12.19461**	**38.18341**
27	Ntumbula 2	Dry	Mbamba	2	12.19359	38.19090

[1] Dry = Camps used during the dry season: Apr - Dec ; Wet = Camps only used during the wet season: Jan – Mar; Abandoned = old dry season camps not used in 2004. Masigulu 1 was abandoned in 2002 due to difficulties of access and problems with elephants.

[2] Nkatope 4 was primarily a Tanzanian traders camp

Fishing camp sites appear to be chosen primarily for proximity to prime fishing sites, ease of access and safety (from elephants and lions). Masigulu 1 was abandoned in 2002 due to difficulties for access from traders and problems with elephants. The fishermen appear to have relocated to either Milola 1 or Ntumbula 1. The majority of fishing camps were located within areas dominated by rocky channel habitats. The grade of the river becomes steeper downstream of Chingwasi and alters most rapidly between the fishing camps known as Ndambalale 1 and Nacatope 1 (Fig. 2). At Ndambalale there is a massive intrusion of granite that lies at right angles to the river. This not only creates a large, deep pool behind it but also forces the river to break into numerous separate flow paths or breakaway channels. The net result, downstream, is the development of a complex array of braided rocky channels, rapids and islands (Fig. 1; Plate 19). Directly above Mantidano and below Nacatope 1 the grade of the river is flatter, the water velocity is lower and the main channel of the Lugenda River meanders repeatedly from the north bank to the south bank, and back again, through extensive deposits of sand.

For management it is significant that the majority of camps (86 %) are on islands and, at least early in the season, most are difficult to reach without the aid of a canoe. In addition, many of the camps are built beneath trees and as a result would be difficult, if not impossible, to see from the air e.g. Milola 1, Grestina 1. The braided river channels between the fishing camps Ndambalale 1 and Nakatopi 1 (Plate 19) would be particularly difficult to census from the air as they are extremely complex and many of the islands are heavily vegetated. An aerial survey of the fishing camps completed by Bills (2004) from a Cessna flown at 200ft above the ground in August 2003 identified only five fishing camps in the study area.

Plate 19: Braided channels in the Lugenda River

Plate 20: Nakatopi 2 fishing camp in rocky channel habitat on the Lugenda river

Plate 21: Milola 1 fishing camp on a vegetated island in the rocky channels of the Lugenda River at the beginning of the season

3.1.4. Origin of the fishermen and traders

The majority of fishing camps are used by local fishermen (n = 25 camps; 83%; Table 2) with three fishing camps utilized predominantly by Cabo del Gado fishermen (10%; Grestina 1 & 2, and Nanyimbu 2) and one camp with a several Tanzanian traders (Nakatope 4).

Individuals at a fishing camp are generally from the same or nearby villages with little mixing between Niassa Reserve & Cabo del Gado fishermen. However in a few cases an "outsider" was a close relative to a Mbamba fishermen and based at the camp of his relatives rather than a Cabo del Gado camp. Analysis of a sample of fishermen utilizing the study area (n = 218; Appendix 1) shows that majority of fishermen are from villages within Niassa Reserve (76 %) mainly Mbamba village, with 23 % from Cabo del Gado (Fig. 3) and only 1 % from Tanzania. However, it is likely that the numbers of Tanzanian people actually fishing in the study area have been underestimated as they are reluctant to provide their names and frequently avoid contact. The home villages of the Cabo del Gado fishermen include Lizongole, Malaranje, Monpe, Montepuez, Balama, Xixano and Toma villages. Traders are exclusively "outsiders" in the area for short periods (2-3 weeks), primarily from villages in southern Tanzania from the Masasi (via

Gomba; 183 km) and Tunduru districts (via Nyati; 143 km) although several traders from Cabo del Gado were also working in the study area.

3.1.5. Numbers of fishermen and traders

Since only one fisherman generally uses each smoking oven, the number of smoking ovens in a fishing camp provides a fairly reliable index of the number of serious fishermen using a camp with one notable exception: Matakiwa (Ndambalale 1) is a full time fisherman who seldom returns to Mbamba and utilizes multiple ovens (4-5) and a variety of techniques to catch and process his substantial catch. Using the number of ovens as an index (and taking Matakiwa's ovens into account), we estimate that a minimum of 250 fishermen (10 fishermen / km of river) were utilizing the 30 active camps in the study area during the peak fishing period (Oct – Nov; Table 2). This does not include the young boys and teenagers who were present as helpers in several of the camps (approx. 20-30). While these children do not have their own drying ovens, many do fish independently (section A3.3.6).

Fig. 3 Origin of fishermen (N = 218) fishing in the study area during the dry season of 2004

A provisional list of the names of fishermen (N = 218) utilizing the study area, the camps they use, their home villages and predominant fishing method are presented in Appendix 1. This list will be added to in 2005. For management purposes an additional list of 14 local particularly influential fishermen using this portion of the Lugenda River and the camps they represent is presented in Appendix 2.

Significant numbers of traders were also based at these fishing camps for short periods (2-3 weeks at a time) throughout the season. While it was difficult to obtain an accurate estimate of the numbers of traders moving through the area since there is a constant turnover of new traders, we estimate that a minimum of 50 traders worked on the river at any one time during the peak season. This was determined by subtracting the known number of active fishermen and their children on the islands in October-November from the total number of people counted in each camp. In total at least 330-350 people lived on this 25 km stretch of river during October to November 2004 (14 people / km).

3.1.6. Monthly and annual changes in numbers of fishermen and fishing camps

The number of active fishing camps did not remain constant but tended to increase during the season through the development of satellite camps, and reached a peak in late October. In May/June only the 11 permanent camps were active, yet by peak season this had increased to 30 active camps. Satellite camps appear to have been established either because of an influx of new fishermen into the area and established camps were already full or because fishing declined in an area and some fishermen moved from one camp to another site. An example of the later case is Grestina 3, which was established when fish catches declined at Nakatopi 1. Preliminary data also suggests that the number of fishermen in the camps increased during the season with Milola 1 in particular showing a ten-fold increase in the number of ovens (Table 3) and similar increases in the number of gill nets and traps being deployed.

Table 3: Increase in the number of ovens in four fishing camps during the 2004 dry season

Fishing Camp	Number of ovens		
	Jun / Jul	Aug / Sept	Oct / Nov
Milola 1	2	14	20
Nakatopi 1	2	5	12
Ndambalale 2	4	9	9
Grestina 1	?	8	24

Some of the permanent camps appear to have been in use by fishermen for many years. Several fishermen (50 – 60 year olds) using the *Milola* fishing camp came to fish at this same camp with their fathers when they were children; *Grestina 1* camp appears to have been named by the crocodile hunter that was based near this camp in the early 1960's. More recent graffiti (name & dates) carved into trees at some of the camps indicated that the camps had been in use during the war period (1980s).

Since only one season of data has been collected it is, at this stage, impossible to determine whether the number of people utilizing the river is actually increasing and if so, at what rate. The only historical data available is from Tello & Dutton (1979), who completed an aerial survey of the Lugenda River by helicopter in 1977. This early report clearly illustrates that this particular area (Mbamba to Msangezi confluence) has always been a high intensity fishing area. The maps from this report identified only two fishing camps in the study area (with seven canoes, five barriers) but this data should not necessarily be treated as proof that fishing activities have increased, as fishing camps are easy to miss from the air.

However, it is both our perception and the perception of many local fishermen that the number of people in the study area increased markedly between 2003 and 2004. Anecdotal data from Milola 1 supports this: in September 2003 only five ovens were active but this had increased to 20 ovens by September 2004.

Conversations with fishermen at Milola suggest that several factors may have driven the increase:

a) The influential elder of Milola 1, Sandali Ibu is a traditional healer and popular personality who attracts people to his camp.
b) Some fishermen translocated to Milola after abandoning Masigulu 1.
c) There has been a general influx of fishermen from other villages i.e. Macalange and Mecula to the Lugenda River.
d) Many fishermen believe the Rovuma River fishery has either collapsed or is too competitive due to the substantial pressure from the Tanzanian north bank. As a result more and more people from inside and outside the reserve are arriving to fish on the Lugenda River. There is currently no data to determine if this is true.
e) There has been a general increase in the number of people fishing for a living as it provides one of the only means of significant income generation (Section A3.2.2) in Niassa Reserve.

3.2. Dynamics of the fishery

3.2.1. Fish processing

Fresh fish are gutted by making a small lateral incision across the belly and squeezing out the contents of the abdominal cavity. These gut contents are then boiled to produce oil. The gutted fish are skewered on a bamboo stake (to prevent them falling apart when dry) and placed, in rows, on a smoking rack and covered by palm leaves (Plate 22). A fire is lit below the rack and the fish are smoked until dry (typically 2 - 3 days). Small fish are air dried on rocks in the sun (Plate 23) or suspended from a rope in camp. The smoked fish are then packed into large baskets (K*angara*) for transportation and sale.

3.2.2. Trading & the value of fish products

The system of trading and selling the fish is complex. The fishermen either sell or barter processed fish directly to traders at the fishing camps or transport the fish themselves to markets for direct sale to consumers. The preferred fish for trading are the medium sized mud suckers (*Nyingu* and *Nchali*; *Labeo sp*.) and medium sized bream (*Likwale)* with the "by catch" generally eaten or smoked and sold by the fishermen themselves. At present the preferred fish are also the most common fish caught (Section A3.4.1).

Plate 22: Fish smoking on an oven at a fishing camp on the Lugenda River

Plate 23: Small fish being sun-dried on a rock

Some local fishermen prefer to transport their smoked fish on bicycles to Tanzania themselves where they can sell it for cash (Tanzanian shillings). While they do not necessarily get better prices in Tanzania per fish, a wider variety of goods can be bought with the proceeds. At the fishing camps each medium sized fish (smoked or fresh) regardless of type is sold for Mt 5 000 ($ 0.25) and two small fish are sold for Mt 2 000 or the equivalent in goods to traders who visit the camps specifically to trade in fish (Table 4). The same smoked fish are sold for Mt 7 000 - Mt 10 000 in the markets in the bigger villages such as Mecula.

Table 4: A sample of the types of goods traded for fish on the Lugenda River and their average prices, where 1 fish is worth Mt 5 000. These prices are approximate as some negotiation takes place.

Item	Price	
	Fish	Metacais
Radios	450	1 700 000 - 2 250 000
Bicycles	350 - 400	1 700 000 - 2 000 000
Blankets	150	750 000
Chingundenje net	140	700 000
Panga / Machete	50	250 000
Nets (50m)	30 - 40	150 000 - 200 000
Pots	25	125 000
Sugar (1 kg)	20	100 000
Capalana	20	100 000
Palm rope (made locally)	15	75 000
Cups	10	50 000
Plastic bowls	10	50 000
Torches	10	50 000
Maizemeal (1 kg)	10	50 000
1 guineafowl (snared locally)	5	25 000
Biscuits (1 small packet)	1	5 000

In the fishing camps fish is usually bartered rather than sold for cash. While many of the goods offered can be considered essentials (salt, oil, sugar, maize-meal, nets, batteries, pots) some of the goods are luxuries (radios, jewellery, gin), which suggests that the fishery is more than simply a subsistence fishery (Table 3). The prices offered by the traders are highly inflated. For example, the traders price for 1 kg of sugar is 20 fish, the equivalent of Mt 100 000, this same sugar is sold in Mecula for Mt 20 000 and in Cuamba for Mt 15 000. The traders price for a poor quality bicycle is 350 fish, the equivalent of Mt 1750 000, yet a good quality bicycle can be bought in Cuamba for Mt 1 350 000. The willingness of the fishermen to pay these prices reflects both their isolation and lack of knowledge of how much goods should cost and their lack of alternatives. Many of the goods offered by the traders are not available in the more isolated villages such as Mbamba and Nkuti village, and Mecula is a long distance to travel.

Since fishermen sell much of their catch at the fishing camps and there are several pedestrian paths out of the fishing camps, it is difficult to accurately determine how many baskets of fish leave the study area. However, six fishermen estimated their catch in the 2004 dry season as follows:

a) Sandali Ibu (mainly traps): 6 baskets in total; 1 sold in local villages (Mbamba) + 2 transported on bicycle to Tanzania + estimated 3 sold to traders.
b) Mario Sandali (gill nets & traps): 4 baskets in total; 2 sold in Mbamba + estimated 2 sold to traders.
c) Maderu Selemani (gill nets): 1 basket in total sold to traders.
d) Laini Selemani (traps): 2 baskets in total sold to traders.
e) Matakiwa (traps & gill nets): at least 10 baskets in total.
f) Carlos Augosto (gill nets): 7 baskets in total; 1 sold in village + 6 sold to traders.

If we conservatively estimate that each fishermen fills only two large baskets of fish during the dry season (average 35-50 kg dry weight) this amounts to at least 18 - 25 tons of dried fish (250 fishermen x (2 x 35 kg) or an estimated 35 –50 tons of fresh fish leaving the study area in the 2004 dry season and a seasonal income of US$ 175 / fisherman.

A minimum value for this fish can be estimated (1 US$ = Mt 20 000):

1 fish	**=**	**US$**	**0.25**
1 basket (350 fish)	**=**	**US$**	**87.50**
2 baskets	**=**	**US$**	**175.00**
500 baskets (250 fishermen)	**=**	**US$**	**43 750.00**

Of course the fishermen seldom sell their fish for cash, but rather earn the equivalent in goods.

Using a participatory interview technique, Wiinblad (2003) showed that a typical Niassa community considered "people with good opportunities" (the highest socioeconomic group identified by the community) to be those people with means and power, an improved house, bicycle, radio and a lot of food and a yearly cash income of US $80 –200. By this definition many of the fishermen in the study area are considered to be in the highest socio economic group. Given that the annual income of local people in Chipanje Chetu living in similar conditions on the eastern side of the Reserve has also been estimated as only US$37 per head (Anstey 2004), it is obvious that fishing provides an important form of income generation and a source of goods for Niassa inhabitants. Many of the local people consider fishing the only way they can obtain significant amount of cash and secure the goods they want and need. To put this all in perspective, the average monthly salary of a game scout working in Niassa Reserve (one of the few formal work opportunities available) is Mt 800 000 – Mt 900 000 or US$ 40 - 45 plus food rations. This amounts to an annual salary of $ 480- 540 which is equivalent to 5 - 6 baskets of fish.

Both fishermen and traders prefer to trade at the fishing camps rather than in the villages, largely because of a perceived increased in productivity. The traders frequently assist the fishermen with processing the fish, collecting firewood and cooking the meals. This allows the fishermen to spend more time fishing, which increases their productivity. In addition they do not need to transport their fish to market themselves and can buy food supplies *in situ*, which allows them to spend longer fishing between trips to their village. The traders benefit by the increased productivity of the fishermen as they can fill their baskets quicker and can therefore make more trips back and forth within a single season.

3.2.3. Transport

At present the single most important factor limiting the amount of fishing in the study area is transport. Only a single large basket of fish (35-50 kg) can be transported out of the study area on the back of a bicycle at a time (Plate 1; Cover plate). Both traders and fishermen therefore have to leave the fishing camps when the basket is full to transport it to market. In addition, only a single basket of food supplies (maize-meal, salt) and trading goods can be brought into the fishing camps in one trip and this also constrains the amount of time a fisherman and traders can subsist at the camp away from the village. There is therefore a constant flow of traffic through the study area in and out of the fishing camps. The amount of time a fisherman or trader takes to complete the round trip to his destination village and back obviously depends on the distances travelled. A Mbamba fishermen or trader transporting a basket of fish for sale in Tanzania or Cabo del Gado might be away for 2 - 3 weeks (300 – 400 km round trip) while a Mbamba fishermen transporting a basket of fish home to Mbamba will only take two days to get there and back. Cabo del Gado traders from Toma and Xixano take 3 days to return to their home villages on foot and 1 day on a bicycle. This may be different in areas where there is access to a road and regular car traffic such as Mussoma.

3.2.4. Licensing and law enforcement

Since we do not have a clear understanding of Mozambican law, this section should be viewed as preliminary information based on our on-the-ground observations of how the system is working in the study area. As we understand it, at present all fishermen are required by Mozambican national law to buy a license to fish and a separate license to transport the fish. These licenses can be purchased from Agricultura offices in any district capital (Mecula, Montepuez, Marrupa etc.). By law, any person who comes from a district that includes a portion of the Lugenda riparian zone is entitled to fish in the Niassa Reserve (B. Chande pers. com.), even if the home village of the fisherman lies well outside the Niassa Reserve boundaries. This means that "outsiders" are legally entitled to come into the reserve to fish provided they buy a license and there are currently no specific regulations attached to fishing in a protected area. While the fishermen were all aware that a license was required to fish, the licensing system is, at this stage, difficult to enforce, provides little monitoring information and many fishermen do not possess licenses (particularly early in the season). At present any law enforcement or monitoring that does take place is conducted by reserve scouts or hunting concession scouts not Agricultura

itself. We observed several incidents during 2004 that highlight the difficulties in enforcing licensing rules:

- The scouts are not aware of all the fishing camps and tend to only visit those well established camps that can easily be reached from the main bank without a canoe. As a result many fishing camps were never visited during the 2004 season.
- The fishermen were often aware of scout patrols into the study area at least 48 hrs before they arrived and many fishermen and traders without licenses simply hid from the patrol.
- During a particular patrol, several fishermen were fined for not having a license and asked to pay the fine of 50 fish (Mt 250 000) immediately. However, since this fish went directly to the individual scouts not the reserve this was resented by the fishermen. A lack of understanding of how to deal with fishermen without licenses lead to abuse of the system from both sides.
- There was no clear understanding by either the fishermen or scouts as to what the penalty was for not having a license. In addition, the concession holders and core area of the reserve have differing policies with regards to the fishermen and zonation. Fishermen on the Lugenda River therefore have to remember different rules for the north and south bank of the river. This caused confusion throughout the season.
- In 2004 attempts to dismantle several camps due to irregularities had little effect as within 48 hrs these camps were operating again as normal.
- In October a no-fishing zone was declared north of the Luambezi River. Yet, Kambaku camp then gave three local fishermen from Mbamba village special permission to fish in this area. This lead to resentment amongst other fishermen.
- Many fishermen ignored the ban on fishing in the area downstream of the Luambezi by fishing at night and returning in the early morning to established camps within the accepted fishing zone.

There also appear to be a number of problems and inconsistencies specifically related to the current licensing system:

- There are different license formats in different districts. The licenses allow as many as ten fishermen to be named on a single license. The number of licenses issued therefore does not reflect the actual number of fishermen permitted to fish in a given zone.

- Licenses are available throughout the year and are available for varying amounts of time (1 month, 3 months, 6 months). It is therefore impossible to determine how many people have licenses at any one time in any one zone
- The licenses are issued in a variety of places for the same fishing sites i.e. both Montepuez and Mecula issue licenses for the study site. There is no way of knowing how many licenses have been issued.
- Each license requires the fisherman to identify the zone he will be fishing in, but there is no consensus on the zones and their boundaries. Does this mean the fishing camp or the area where he will actually fish? Some fishermen have permission to fish the entire river.
- Some licenses do not provide any limits on the amount or type of fishing gear used.
- The price of the official license varied erratically. On one occasion a fisherman bought a license for Mt 25 000 per person, one month later the price had changed to Mt 65 000 for 5 people.
- A variety of different types of licenses were produced by the fishermen when asked ranging from handwritten licenses to the various official licenses issued by the various Agricultura district offices (Plate 24).
- The majority of fishermen cannot read or write and have no idea what an official license should look like and what it must stipulate.
- The licenses are on flimsy pieces of paper, they get wet and are often impossible to read.
- The license format means fishermen simply add their own names to the piece of paper or alter information.
- Many Mbamba fishermen do not have the correct identification papers and are reluctant to go to Mecula to buy a license because of the possibility of being stopped by the police. In addition for Mbamba fishermen (which make up the bulk of the people fishing on the river) the Agricultura office lies in Mecula, 40 km by pedestrian path (via Nkuti) and 70 km by road.
- License serial numbers issued by Agriculture often do not correspond with the date of issue.

Plate 24: Official license from Agricultura, Mecula

Plate 25: Many of the licenses get wet and are unreadable

3.2.5. Concerns and problems experienced by the fishermen

During conversations the fishermen highlighted a number of problems and concerns:

- Local fishermen are concerned about the increase in the number of "outsiders" arriving to fish (outsider traders are welcomed) on the Lugenda as they feel the fish stocks will decline. They have heard that fishing is no longer profitable on the Rovuma River.
- There is a general perception that the size of some fish e.g. Campango and Vundu has already decreased.
- During October /November many fishermen suffered from waterborne diseases, particularly diarrhoea /dysentery due to declining water quality around the fishing camps as the river levels dropped and density of fishermen reached a peak.
- Local fishermen were concerned about fish poisoning particularly the use of "Ntofilo"(section A3.3.8).
- There was general confusion about what they were allowed to do and where they were allowed to fish. Some resentment was also noted when they were not consulted when decisions were made about no-fishing zones.

3.3. Fishing methods

Nine different fishing methods were identified, each using a different type of equipment and each being designed to exploit a different niche and/or different spectrum of fish species. Trap fishing and gill netting were the most common fishing methods. In general, the older fishermen used trapping and rod and line, while younger fishermen predominantly did the more labour intensive gill netting. Chingombo net fishing was exclusively the preserve of young children and teenagers. Many fishermen used a variety of different techniques depending on local conditions. There did not appear to be any ownership of fishing sites either by individuals or specific fishing camps. While small groups of fishermen might fish in the same area by choice, fishing gear and the resulting catch were generally individually owned. The only exceptions were fish caught by Chigundenje netting where more than 3-4 people were needed to pull the net and the catch was shared, although the net was still individually owned. Every day each fisherman contributed some fresh fish for the communal cooking pot but the remains of the catches were placed on individual smoking ovens. The only other time we observed catches being shared was when

fishing was being done to provide food for a specific ceremony (funeral) to be held in the village. The nine techniques are described in more detail below.

3.3.1. Fish trapping

A significant proportion of the fish being caught in the study area are caught by unbaited, standard conical shaped valve traps (*nsangulo; nasa*) made locally from bamboo. The traps are placed upstream of barriers (*lipata*) that were built across the river using rocks, tree trunks, the branches of trees, sticks and palm leaves (Plate 26). By creating one or more gaps in the barrier, outflow points are formed and immediately above each of these a valve trap is positioned and weighed down with a rock. The force of the out-flowing water also helps hold the trap in position. Fish moving upstream are forced to use the outflow as the only means of circumventing the barrier. Natural barriers to water flow such as rock sills and/or rapids are generally chosen as sites for barrier construction. The barriers are built wherever gaps occur in the rapids and because these gaps also serve as the major flow paths for water, the barriers need to be substantial enough to both resist the flow and impound the water upstream. Towards this end palm leaves and grass are used to impede water flow and physically dam the river above. The majority of barriers fall apart after a few weeks however a few barriers are substantial and supported by conical shaped rock gabions strapped together with bamboo (Plate 27). Barriers are abandoned and new ones constructed throughout the season in response to changes in the river course and level.

Traps are individually owned with each fisherman owning an average of three traps (range = 1 - 6; n = 28). Barriers located within the study area ranged in length from 1 - 90 m, with 93 barriers, amounting to a total length of 2158 m, constructed within the study site during the dry season of 2004. The barriers were confined almost entirely to rocky channel habitats.

3.3.2. Insevila trap fishing

Insevila fishing is an effective traditional form of trap fishing specifically designed to catch the large numbers of small (juvenile) fish that move into the back channels of the Lugenda River at night. During the day a pair of barriers made from sticks, grass and sand are built across shallow sandy channels of the river, one upstream of the other (Plate 28). When closed off at night these barriers effectively prevent the escape of any fish in the confined area. A small, fine mesh valve trap, different in mesh size to the more common valve trap used, is then placed in the

downstream barrier and the gap serves as the only means of escape for the fish when they move out of the channel the following day. The movement of the fish is thought to be induced by the need by the fish to avoid predators (such as kingfishers) during daylight hours. Occasionally, the downstream barrier tends to impound water in the back channel. This means that once the water level starts to drop after insertion of the trap, the out-flowing water is sufficient to induce a mass movement of fish downstream.

The catch, which often includes freshwater prawns, is emptied from the trap into a depression made in the sand or into natural potholes (Plate 29). Since the catch is comprised essentially of juvenile fish, it is left un-gutted and is sun-dried on rocks. Insevila fishing is the only fishing method confined to the sandy channel habitats. In the study area 49 insevila barriers containing 19 traps were identified. The total length of the barriers constructed amounted to 1132 m. Insevila fishing is most common in the later part of the fishing season (September – November) when water levels are low.

3.3.3. Rod and line

Rod and line fishing is used to catch specific species such as campango, barbel and vundu which, being whiskered species, are generally able to avoid being caught in gill nets. A short piece of heavy gauge nylon, seldom longer than 3m, is fixed to a bamboo rod. Mormyrid fishes (e.g. bottlenose) and burrowing crickets (*jalemba;* Subfamily: Maxentius) are commonly used as bait and attached to a large hook. In the fishing camps young children also use rod and line to catch species such as *Ngalala* (imberi; *Brycinus imberi*) for food.

3.3.4. Static lines

On occasion, static lines with baited hooks are also used to catch fish such as Campango and barbel. The static lines are attached to stakes that are left permanently embedded in the floor of deep pools and, with the aid of a canoe, are checked every morning.

Plate 26: Typical valve trap barrier (lipata) and standard valve traps

Plate 27: Substantial trap barrier with rock gabions (©GW Begg)

Plate 28: Insevila barrier and traps ready for setting

Plate 29: Catch from insevila trap comprising juvenile fish that are then sun-dried

3.3.5. Gill netting

Gill nets (*jalife*) are used extensively throughout the study area as a non-traditional means of catching fish. Both monofilament and two-ply nets are used. These are made in China and purchased in Tanzania, Pemba and Mecula or from traders. The mesh size varies from 25 – 75 mm (No. 1 = 25 mm; No. 2 = 50 mm; No. 2.5 = 62.5mm; No. 3 = 75 mm) stretched mesh. From a sample of 57 fishermen, nets of mesh size 2.5 (74 %) and 2 (19 %) are the most common and are usually the only size that can be bought in Mecula. Fishermen may own a variety of different sized gill nets. Nets are 45 m long (when new) and vary in height from 1.5 – 2.5 m. A head rope woven from palm leaves and floats made from reeds, bamboo or a light buoyant timber are fixed to each net. A bottom line, also made from woven palm fronds, is fixed to each net and weighted by stones tied on with bark or palm leaves.

Unlike gill netting in other areas where gill nets are set at night and only checked the next morning, gill net fishermen in Niassa regularly check and reset their nets during the night. Gill nets are set at dusk from a dugout canoe and are generally left in place for 1 – 2 hours (Plate 30). Throughout this period the nets are kept under close scrutiny to prevent crocodiles from stealing fish and damaging the nets. Battery operated torches or, in some cases, flares made from bamboo tied to the prow of a canoe, are used for illumination. On some occasions, fishermen actively drive fish into gill nets by using a wooden bell shaped "chibonga" that is plunged into the water as the fisherman paddles his canoe in the general vicinity of the net line. At the end of each period the nets are lifted and brought to shore, the fish removed and the nets cleaned of debris such as leaves and sticks. The nets are then re-set in a different location. The process is repeated 3 - 4 times a night, but the fishermen generally take a break at midnight in order to cook a meal and gut any fish caught by that time (Plate 31). Full moon periods are considered unproductive periods in which to fish. Gill net repairs are undertaken by tying the damaged mesh either with bits of plastic obtained by shredding sacks, with small strips of palm leaves or the fibres derived from the bark of baobab trees.

At present, gill nets are an expensive item of equipment for local fishermen to buy (Mt 45 000 – Mt 50 000) and are therefore highly valued. As a result fishermen expend an unusual amount of time and energy checking and reseting the nets during the night in an effort to reduce crocodile damage and remove debris. This labour intensive technique should be encouraged, as it appears to limit the number of crocodiles caught in the gill nets. There is a danger that as fishermen

become more prosperous and competition increases, they might switch to the more damaging (for crocodiles) technique of leaving their nets in overnight as is practiced elsewhere in Africa (Kosi Bay, South Africa, Kyle 1999; Lake Kariba, Zimbabwe, McGregor in press; Okavango, Botswana, A. Leslie pers. com).

On average, each gill net fisherman owns four nets (n = 124; range: 1 - 12). It is currently impossible to accurately determine the number of gill nets in use in the study area due to the ineffective licensing system and dynamic nature of the fishery. However, if we assume that at least 50 % of the fishermen on the river are using gill nets (the ratio of gill net to trap fishermen at Milola 1 = 50 %, n = 28) then at least 500 gill nets could potentially be in use during the peak fishing season (125 gill net fishermen with a mean of four nets /fisherman). This amounts to 22.5 km of netting in 23 km stretch of river although obviously not all nets are in use at the same time.

3.3.6. Chingundenje fishing

Chingundenje fishing is similar to seine netting and is done during the day. It involves the use of a 37 mm monofilament mesh, deep (2.5m) drop gill net fitted with a float line and weighted bottom line and the combined activities of a team of fishermen who actively flush the fish from their hiding places by swimming and diving while gradually pulling the net closed. The net is set in deep, rocky channels and pools in such a manner as to enclose whatever fish may be present in the area. By diving under water and flushing the fish from their hiding places the fishermen gradually purse the net and, as it closes, the fish within the net are either gilled or become entangled in the folds of the net as it is removed. Chingundenje fishing is not dissimilar to chingombo fishing (see below) except that it is on a much larger scale and involves a team of four or five fishermen. One of the disadvantages of chingundenje fishing is that large crocodiles frequent the sites where this form of fishing is practiced. Consequently, fishermen are more at risk of being attacked by crocodiles using this technique than any other (Section A3.5). Chingundenje fishing was primarily utilized at the end of the season, and became increasingly common during Oct - Nov.

Plate 30: Fishermen setting gill nets in rocky channel habitat

Plate 31: Typical catch from a gill net

Plate 32: Teenager fishing with Chingombo net

Plate 33: Fisherman fishing with a throw net

3.3.7. Chingombo fishing

Chingombo fishing has been devised by the local community as a way of catching fish that are known to seek shelter beneath rocks and fallen trees. It is an active daytime fishing technique generally practiced by young children / teenagers who utilize scraps of discarded gill nets to catch fish in shallow back channel environments. A small (40cm x 20cm) panel of gill net (various mesh sizes) is attached to two pieces of bamboo and staked in the channel immediately downstream of a site, such as a rock, where fish (mainly mud-suckers) are considered to be hiding (Plate 32). By diving underwater the fish are flushed from their hiding places and, as the fish invariably move downstream in their effort to escape, they are then caught in the net. A small float attached to the net provides an indication of where the nets are and when fish are caught. The fish that become entangled in the net are immediately removed. On average each fishermen has six devices (range 3 - 10; n = 22). The fishermen are selective, with the mudsuckers (*Nyingu, Nchali; Ukangala*) and bream (*Likwale)* comprising the favoured catch while squeakers and small bream are frequently released.

3.3.8. Throw netting

Only two of the fishermen in the study area used conventional throw nets purchased from Tanzania (Plate 33) It is considered a highly technical method and is mainly used by fishermen from Tanzania. Given the nature of the river (deep, clear and rocky) and the predominance of non-shoaling fish species, this technique is unlikely to be particularly successful and is unlikely to become a very common fishing technique in the future.

3.3.9. Poisoning

In late 2003 we observed Euphorbia being used to poison fish in pools along the Nkuti River (Lugenda River tributary; Begg & Begg 2004b). However, no incidents of this type of poisoning were observed in 2004. All fishermen were aware that poisoning is illegal. In September reports were received from Kambaku hunting camp of a possible poisoning incident (buffalo). While we did not examine the carcasses at the time, we have since seen photographs and video footage of the carcasses (S. Veiga pers. com.). Given the number of animals killed in a small area and their strange body positions (necks outstretched), it is our opinion that these animals were poisoned. Unfortunately no water samples or tissue samples were taken at the time and this cannot be confirmed. At the request of SGDRN, we asked local fishermen about the incident. They were

adamant that the poisoning incidents were primarily the work of "outsiders" particularly fishermen coming in from Cabo del Gado or Tanzania for a short period. The fishermen from Nakatopi 1 fishing camp volunteered the information that a poison called "Ntofilo"was being bought from the cotton farmers in the Montepuez area and used in the Niassa Reserve to poison fish in pools. Local fishermen were scared of this poison as drinking the water or eating the fish made them very sick. A vial of possible poison was found at one of the fishing camps and delivered to us by the Warden for analysis. We sent the vial to the Poison Working Group of the Endangered Wildlife Trust (Johannesburg) for analysis and it tested positive for Endofuran, a common pesticide used on a variety of crops and deadly to fish (the analysis report from the Toxicology Department of Onderstepoort has been lodged with SGDRN).

3.4. Fish catches

3.4.1. Catch composition

During the study period, 203 individual catches from seven different fishing methods (Fig. 4) were measured, representing 11 386 fish and 17 fish types. Overall 90 % of the fish catch was made up of only four species (Fig.5); two species of mudsuckers locally known as *Nchali* (rednosed mudsucker; 27 %) and *Nyingu* (leaden mudsucker; 44 %) and two species of bream known collectively as *Likwale* (Rovuma bream and red breast bream; 19 %). Comparison of the different fishing techniques showed that *Nyingu* was the most common fish caught using all techniques except Insevila traps (Table 5). Insevila traps were the only fishing technique to catch *Chilembanazi* (silver barbel) and *Chilenje* (northern Churchill). Given the predominance of the mudsuckers and bream in the catches, the number of species caught by the different techniques (species selectivity) is more a reflection of the number of catches measured than any feature of the fishing technique itself. Thus the low species selectivity for the throw net is not necessarily a reflection of the technique but is primarily a consequence of only one catch being measured. More data are needed before differences in the catch selectivity of different fishing methods can be explored.

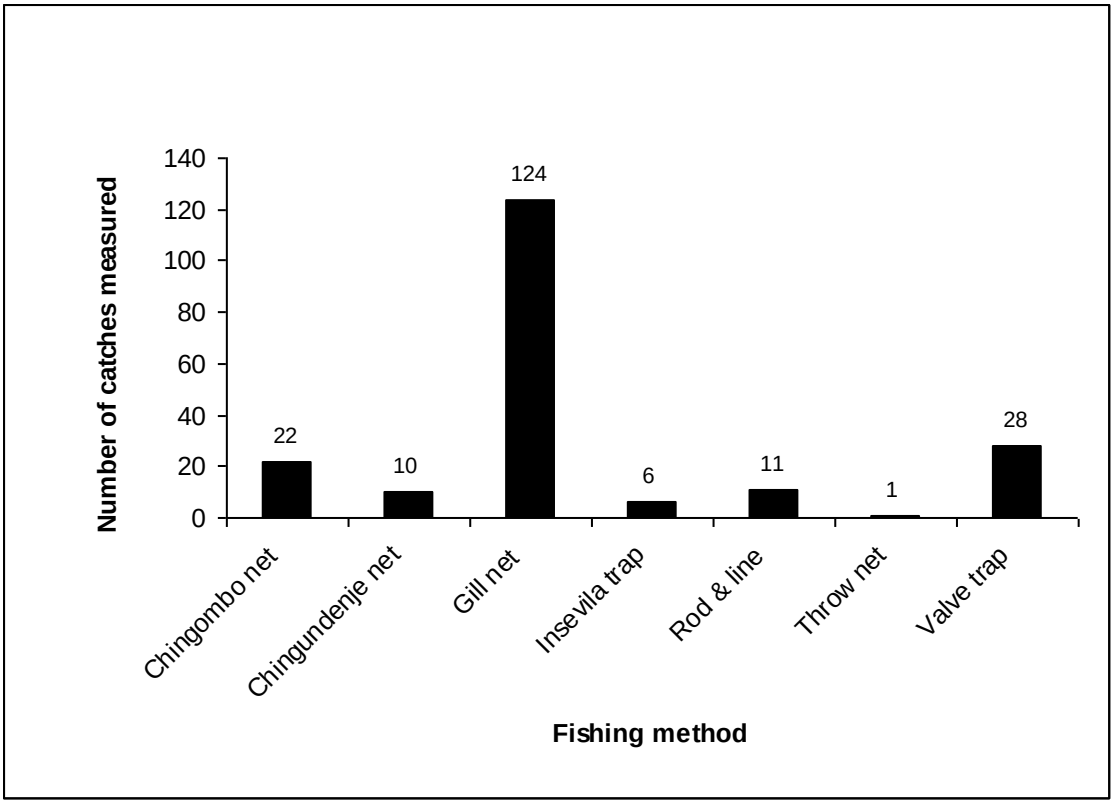


Fig. 4: Number of catches measured from different fishing methods during the 2004 dry season (n = 202)

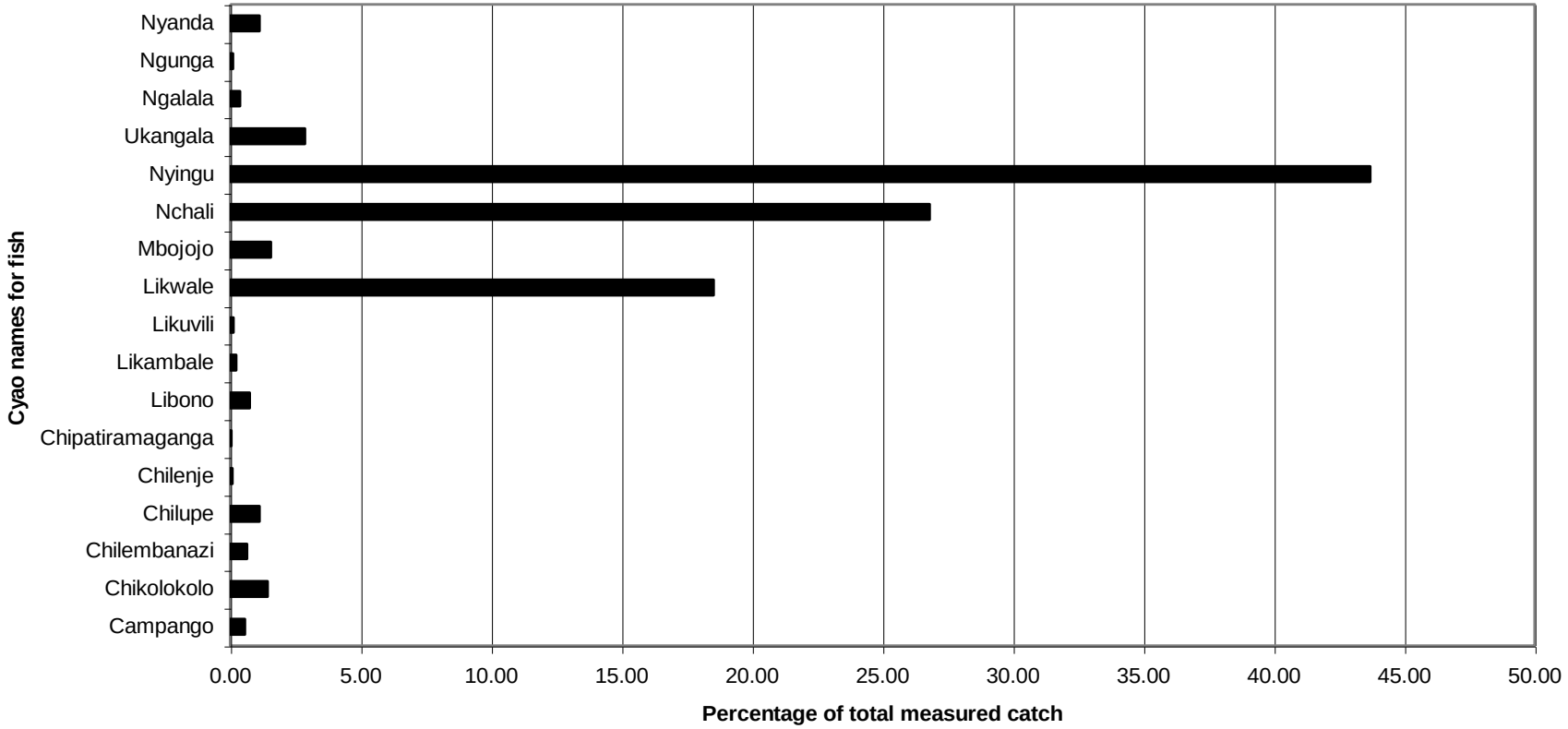


Fig. 5 Relative proportion (%) of fish types in measured catches from all fishing methods (n = 11381 fish).

The Cyao names represent the following fish species: **Campango** = *Bagrus orientalis*; **Chikolokolo** = *Synodontis sp*. (squeakers).; **Chilembanazi** = *Paraeutropis longifilis* (silver barbel); **Chilupe** = *Marcusenius sp.* (Bulldogs); **Chilenje** = Petrocephalus catostoma (northern Churchill); **Chipatiramaganga** = *Leptoglanis rotundiceps* (sand catlet); **Libono** = goby species; **Likambale** = *Clarias sp*. (catfish); **Likuvili** = *Heterobranchus sp.* (Vundu); **Likwale** = *Oreochromis sp & Tillapia rendalli* (bream); **Mbojojo** = *Barbus sp.* (barb); **Nchali** = Labeo cf. rosae (red-nose mudsucker); **Nyingu** = *Labeo* cf. *molybdinus* (leaden mudsucker); **Unkangala** = *Labeo cylindricus* (redeye mudsucker); **Ngalala** = *Brycinus sp*., *Mesobola* cf. *brevianalis* (robbers & sardines); **Nyanda** = *Mormyrus longirostris* (eastern bottlenose).

The presence of vundu (*Heterobranchus sp*) locally known as *Likuvili* was confirmed and DNA, voucher and dried samples were collected and have been sent to R. Bills (SAIAB). In addition several additional samples of fish *(Eleotris sp*., locally *known as Lidukwe*.and *Chiloglanis sp*.) that are new records for Niassa Reserve were also collected and sent to R. Bills (SAIAB).

Nyingu and *Nchali* also represented the bulk of the catch in biomass (88 %; Fig. 6) with *Likwale* (4 %) *Libono* (1 %) and the larger species *Campango* (1 %), *Likuvili* (2 %) representing a further 9 % of the total catch biomass. The remainder of the catch biomass was made up of the other 11 fairly small, and less common fish types (3 %), all individually representing less than 1 % of the total catch biomass.

On average chingundenje fishing yielded the largest catch per device (12 kg / net; Table 5) but the catch had to be divided between the 4 - 5 fishermen and only one device could be used at a time. Insevila traps also yielded large catches (7 kg / device), but the catch comprised juvenile fish of all the fish types (including juvenile *Campango*). Traps and nets yield similar catches per device (3 kg / device; Table 6).

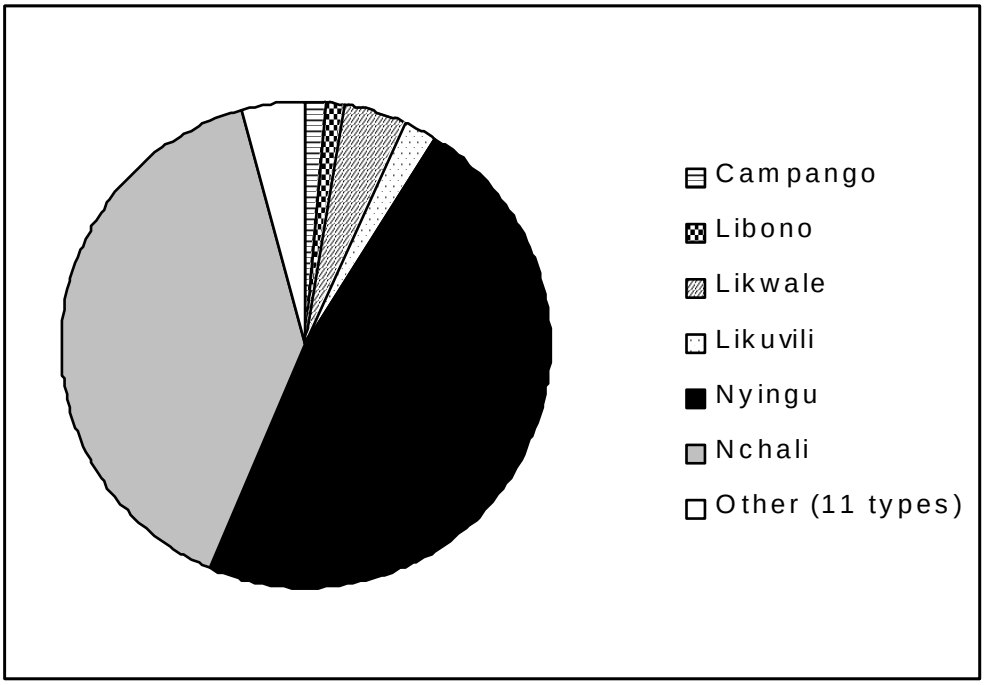


Fig. 6: Percentage biomass contributed by each fish type to overall catch (598 kg of fish weighed)

Table 5: A comparison of the average catch yield per fishing device

Fishing method	Devices / person Mean (range)	Sample size No. of catches weighed	Catch weight Mean ± Standard Error
Chingombo nets	6 (3 – 10)	16	0.5 ± 0.1
Standard valve trap	3 (1- 6)	22	3.1 ± 0.7
Insevila trap	2 (1- 2)	5	7.1 ± 1.7
Gill net	4 (1–12)	106	2.9 ± 0.2
Chingundenje net	1	11	12 ± 1.7

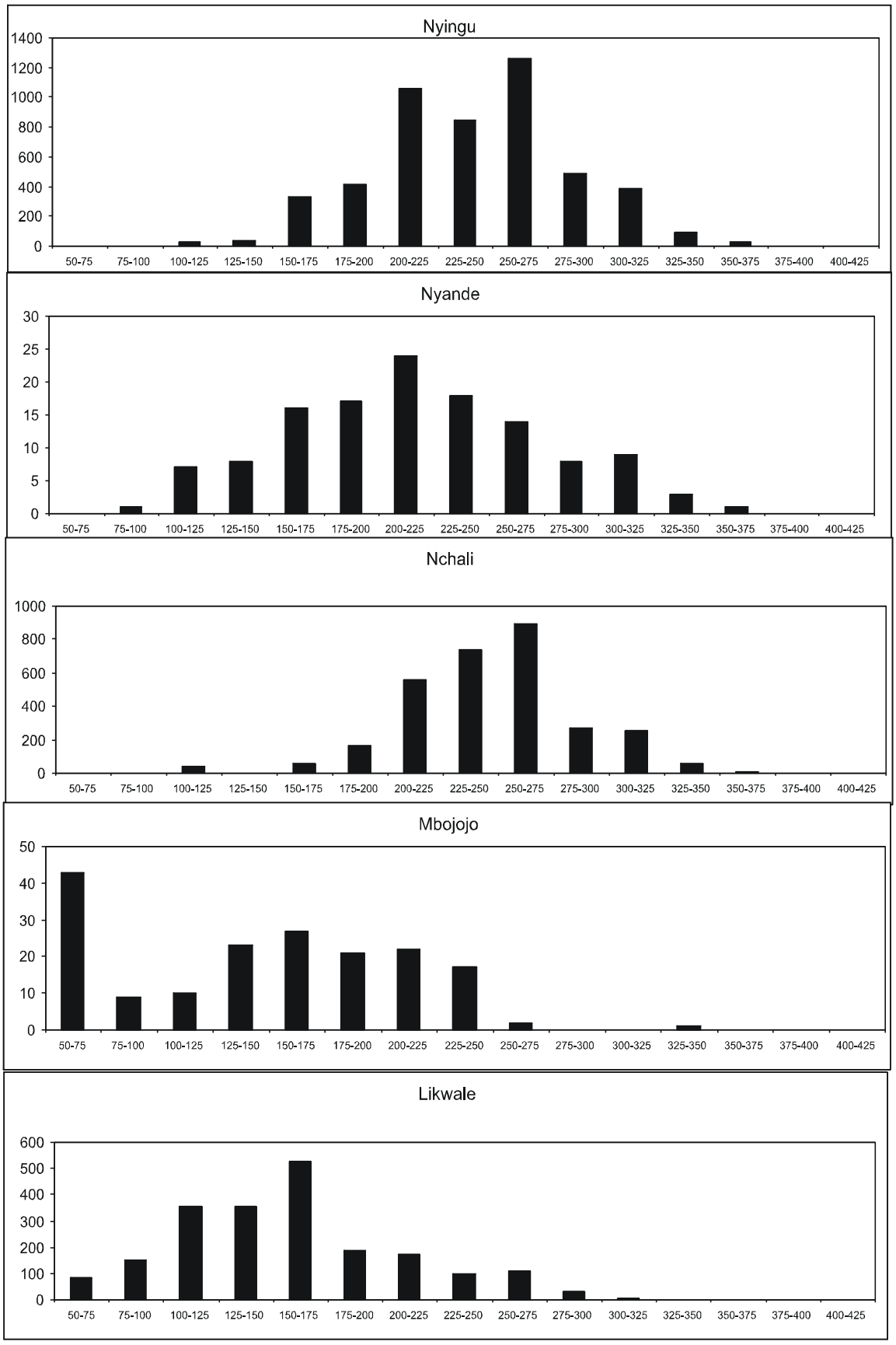
3.4.2. Fish length

A comparison of the mean length of fish caught using different fishing techniques is shown in Table 6. Statistical analysis of the average length of five of the most common fish caught in chingundenje nets, gill nets, insevila traps and standard valve traps shows that for all species the different techniques caught significantly different sized fish (ANOVA; *Nyingu* $F = 152$, $P < 0.05$; *Nchali* $F = 80.3$, $P < 0.05$; *Likwale* $F = 199$ $P < 0.05$; *Mbojojo* $F = 118$, $P < 0.05$, and *Chikolokolo* $F = 18$, $P < 0.05$). Chingombo nets were excluded from the analysis as fish were selected after being caught. Too little data were available from throw nets for further analysis. As expected Insevila trap fishing caught significantly smaller fish than all other techniques due to the small mesh size of the trap while gill net fishing caught significantly larger fish than the standard valve trap (Nasa) for all five of the common fish. While it was not possible to analyse the gill net catches from different mesh sizes as an individual fishermen might use a variety of nets, the most common mesh size in use in the study area was a No. 2.5 net (62.5 mm; see section A3.3.5). These net sizes are also preferred by the fishermen as the traders pay the best prices for medium sized fish.

For several of the fish types, data are presented showing the length frequencies (Fig. 7). These data may be useful for future comparisons between river systems and within the same river over time. In conversation, the fishermen suggested that the size of catfish, vundu, and campango in the Lugenda River had declined in the last few years.

Table 6: Comparison of the size (total length) of each fish type caught using different fishing methods

Cyao common name	English common name	Fishing method Mean ± Std Error (N)					
		Nets				Traps	
		Chingombo	Chingundenje	Gill	Throw	Valve trap	Insevila
Campango	Campango	0	426 ± 105 (9)	440 ± 19 (43)	0	265 ± 34 (2)	274 ± 152 (3)
Chikolokolo	Squeakers	200 (1)	209 ± 8 (34)	207 ± 5 (69)	0	161 ± 5 (57)	120 (1)
Chilembanazi	Silver barbel	0	0	0	0	0	131 ± 3 (73)
Chilenje	Churchill	0	0	0	0	0	86 ± 5 (9)
Chilupe	Bulldogs	219 ± 5 (7)	0	107 ± 3 (9)	0	127 ± 4 (59)	91 ± 5 (52)
Chipatiranaganga	Catlet	0	0	117 ± 9 (3)	0	0	440 (1)
Libono	Gobies	195 ± 17 (4)	225 ± 25 (2)	302 ± 29 (13)	0	254 ± 21 (23)	163 ± 7 (42)
Likambale	Catfish	0	465 ± 95 (2)	387 ± 38 (15)	0	472 ± 23 (5)	0
Likuwili	Vundu	0	580 (1)	502 ± 91 (6)	0	400 ± 42 (3)	0
Likwale	Bream	175 ± 11 (11)	150 ± 3 (300)	171 ± 2 (809)	173 ±11 (6)	156 ± 2 (708)	91 ± 3 (273)
Mbojojo	Barbs	0	170 ± 8 (19)	180 ±5 (89)	290 ± 50 (2)	141 ± 13 (12)	65 ± 3 (55)
Nchali	Rednosed mudsucker	196 ± 11 (11)	222 ± 3 (376)	249 ± 0.72 (2550)	260 ± 6 (20)	241 ± 3 (92)	0
Ngalala	River sardine, robber	0	120 (1)	137 ± 2 (23)	0	110 ± 5 (19)	0
Ngunga	Eels	0	0	517 ± 191 (3)	0	604 ± 116 (7)	0
Nyanda	Eastern bottlenose	0	158 ± 5 (4)	237 ± 10 (49)	0	234 ± 7 (52)	151 ± 8 (23)
Nyingu	Leaden mudsucker	216 ± 2 (391)	220 ± 2 (839)	249 ± 0.8 (3070)	267 ± 5 (58)	222 ± 2 (609)	207 ± 13 (3)
Ukangala	Red-eye mudsucker	136 ± 14 (11)	0	161 ± 3 (36)	0	120 (1)	102 ± 2 (278)



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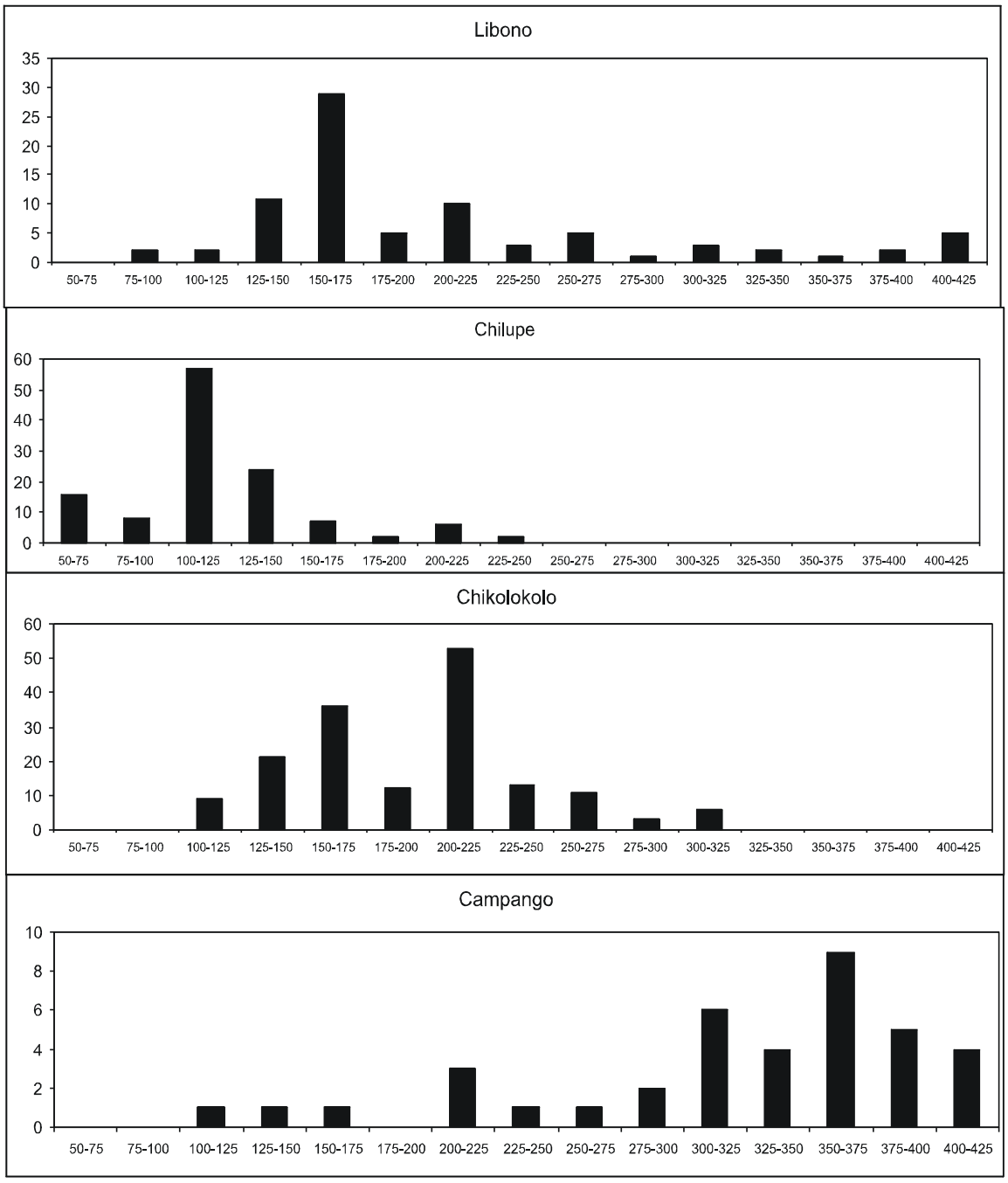

Fig. 7: Length frequency data for the more common species measured during the 2004 dry season, Niassa Reserve.

3.4.4. Impact of the fishery on fish stocks

Without data from other areas and years it is currently impossible to assess accurately the impact of the fishery on the fish stocks. Further monitoring is essential if the impact is to be assessed. In addition, not being fisheries experts we can only provide a preliminary descriptive overview of the data that were collected. Further in depth analysis would need to be done by an expert familiar with a similar river system. However, the preliminary data collected in 2004 do suggest that the current complex system might be self regulating. We would recommend caution in management as dramatic changes in the system might cause the whole dynamic to change. Certainly any changes to the current system need to be closely monitored with regular feedback (adaptive management).

The data also suggest that we need to be careful about making value judgments about the effects of "traditional" (traps) versus "non-traditional" (gill nets) fishing techniques. Each technique is adapted to particular river conditions and fish species. There is no evidence at this stage that gill nets are more destructive to fish stocks than traps. In fact, gill nets are catching significantly larger fish than traps, require less harvesting of plant resources than the construction of barriers and do not impound the river. In addition, the demand for medium sized fish by the traders supports the use of 63 mm mesh gill nets or larger. It is also encouraging that the fish species most highly in demand are also the most common fish (by far). There is some suggestion from the local fishermen that the larger species (Vundu, campango and barbel) caught on rod and line are smaller than they were in the past and this should be monitored as it is these species that might be most affected by over-fishing (R.Bills pers. com.).

Little data were collected on the gonad condition of the fish being caught by fishermen as this type of monitoring frequently inconveniences the fishermen as it requires fish to be gutted in a different manner upsets subsequent staking of the catch. Nevertheless, where examination of the gonad condition was possible we found that in the months of September and October the bulk of the catch was comprised of inactive individuals, with the exception of several bream (*Likwale*), which were in an active state. There was a marked change once the river began to pulse in November in response to rainfall in the catchment. As many of the fish in the Lugenda River are anadromous species (i.e. breeding when the river and its tributaries come down in flood) this was not an unexpected result. In preparation for the arrival of the floodwaters the gonads of anadromous fish ripen fast and breeding commences as soon as the river is in full spate.

In September / October fishing activity reached a peak in the study site and by late October / November many fishermen complained that fish catches were declining. However, the first rains then occurred and many fishermen moved off the river to prevent their smoked fish from spoiling. The timing of the diminishment in fishing pressure in the study area therefore coincided with an increase in river flow and commencement of the upstream spawning run of the fish population. The marked change that we observed in the gonad condition of the fish (from inactive in October to active/ripe in November) confirmed that the reduction in fishing effort could not have been better timed.

A number of other interrelated factors that affect the fishery include:

- Seasonal variability in fishing techniques and fish catches where techniques are adapted to changing conditions.
- The transience of fishermen, moving as they do from one camp/fishing site to another as conditions change.
- The limiting factors of transport and distance to markets and fishing sites (section 3.2.3). The system already incorporates areas where fishing intensity is low simply due to the distances to the nearest villages. For example: the downstream fishing limit for the majority of Mbamba fishermen is the Chipaputa River confluence, beyond this the distance from the village become impractical for transportation of the fish.
- Climatic factors such as the adverse influence of rainfall on fish drying processes. As a result as soon as the first rains fell in November, the majority of fishermen moved off the river.
- Hydrological events such as flood flows. Many of the dry season camps on the Lugenda River cannot be used during the wet season and fishing largely takes place on the tributaries, particularly the Msangezi River.
- Market forces and trading prices. The preferred fish for sale are also the most common fish and the market is therefore unlikely to be driving rare fish to lower levels.

The net result is that any possible negative impacts arising from the effort expended in the peak fishing period (September – November) are probably short lived. The fish population not only has an opportunity to recover but also breed before the onset of the next fishing season. There is also the potential for recruitment and the influx of stocks from above and below the study area.

3.5. Conflicts with other animals

At the end of the fishing season large quantities of discarded gill nets and old batteries are left on the islands at the fishing camps and these will be washed into the river during the wet season. This could cause a problem for a wide variety of wildlife. It is easy to burn the discarded nets and to collect the non-degradable rubbish and we suggest this should be done at the end of the dry season.

Conflicts between fishermen and other animals are minimal and largely confined to the damage by African clawless otter (*Kawusi*; *Aonyx capensis*) to valve traps and by crocodiles (*Ngwenya / Mamba*) to gill nets. As mentioned in a previous report (Begg & Begg 2004) the fishermen are remarkably fatalistic about the damage to traps by otters. However, given an opportunity both these species are killed. The otters are also elusive and there is little the fishermen can do and as a result appear to be killed. On one occasion, a fire was lit in the entrance of a rocky hollow thought to be an otter den, however no otters were killed.

Gill net fishermen experience regular damage to their nets from crocodiles. As mentioned previously they attempt to reduce the damage by checking the nets regularly through the night and using torches to dissuade crocodiles from coming too close to their nets but crocodiles are killed if caught (Section B: B3.1.5). Chingundenje fishing results in the most crocodile attacks and several fishermen have been injured. We know of at least four local fishermen that has been seriously injured by crocodiles in the last 10 years when chigundenje fishing in deep pools within the study area. As a result two large crocodiles in these pools were killed in 2000. In November, a Cabo del Gado fishermen (Grestina 1) was bitten on the arm also when Chingundenje fishing in the study area. Outside of the study area a fishermen was severely injured when fishing opposite Indapata Camp, Luwire (Block C)

Hippo are a threat to fishermen in canoes but direct conflict appears to be avoided at night by lighting fires, using torches and throwing rocks to chase the hippo off. One Tanzanian person was apparently killed by a hippo a few years ago and was buried near Ntumbula camp. This was not reported to the authorities. Yellow-billed kites steal fish from fish drying areas such as the surface of rocks. The birds are generally prevented from scavenging by spreading gill nets over the catch. On rare occasions elephants also damage traps and barriers. Elephants are an ever-constant threat to fishermen and traders. Fires are lit regularly to clear thick grass and reed beds (favoured by the elephants) to improve visibility and keep them away.

3.6.Other resources utilized in the study area

3.6.1. Honey

Honey is a highly valued resource and is gathered opportunistically by all resource users both from the common *Apis mellifera* bee and from mopane bees *Plebina denoita*. Details of honey gathering techniques have been described previously (Begg & Begg 2004b). Our particular aim in 2004 was to identify "permanent" honey gathering sites within the study area, i.e. wild hives in baobabs and rocky cavities that are harvested each year rather than sites where honey is harvested opportunistically by cutting the tree down. Many of these sites have been known for generations and while they do not appear to be individually owned, the more remote sites are harvested by the same families year after year and honey gathering is an important cultural event. The honey is not usually sold but is shared amongst family members. A variety of plant products are used for harvesting the honey, including bamboo torches, bark ropes (*Ntumba; Sterculia quinqueloba*), and special wood for ladders and stakes used as climbing pegs (Table 6; Plate 34). Harvesting of honey from these sites is considered highly technical with the techniques passed down from one generation to the next. During the study period 20 sites (some included as many as five hives) regularly harvested for honey were identified: 18 in baobabs and two cliff sites (Fig 3).

3.6.2. Plants and crafts

A wide variety of plants are utilised by the fishermen and traders within the study area with a preliminary list provided in Table 6. This list is in no way exhaustive and does not include medicinal or food plants used in the study area as these have been intensively studied in previous resource use studies. Instead we focused on those plants used specifically for fishing and honey

gathering activities. The single most important resource used by the fishermen was firewood, which is needed to feed the more than 250 smoking ovens and for food preparation for more than 350 people. In most cases dead wood was collected with notable deforestation observed around only two fishing camps (Chiyangwasi and Grestina 2). Five species of trees are used to make canoes *in situ* in the study area; *Ntumbati* (Mukwa, *Peterocarpus angolensis*; lasts approx 5 years); *Njale* (*Sterculia sp*; lasts approx. 2 years); *Ngoza* (*Sterculia sp*, lasts 3-4 years), *Ncongo* (Pod mahogany, *Zanthocersis zambesiaca*, last 8 years but sinks quickly) and *Ngongo* (marula; *Sclerocarya birrea*, lasts 2-3 years). We estimate that 10 new canoes are made in the study area each year and we located seven trees felled within a kilometre of the river during the 2004 study period (Plate 35). While some fishermen make their own canoes, two Mbamba people are known as specialist canoe makers, Daimu Vacuwa and Issa Assani.

Palm fronds (*Hyphaene coriacea*) are heavily used for making rope, beds, shelters and baskets (for honey collection, to carry fish). For rope making the young shoots of the palms are harvested, placed in the sun to dry and then spilt into even lengths. One large 9 kg raw bundle of dried young fronds is used to make 2-3 standard rope bundles of 110 m in length. Each 110 m length is used to make one large bed (Plate 36). This harvesting, whilst extensive, does appear to be sustainable as the terminal buds of the palms are not removed and shoots grow back within 1-2 months. Bamboo is also widely used to make snares, rods, valve traps, baskets, flares and floats. Around villages both bamboo and palms are perceived as being scarce (Wiinblad 2004).

A number of plant products are also utilised to make objects such as wooden spoons, woven baskets, pottery pots, baobab seed containers and brooms. These objects all have the potential to be marketed as crafts to visitors to the reserve. While there is currently no market for these crafts, photographs are presented here to indicate the potential for future eco-tourism ventures (Plates 37-40). Sale of these crafts could provide valuable income for local residents.

Plate 34: A variety of items made from plant products used when honey gathering

Plate 35: Newly carved dugout canoe

Plate 36: Bed made from palm frond rope

Plate 37: Basket made from bamboo and palm fronds

Plate 38: Basket woven from inselberg grass

Plate 39: Wooden spoons from Mbamba village

Plate 40: Pottery pots made in Mbamba village with old pottery shards found throughout the study area

Fig. 8: Positions of baobab and cliff honey gathering sites and snares found during the 2004 dry season. Sites located outside the main study area are also shown for completeness

Table 6: Preliminary list of plants utilized in the study area for fishing and honey gathering

Local name	Common name	Scientific name	Part used	Utilization
Unknown	Waterberry	*Syzygium sp*	Branches	Fish barriers, smoking ovens,
Unknown	Reeds	*Phragmites mauritianus*	Stems	Net floats
Unknown		*Vetavaria sp.*	Whole plant	Fish barriers
Unknown	Nile cabbage	*Pistia stratiotes*	Whole plant	Feeding feral pigeons
Nasi	Bamboo	-	Stems	Baskets, fish traps, stakes for fish, flares, pole for canoe
Ncongo	Pod mahogany	*Zanthocersis zambesiaca*	Trunk	Canoe
Ngongo	Marula	*Scerocarya birrea*	Fruits	Food
			Trunk	Canoe
Ngoza		*Sterculia sp.*	Trunk	Canoe
Ngwamba / Nkundu	Lala palm	*Hyphaene coriacea*	Leaves	ropes, baskets, roofing, covering fish. fish barriers
Njale		*Sterculia appendiculata*	Trunk	Canoe
Nonje	Baobab	*Andansonia digitata*	Fruit	Food
			Seed pods	Containers for oil
			Bark	Repairing nets
Ntumbati	Mukwa	*Pterocarpus angolensis*	Trunk	Canoe
Ntumbu	Sterculia	*Sterculia quinqueloba*.	Bark	Ropes for honey gathering

3.6.3. Snaring

The majority of snares were found close to the fishing camps with snaring occurring more frequently at the start of the dry season (April / May) when fishing activities had not yet reached a peak. Meat is dried on the fish drying racks and either eaten locally or sold in the villages. Guineafowl are routinely snared in fairly large numbers and five snaring sites were found near fishing camps with an average of 18 snares per site (Plate 41). The guineafowl are frequently sold to other fishermen for five fish (Mt 25 000). Given the large number of guineafowl in the study site with an estimated density of 61 guineafowl /km^2 (estimated from road strip transect of 25 km; Section B2.0) and an average group size of 38 ± 4 individuals (n = 36; range = 14 - 73), it is unlikely that this snaring is unsustainable at present. Small birds are also caught using bird lime from the "nola" tree or by using a bamboo trap (*Liululu;* Plate 42) which is placed over drying pools. As many as 300 small birds could reportedly be caught in one trap.

In addition 12 large wire snares were dismantled with 1 waterbuck and 1 impala found dead. In most cases wire from the electric "elephant" fences was used to make the snare. These snares are particularly dangerous for wild dogs. On one occasion a group of wild dogs killed a waterbuck still alive in the snare however a number of other snares were also still open in the area. The longest snare line was 580 m in length with seven snares. We also received information that elephants which go into the crop fields are killed by using pit-stake traps (*Labata*) on paths. The elephants injure their feet on the stakes and later die.

Plate 41: Guineafowl snares found near the fishing camps

Plate 42: Bamboo bird trap placed over pool of water to catch small birds for food

4.0 Conclusions, Research Priorities & Management Recommendations

4.1. Conclusions

- Fish are the most important natural resource utilized in the study area although other resources such as honey, bush meat and plant products are also used.
- Management of fishing activities will also reduce pressure on other resources as the resource users are the same.
- The specific section of the Lugenda between the Mbamba River and Msangezi Rivers is a high intensity fishing area due to its access and to the prime fishing habitats provided by the braided channels. This is not a new phenomenon.
- Fishing and fish trading currently provides a vitally important industry for a significant number of Niassa Reserve residents as well as people from outside the reserve boundaries (Cabo del Gado and Tanzania).
- At the current level of exploitation the fishery is transforming from a subsistence fishery into a commercial enterprise. It is the only feasible way for many local people to obtain the cash and goods they require.
- With fishermen and traders converging on the Lugenda river from at least seven different districts in northern Mozambique and some villages in Tanzania, the fishery can be regarded as an "open access system". This complicates management of the fishery and management of the protected area
- There is currently insufficient evidence to suggest that fish stocks are declining. A number of interrelated factors are acting as natural checks and balances on the fishing intensity. Whilst a decline in fish stocks due to over-fishing was apparent by the end of the study period this was accompanied by a self-induced reduction in fishing effort and the system may therefore be self limiting with sufficient recovery over the wet season.
- At present a major factor limiting fishing effort is the long distances fishermen have to travel to get their fish to a market, as well as the limitations arising from the mode of transport by bicycle.
- Law enforcement of fishing activities is extremely difficult given the large area involved, the difficulties in accessing the fishing camps (islands) and the continual movement of the fishing communities and traders.
- There is currently no effective monitoring system of fishing activities and the current licensing system has a number of problems.

- Given the importance of the Lugenda and Rovuma river systems to the local people and continued health of the Niassa ecosystem, it is critical that management of the fisheries is a priority of the Management Plan.

4.2. Research priorities

- Establishment of long term monitoring of the fishery is essential. At this stage it is impossible to assess whether the rivers are being over-fished as there is only one season of data from a restricted site. In particular, the following data are needed:
    - A foot/ canoe survey of the Lugenda and Rovuma rivers to map fishing camps, high intensity fishing areas, and pedestrian paths into the fishing areas. Aerial censuses do not provide accurate results. These data are needed for the mapping of practical no-fishing zones and effective law enforcement.
    - Monitoring of individual fish catches including measurements of fish, species composition and type of fishing methods from a variety of sites during wet and dry season.
- Given the importance and extent of fishing activities in Niassa Reserve, we believe a fulltime post for a fisheries officer is essential to coordinate and analyse data collected. At present there is no central person collating the fishing information collected by the WWF community officers, hunting concessions, biodiversity studies, Agricultura and reserve law enforcement.
- A number of fish monitors, drawn from the local communities and supervised by the fisheries officer, could be hired to collect the data. A number of fishermen have already expressed an interest in doing the type of monitoring work done by O. Muemedi in this study. The advantage of hiring people from the fishing communities is that they already possess an in-depth knowledge of the fishing sites, camps and methods, understand the dynamics of the fishing communities and are non-confrontational (not law enforcement). This would also provide an alternative form of income for several fishermen and would include the fishermen in management decisions. Each monitor could be set up with the minimum of training and equipment (scale, clipboard, measuring board, radio) but would require regular supervision.

- It is our opinion, supported by R. Bills (pers. Com.), that an indepth study of the Niassa Reserve fishing industry would make an interesting and worthwhile PhD study (2-3 years) for a Mozambican student through an appropriate university. The results would be of immense value to Niassa Reserve and the study could involve setting up an appropriate management system, training fish monitors etc.

4.3. Management recommendations

In our discussions with the fishermen they have offered many useful ideas on how to manage the fishery. In all cases we recommend that management decisions are based on actual data so that feasible limits can be set and conflict minimised

- At present, we do not believe any new restrictions on the types or quantities of gear used by local fishermen is necessary as the system appears to be self limiting and more data is required. The ban on fish poisoning should remain in place with heavy penalties and use of small mesh gill nets (No. 1; 25 mm) discouraged or banned entirely.
- We recommend that a fishing association representing the local fishing community be set up in Mbamba village. This would facilitate getting information to the fishing community, provide them with a way to get complaints to SGDRN and would encourage them to participate in management decisions.
- The establishment of no-fishing zones could initially be set up with minimal conflict by identifying areas in rocky channel habitat where fishing intensity is relatively low due to the distances from villages and roads i.e. the area downstream of the Msangezi or Chipaputa Rivers.
- Ultimately the issuing of fish licenses needs to be revised and streamlined. Possible improvements could include:
    - One license per fishermen indicating the number of fishing devices for a set price Mt 25 000.
    - Issuing of the licenses needs to be controlled by SRN from one central office. No licenses should be issued by offices outside the reserve.
    - Licenses should only be issued at specific times for a specific period e.g. four times a year for three months. This will also SRN to put a limit on the number of licenses issued.

  - The river could be divided into distinct fishing zones. A limit to the number of licenses issued in each zone could then be set. The limits should be based on real data from each zone so that realistic limits can be set. For instance the number of licenses issued for the Mbamba to Msangezi zone could be limited to 200.
  - Licenses should be provided in a plastic sheet – bag to prevent damage (Plate 25) as has been implemented in other parts of Africa (Kyle 1999)
  - An incentive system could be introduced whereby fishermen who have a license can obtain appropriate fishing gear (nets) or basic goods (salt, maizemeal, oil) at better prices that they get from Mecula or the traders. This could be done by simply buying bulk stock outside the reserve (Cuamba) and making it available to the fishermen. This would encourage fishermen to buy licenses and thereby provide improved monitoring information and improve relations.
- A limit on the number of new fishing camps established could be set. Based on the survey recommended above, only well-established sites could be allowed. This would aid management and fish monitors as it would allow them to find the fishermen.
- The rights to fish and obtain a license could be linked to other obligations in line with fishing in a nationally and globally important protected area. For example, if snaring of large game is found in an area, fishermen could lose their fishing licenses for that camp or area, or the number of licenses issued in that area could be decreased
- Clear rules are needed for what the consequences are for not having a fishing license, fishing in no-go areas, using poison etc..
- If it is possible, we would recommend that the number of outsiders allowed to fish in the reserve be limited or stopped (to prevent "tragedy of the common" in this open access system). This would immediately limit the number of people fishing on the Lugenda River and would simplify management and law enforcement. The "outsiders" are frequently unaware of rules related to living within the protected area. This would also provide a tangible benefit for the local residents who are the ones dealing with the negative benefits of living with increasing numbers of "problem" animals i.e. high densities of elephant, bush pig and baboon.
- The pedestrian routes of the traders could be mapped and then stipulated. Traders not found using these approved routes could be fined.

Section B: Density of key animal species

1. Introduction and objectives

The aim of these investigations was simply to provide baseline information on the relative abundance, distribution and habitat use of the some of the key species in the study area that were highlighted at the Niassa Biodiversity Workshop held in Maputo in April 2004. We believe this type of information may provide a valuable basis for comparison with future studies. We concentrated on crocodiles *Crocodylus niloticus*, hippo *Hippopotamus amphibius*, African skimmer *Rynchops flavirostris* and ungulates, particularly impala *Aepyceros melampus*. Data on carnivores, particularly lion, African wild dog, spotted hyaena and honey badger within the study area are provided elsewhere (Begg & Begg 2004a, Begg & Begg 2005).

2. Methods

Data were collected throughout the study period (May – Nov) with an intensive survey of crocodiles conducted over a two-month period at the end of the dry season (Oct – Nov). The general methods employed included opportunistic observations, conversations with fishermen and daylight and spotlight transects (crocodiles and herbivores). In all cases the habitats used by the animals were specifically noted (see habitat and vegetation types listed in Table 1) to provide preliminary information on where these animals are most likely to be found.

African skimmer were located opportunistically whilst walking the river channels. Hippo were located and counted opportunistically but were also indicated by fishermen who have detailed knowledge of the river channels. For crocodiles, spotlight counts (sandy channels = two transects each 2 km; rocky channels = three transects; 0.5 km, 1 km, 0.6 km; 14 hrs of walking

and canoeing) and spoor counts (90 hrs of walking) were used to assess distribution, age structure and abundance of crocodiles in the study areas. For each crocodile spoor or sighting, the GPS position and basic habitat type (back channel, main channel, rocky or sandy) were noted. Wherever possible, measurements of the hind foot length were recorded to provide an indirect estimate of total body length (12:1 ratio for hind foot to total body length; J. Hutton and A. Leslie pers. com). Since the main channel of the Lugenda was often too deep or fast flowing to cross on foot, the data collected using both methods were obtained primarily from the north bank of the river, however wherever possible back channels were also surveyed. Although this may bias the information obtained about the distribution and abundance of crocodiles, it is unlikely to affect the size data. In addition, due to the difficulty of locating spoor and spotlighting in rocky channel habitats, baits consisting of small portions of meat from an elephant carcass shot in Luwire (Block C) were set at a number of locations in one of the back channels near our camp and kept under close observation.

Herbivores were censused along a repeated road transect (n = 21; 25 km) driven through the study area. Both early morning (05.30-08.00) and night spotlight counts were done and in both cases the number of animals of each species, group size, GPS coordinates and habitat were recorded. Transects were driven slowly at 10-15 km/h with at least two observers and at night a spotlight was shone on both sides of the road with a sweeping action. While emphasis was given to counting impala, data on waterbuck, kudu, sable, eland, zebra and hartebeest were also collected to provide preliminary information on relative abundance and habitat use. The number of animals of each species observed per transect were counted and converted to the mean number of each species observed per kilometer traveled.

The transect traversed four main habitats within the study area: riparian forest and thicket (4.4 road km), wooded grassland (particularly acacia /palm plains with clay pans; 9 road km), mixed open woodland (5.6 road km) and miombo woodland (6 road km). For each of the habitats the maximum perpendicular distance from the vehicle to the furthest member of a group of animals was estimated. The relative area of each habitat censused along the transect line was then calculated as:

Relative area of Habitat A = (Est. max. sighting distance in Habitat A x 2) x total length of Habitat A

A preliminary analysis of the relative importance of different habitats to impala, waterbuck and kudu was assessed by comparing the habitat used (from sightings of herds) to the proportion of habitats present in the strip transect using a chi-square goodness of fit test.

3. Results

3.1. Crocodiles

3.1.1. Size

The average length of the crocodiles in the study area (extrapolated from the length of the hind foot spoor; 1:12) is 1.6 m, ranging from 0.6 m to 3.1 m (n = 106; Fig. 8). The majority (65%) of the spoor measured belonged to juvenile crocodiles (est. <1.8 m in length; n = 69) with 25 % belonging to sub-adults (1.8 – 2.3 m; n = 26) and only 10 % belonging to adults (≥2.3 m; n = 11). Yearlings, that is crocodiles that hatched during the 2002-2003 wet season (0-18 mths old; <600 mm), were rare with only two records (one caught by a fishermen in a chingombo net and one measured from spoor).

By using bait to attract crocodiles, it was apparent that individuals larger than 3 m may be more common than indicated by the spoor. This is supported by professional hunters from both Kambaku (S. Veiga, pers. com.) and Luwire (D. Littleton and J. Wilson, pers.com.) who report that crocodiles over 3 m are regularly seen at hippo baits. The sizes of the crocodiles taken as trophies by Luwire during the 2004 hunting season were all over 3m in length (3.7 m; 3.1m, 3.4 m; J. Wilson, pers. com.). The largest crocodile seen during the study, a resident in the pool at Ndambalale, was estimated to be 4 -5 m.

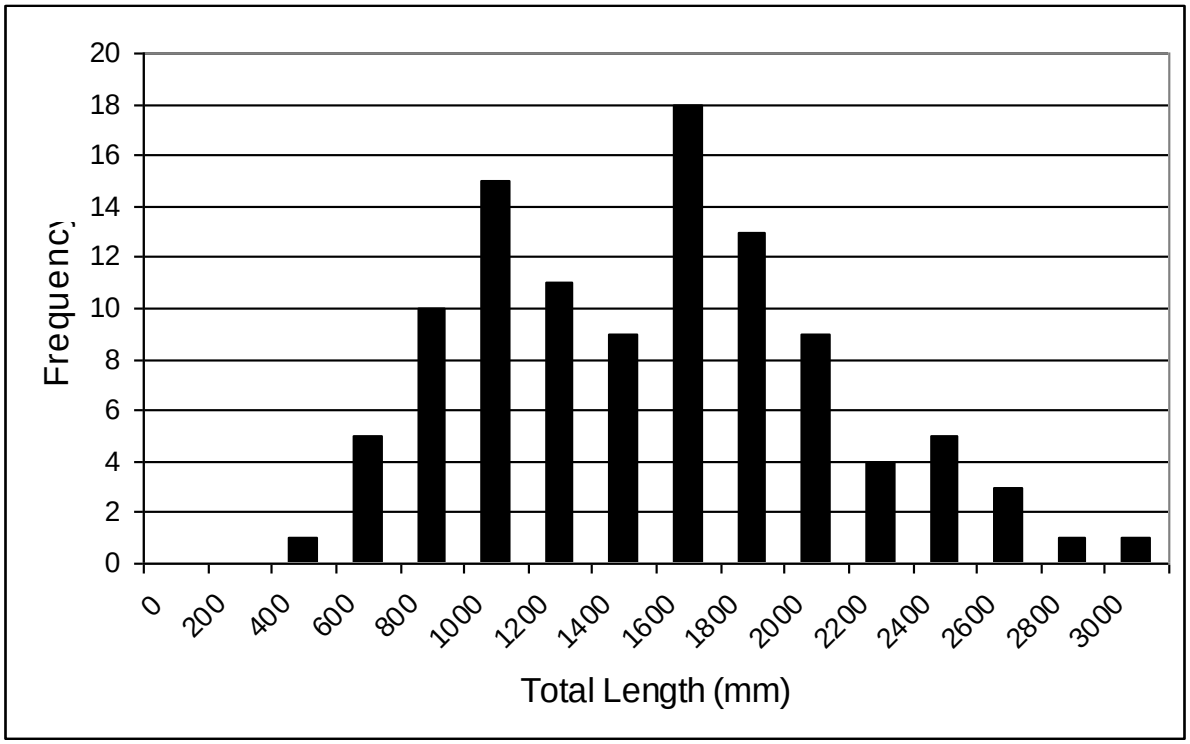

Fig. 9 Size classes of crocodiles found in the study area over the period Oct – Nov 2004 (estimated from hind foot length measurements; 12:1 ratio).

3.1.2. Habitat use and density

Crocodiles were located throughout the riverine zone of the study area but daytime opportunistic sightings were surprisingly rare with only two juvenile crocodiles observed sun basking during the entire study period. Visual observations of crocodiles attracted to bait sites set in representative sections of rocky channel and sandy channel habitat and seen during spotlight surveys in both habitats suggested that individuals from all three age classes were present in both habitats. However, the spoor data show that juveniles were more common in the sandy channels than in the rocky channels (Fig. 9). In addition, with only one exception, all spoor of crocodiles estimated to be from sexually mature adults (over 2.3 m in length; 10-15 years old) were found in rocky channel habitat (n = 9). The exception was the spoor of an adult individual (est. 2.5.m) that was found at an elephant carcass on the bank in sandy channel habitat. Since crocodiles are known to be attracted to the carcasses of dead animals from long distances away, this individual may well have also been a rocky channel resident.

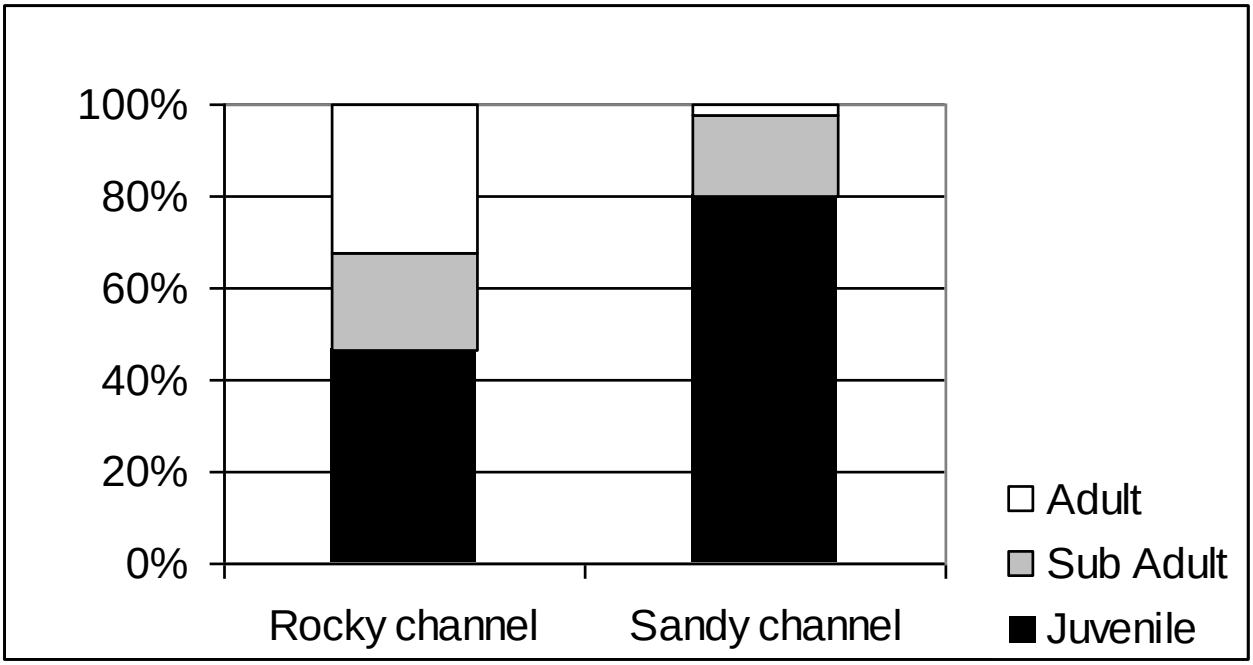

Fig. 10 Habitat use by crocodiles of different ages

An aerial survey of crocodiles completed in 2004, documented only 12 large crocodiles in the entire Lugenda River (B.Chande, pers. com.). All the common survey techniques (spotlight, aerial, spoor) are biased towards observations in the sandy channels where visibility is good (from bank to bank), spoor is easily recorded on the extensive sand bars and the movements of surveyors is not impeded by the vegetated islands and rocky channels. In this study, spotlight counts made in representative sections of the two habitats suggest that crocodiles (all sizes) are relatively common, particularly in the sandy channels (18 .5 ± 1 crocodiles / km; n = 2 transects) compared to the rocky channels (5 ± 2.7 crocodiles / km, n = 3 transects). However, this relatively high density in the sandy channels reflects high juvenile and sub-adult densities, not a high density of adult crocodiles. In addition accurate surveying, whether using aerial censusing techniques or spotlight counts, is particularly difficult in the rocky channel habitats with low visibility, complicated and numerous braided channels and extensive vegetation. Since it is this habitat that supports the majority of adult crocodiles, it is likely that adult crocodile numbers have been underestimated. This view is supported by the professional hunters who have recorded as many as 40 adult crocodiles at a single hippo carcass in the Lugenda River (J. Wilson; D. Littleton, S.Veiga, pers. com.).

This does not imply that there is no reason for concern about the low numbers of adult crocodiles; it simply suggests that more intensive surveying that takes these factors into account is needed before an accurate estimate of the number of crocodiles on the Lugenda River can be determined.

3.1.2. Evidence of breeding

A concerted effort was made at the height of the crocodile breeding season (October / November) to locate nests in the study area. The obvious presence of cohorts of similarly sized juvenile crocodiles in the sandy channel habitat showed that some breeding was occurring although nests appeared to be rare.

Fishermen identified two areas where crocodiles had bred in recent years, Mshaa and Ntumbula both in rocky channel habitat. On searching, three old nest sites and one recently hatched site were found (Fig 10). Two of the old nest sites (one with old egg shells) were on the crest of an island in the Ntumbula area and were reported by the fishermen to have been active in the preceding season (2003). The active nest was found on the crest of a reed covered island alongside the Mshaa hippo pool (Plate 43). The eggs hatched on the 15 November 2004. Evidence of a third old nest site that had hatched the previous year (2003) was found on an adjoining island nearby. The location of one additional exploratory nest site was noted, also in rocky channel habitat. As expected, all nest sites seen were on secluded, well-vegetated sites located high above the river level where there were deep deposits of fine, well-drained sand. The low number of adult crocodiles in the study area may account for the scarcity of nesting sites.

Two burrows used by crocodiles for shelter were located in the riverbank below the root mass of overhanging trees (Plate 44). The branches and roots of trees that have fallen into the river appeared to act as important refuges for many of the small crocodiles in the area.

Fig. 11 Map of the study area showing position of main hippo pools, known crocodile nesting areas and African skimmer observations

Plate 43: Crocodile nesting site with recently hatched eggs, Lugenda River, November 2004 (© GW Begg)

Plate 44: Typical crocodile resting burrow showing spoor and faeces (©GW Begg)

3.1.3. Movement of crocodiles

Data from spoor sightings suggest that the juveniles tended to be sedentary (i.e. consistently remained in the same sites) whereas the larger crocodiles (i.e. sub-adult and adults) tended to be more mobile and move from channel to channel, or from site to site. Spotlighting in the sandy channel habitats showed that in certain places congregations of 12-15 juvenile crocodiles, similar in size, could regularly be found. Large crocodiles, on the other hand, would suddenly appear at certain sites and then never be seen again at the site in question.

On several different occasions (observed by ourselves and fishermen) spoor showed that certain adult crocodiles were wandering several hundred meters at night onto the open wooded grassland plains adjacent to the river (Ntumbula area) to search for prey. Crocodiles also left the water to scavenge / feed on an elephant carcass some 30 m from the bank of the Lugenda River.

3.1.4. Possible threats

Crocodiles do not appear to be used in traditional medicine, nor aree they eaten and skins did not appear to be traded in this area, although crocodile skins from the Lugenda River were reportedly for sale in Mecula. Even taking into account possible problems with survey techniques, the density of adult crocodiles seems surprisingly low given the apparent abundance of fish stocks and suitable habitat. A number of factors may be adversely affecting crocodile numbers in the Lugenda River:

- Historically there were crocodile hunters based in the study area during the 1970's, apparently near the camp called Grestina 1. By all accounts large numbers of crocodiles were hunted during this period (B. Chande pers. com.; conversations with local fishermen) and it is possible that the crocodile population is still recovering from this intensive harvesting. Current levels of hunting are low with a quota of 22 approved for 2004 with only seven trophies taken on the entire Lugenda River.
- Persecution levels also appear low and there is little to suggest that gill netting exacts an unsustainable death toll on the crocodile population at present. The technique employed by the fishermen of checking and removing the gill nets repeatedly throughout the night is likely to be minimizing the conflict (Section A3.3.6).
- However, occasionally young crocodiles (< 1m) become entangled and drown in the nets or, once caught, are killed by the fishermen. We know of four juveniles killed during the

- 2004 study period (Plate 45). On one occasion a teenager fishing with a chingombo net in the rocky channels caught a juvenile crocodile (585 mm) and would normally have killed it, but on our suggestion it was released (Plate 46). Large crocodiles that regularly cause problems for fishermen are also caught and killed by a variety of snare and hook traps, but again this does not appear to be common. Fishermen reported that two large crocodiles were killed in the last five years as a result of ongoing crocodile attacks (Section A3.5).
- In the event of a crocodile nest being found by fishermen, the eggs are purposely destroyed. The number of nests destroyed during the breeding season is unknown.
- The large numbers of people utilizing the study area for fishing during the breeding season of crocodiles may disturb breeding activities. Both the prime crocodile breeding habitats and prime fishing habitats are located in the same sections of rocky channel habitat.

Plate 45: Young crocodile caught in gill net and killed by a fisherman, note puncture wounds from the back of an axe blade

Plate 46: Teenager with young crocodile he caught in a chingombo net.

3.2. Hippo

Our observations suggest that there are at least 80-85 hippo in the study area. The majority of these can be found at three main sites (Fig. 10); the Mpopo hippo pool containing 40 individuals; the Mshaa hippo pool containing 23 individuals and the Arawuji hippo pool containing 8 individuals. Although widely separated, all three pools lie on the north bank of the Lugenda River in the same back channel within rocky channel habitat. Individual animals (lone bulls; n = 10-15) also occur in isolated pools far removed from the main channel of the river. In addition, there is another hippo pool at Chipaputa containing at least 30 individuals lying just downstream of the study area below the new Kambaku camp. In 1977 an aerial survey counted only four hippo in the study area (Tello & Dutton, 1979), which suggests that the hippo population has increased substantially in the last 20 years. A 2004 aerial survey of the Lugenda counted 372 hippo in the entire Lugenda river with an estimated 25 individuals counted within our specific study area (B. Chande pers. com.).

At night the hippo range widely throughout the riverine zone and adjoining wooded grassland whilst foraging. It is likely that food shortages during the extended dry season are exacerbated by the frequent fires that are set in the study area by fishermen and honey gatherers. In many areas the wooded grassland areas are completely bare of grass by the end of August. Conflicts between hippo and fishermen are surprisingly rare considering that in order to set gill nets at night in sites such as Mpopo hippo pool, the fishermen not only displace the hippo (by throwingg rocks at them) but also have to canoe amongst them (Section A3.5). Hippo are hunted by professional hunters in the hunting concessions on the south bank of the river.

3.3. African skimmer

Only one site in the study area, a large sandbank not far from the Luambezi / Lugenda confluence, was found to be regularly utilized by African Skimmer (Fig. 10). The maximum number of birds present observed was twelve (October 2004). The birds used the shallow, broad pools to feed and were observed skimming at dusk and in the early morning. A second possible site was identified at the confluence with Msangezi River.

No nests or eggs were found. However, judging from the behaviour of the birds, mobbing pedestrians, dugout canoes and birds such as storks and plovers, as well as the presence of two sub-adult birds in October 2004, it appears likely that African skimmer do breed in the area.

While the large amount of pedestrian traffic along the river may be affecting the breeding success of the birds, the habitat preferred by the birds (sandy channel shallows) is not the preferred habitat utilized by the fishermen (section 3.3; traps, gill nets) except for insevila trap fishing.

3.3. Impala and other herbivores

Impala were commonly observed in the study area throughout the dry season (100% of transects), and were relatively abundant (15 ± 1.1 impala / km^2; n = 21 transects). Breeding group sizes averaged 11 ± 0.7 (n = 132; range = 6 – 38). Breeding was first observed in the last week of October with the majority of lambs born in early November.

Waterbuck ($2.57 \pm 0.51/km^2$; 88 % of transects) and kudu ($1.54 \pm 0.7/ km^2$; 52 % of transects) were less common than impala but small groups were regularly seen (waterbuck: 2 -11 individuals; kudu: 2-7 individuals). Eland (14 % of transects), zebra (14 %) and sable (24 %) were uncommonly encountered, but during the late dry season (October –November) small herds were seen coming down to the Lugenda to drink (maximum herd size observed; eland: 60; zebra: 23; sable 17). Hartebeest were only seen in the study area at the end of the dry season (Oct-Nov) and Niassa wildebeest were not seen at all in study area during the 2004 dry season and appear to be very rare in this area. Warthog were common throughout the season and throughout the study area. The first piglets were observed on the 29th of September.

A preliminary analysis of habitat preference shows that for impala and kudu habitat use was significantly different to the use expected from habitat availability (Chi square analysis, Impala: $X^2 = 29.66$, $p < 0.05$, df = 3; Kudu $X^2 = 6.70$, $p < 0.05$, df = 3). While impala preferred the open wooded grassland and mixed woodland habitats and avoided the miombo and riparian woodland, kudu preferred the mixed open woodland and riparian woodland, and were less commonly seen in the wooded grassland and miombo woodland. Waterbuck showed no preference for any of the habitats ($X^2 = 0.356$, NS) but as with impala were seldom seen far inland away from the

permanent water in the Lugenda. Too little data were available on other ungulate species for analysis.

Table 7: A comparison of habitat use (impala, waterbuck, kudu) and habitat availability along the strip transect (25 km).

Habitat types	Habitat availability (% total area on transect)	Habitat use (% sightings)		
		Impala	Waterbuck	Kudu
Riparian woodland & thicket	7 %	2 %	5 %	20 %
Wooded Grassland	50 %	73 %	49 %	27 %
Mixed open woodland	21 %	19 %	21 %	40 %
Miombo woodland	22 %	6 %	25 %	13 %

4. Conclusions

4.1. Crocodiles

- Tracks and spotlight counts suggest that crocodiles are fairly common throughout the study area but with a predominance of juveniles and sub adults, and low numbers of adults, particularly adults over 3m in length.
- Adult crocodiles appear to prefer rocky channel habitat and all nesting sites were found in these areas. In contrast, juveniles were more commonly located in the sandy channel habitats (18.5 individuals / km).
- All survey techniques (aerial census, spotlight counts, spoor counts) may be underestimating the number of large crocodiles present due to their preference for rocky channel habitats where accurate surveying is difficult.
- The low numbers of nest sites and yearling crocodiles located is of concern and may be related to disturbance by the high density of people utilizing the rocky channel habitats and the low number of adult crocodiles present.
- While current levels of persecution appear fairly low, young crocodiles are caught and killed in gill nets, specific problem adults are killed in large pools and eggs and nests are habitually destroyed.
- Crocodile attacks appear to occur each year but fatalities are rare (Section A3.5)

4.2. Other species

- Hippo are relatively common with at least 85 hippo in the study area distributed between three main hippo pools in rocky channel habitat and appear to be increasing in numbers.
- African skimmers (12) were seen in only one main location near the Luambezi confluence in sandy channel habitat and appear to be breeding.
- Impala, kudu and waterbuck are the most common ungulates observed in the study area and appear to increasing in numbers with few old males but large numbers of sub-adults and juveniles.
- Impala were the most common ungulates encountered (15 / km^2) particularly in the open wooded grassland and mixed woodland habitats, but were rarely seen in miombo woodland.
- Niassa wildebeest were never observed in the study area.

Section C: Eco-tourism potential

The study area covers only 1 % of the total core area of Niassa Reserve, yet this small section of the Lugenda valley is of particular interest as it is not only intensively utilized for fishing, honey gathering and plant collection activities by both Niassa residents and "outsiders", but it is also scenically very beautiful with significant eco-tourism potential. The complex mosaic of habitats supports good concentrations of game, particularly impala, waterbuck, kudu and elephant and the open wooded grasslands and mixed woodland allow for good game viewing.. The extensive braided channels in portions of the Lugenda River within the study area are of particular interest as they are the focus for both animals and people. Not only does this habitat provide the best fishing opportunities for net and standard valve trap fishing, but adult crocodiles appear to prefer these channels. In addition the three main hippo pools in the area are all in rocky channel habitat and these pools support more than 80 hippos. These channels provide numerous photographic, game viewing and birding opportunities. Taita falcon, crowned eagle, and bateleur breed in the study area while other good birding species like African skimmer, Pels fishing owl, African finfoot, palmnut vulture, narina trogon and Livingstone flycatcher are seen in the riverine woodland. The scenery, with large inselbergs (*Lipumbulu*, *Nkopola* and *Mbamba*) close to the river, provides a spectacular backdrop for photographic safaris.

While there are currently no villages in the study area there is convincing evidence that this area has been utilized by generations of fishermen and honey gatherers. Not only have many of the fishing camps been in use for decades, but there are also several gravesites in the area, at least two old smelting sites and the grave of Chief Nantusi, which is of spiritual importance to many residents of Mbamba village. Traditional eco-tourism ventures or hunting safaris in this area might be difficult given the large amount of pedestrian and bicycle traffic. Rather the importance of this area to the local people suggests that eco-tourism ventures that include aspects of cultural tourism might be successful here. Not only would cultural tourism broaden the experience for the visitors, but it would also provide local residents with alternative income generating opportunities directly related to their current skills and involve them in the activities in the area. Many of the local fishermen currently utilizing the area consider fishing and the sale of the smoked fish product their only means of obtaining cash and securing the goods they need. Providing other alternatives, would lessen the pressure on the fishery and might have the added benefit of fostering a new appreciation for the value of wildlife.

Many of the current activities of the local people would be of interest to visitors. Traditional walking safaris could be combined with trips to witness honey gathering and fishing techniques, rope and bed making, axe making, forging, and canoe building, all lead by local experts. In addition the locally carved dug out canoes are better designed to navigate the rocky channels than many western designs and day trips down the river lead by experienced local fishermen are an experience already successfully offered by some hunting concessions to their clients. Involvement could be linked to providing incentives for local resource users to buy fishing licenses, use ecologically friendly techniques and minimize game snaring around fishing camps. Similar initiatives have been successfully implemented elsewhere such (for example: Brazil, Anon 2004; Myanmar, Rabinowitz 2001). Operators using this area could then use these opportunities and local knowledge to effectively monitor resource use. A number of crafts suitable for sale to visitors are already being made in the area. We do not believe that the large number of people in this study area necessarily detracts from its potential; rather we believe the people enhance the experience and make Niassa a unique destination different to many of the other competing big game areas.

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Appendices

Appendix: 1: Preliminary list of fishermen utilizing the study area indicating their home village, fishing camp and where possible type of fishing gear. The names marked with an asterix are children or teenagers.

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
ABASI MUSA	MSANGEZI 1	GOMBA / MECULA, N.R	
ABROCIO CHAIBU	GWIMBI 2	MACALANGE, N.R.	1 CHINGUNDENJE NET
ABULQUEQUE MARATI	GRESTINA 1	CABO DEL GADO	
ADAMUS KITWARA	MASSIGULA 2	MBAMBA, N.R.	TRAPS
ADELINO JOAO	NAKATOPI 1 /GRESTINA 3	MBAMBA, N.R.	3 GILL NETS
AJALI LAINI*	MILOLA 1	MBAMBA	7 CHINGOMBO NETS
ALBERTO	NSANGESI	MBAMBA	6 GILL NETS
ALBERTO JOZE	GRESTINA 2	CABO DEL GADO	
ALBERTO MUSSOMA	NAKATOPE	MACALANGE, N.R.	1 TRAP
ALBERTO RACHABU	NAKATOPE 3	CABO DEL GADO	
ALI RACHIDI	GRESTINA 2	CABO DEL GADO	
ALICHANDRE ZIZARIO	GRESTINA 2	CABO DEL GADO	
AMBROCIO CHAIBU	NACATOPE 1	MACALANGE, N.R.	
AMDOTA AUSSIRI	GRESTINA 2	CABO DEL GADO	
AMIODA AUSSI	GRESTINA 2	CABO DEL GADO	
AMISI SALUMU	NTUMBULA 1	MBAMBA	3 TRAPS
AMORI JABRI	NAKATOPE 2	MBAMBA, N.R.	1 CHINGUNDENJE NET
ANRELMO BENKO	GRESTINA 1	CABO DEL GADO	
ANTONIO ACHIBO	NACATOPE 1	MBAMBA, N.R.	5 GILL NETS
ANTONIO JOAO	GWIMBI 1	MBAMBA, N.R.	
ANTONIO MUSSA	NACATOPE 1	MUSSOMA	1 CHINGUNDENJE NET
ANTONIO RASSULI	GRESTINA 2	CABO DEL GADO	
ANTONIO SEBASTIO	NACATOPE 1	CABO DEL GADO	3 GILL NETS
ANTONIO WASSIA	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE, GILL NETS
ARDI MATEMBESSI	NDAMBALALE 2	MECULA	5 GILL NETS
ARMANDO ISSA	NAKATOPI 1	MBAMBA, N.R.	3 GILL NETS
ARTURI ISSA	NACATOPE 1	MBAMBA, N.R.	5 GILL NETS
ASHIMU RAVIKI	MASSIGULA 2	MBAMBA, N.R.	TRAPS
ASSANI BACAR	GRESTINA 2	CABO DEL GADO	
ASSANI BIHAKI	MASSIGULA 2	MBAMBA, N.R.	TRAPS
ASWALA ASSANI	MASSIGULA 2	MBAMBA, N.R.	1 CHINGUNDENJE NET; TRAPS; GILL NETS
ATRESANI	MILOLA 1	MBAMBA	5 GILL NETS
AUGUSTO RACHIDI	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET; GILL NETS
AUMAILI ALIVA	MILOLA 1	MBAMBA	2 GILL NET
AUSI AMIDO*	NACATOPE	MBAMBA	3 CHINGOMBO

Appendix 1: cont…

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
AUSI ASANI	MSANGEZI 1	GOMBA/MECULA, N.R	
AUSI TAULIBU	MILOLA 1	MACALANGE, N.R.	1 TRAP
BACALI HISSUFU	NACATOPE	MBAMBA	2 TRAPS
BACAR MACINCHILI	GRESTINA 1	MBAMBA, N.R.	
BAKILI WAITI	GWIMBI 1	MACALANGE, N.R.	
BANANA LONLA	GRESTINA 2	CABO DEL GADO	
BECHAMI	GRESTINA 1	CABO DEL GADO	
BONDIO NTILA	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET; GILL NETS
CALISO ANTONIO	GRESTINA 2	CABO DEL GADO	
CAMILU HIWENI	MILOLA 1	MBAMBA, N.R.	6 TRAPS
CARLIDU TWALIBU	MILOLA 1	MACALANGE, N.R.	5 TRAPS
CARLINDO SANDALI	NDAMBALALE 1	MBAMBA, N.R.	
CARLOS AUGOSTO	NACATOPE 1	MBAMBA, N.R.	6 GILL NETS
CARLOS SAIDI	NACATOPE 2	MBAMBA, N.R.	6 GILL NETS
CARLOS SANI	GWIMBI 1	MBAMBA, N.R.	
CASIMU CASIMU	MILOLA 1	MACALANGE, N.R.	4 GILL NETS, 3 TRAPS
CASIMU HIWENI *	NACATOPE 2	MBAMBA	5 CHINGOMBO NET
CASSIMU CHAVIER	MASSIGULA 2	MBAMBA, N.R.	TRAPS
CASSIMU DAVIDE	GRESTINA 1	CABO DEL GADO	
CASSIMU WAITI	MILOLA 1	MACALANGE, N.R.	3 GILL NETS
CHABILI CHANGA	MILOLA 1	MBAMBA, N.R.	2 TRAPS
CHAIBO LAIYLA	NSANGEZI	MBAMBA	4 GILL NETS
CHAIBU ASSINI	MPALETA 1	MBAMBA, N.R.	
CHAIME ACHIMU	NAKATOPE		
CHAMBRU ISSA	NAKATOPI 1/GRESTINA 3	MBAMBA, N.R.	6 GILL NETS
CHARIFU MUSA	MSANGEZI 1	GOMBA/MECULA, N.R	
CHARIFU MUSTAFA	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET; GILL NETS
CHEI WAITI	NTUMBULA 1	MBAMBA, N.R.	6 GILL NETS
CHIGWEZO	MILOLA 1	MBAMBA	1 GILL NET
CHOCHI OSCAR	MPOPO	MECULA, N.R.	
CHUMA SANDALI*	NACATOPE 1	MBAMBA	5 CHINGOMBO NETS
CINCO MATOLA	GWIMBI 2	MACALANGE, N.R.	
CITORE CALIFA	GRESTINA 1	CABU DEL GADO	
DAIMO SAIDI	GWIMBI 2	MACALANGE, N.R.	1 CHINGUNDENJE NET
DAIMU VACUWA	MBAMBA	NDAMBALALE	9 GILL NETS
DANIBOI SANDE	NACATOPE 1	MBAMBA, N.R.	4 GILL NETS
DELEMANI AGUSTINHO	GRISTINA 2	CABO DEL GADO	
DIAS AMISSI	MPALETA 1	MBAMBA, N.R.	
DIAS MAURICIO	NACATOPE 2	MBAMBA, N.R.	3 GILL NETS
DINI YASINI	MILOLA 1	MBAMBA, N.R.	2 TRAPS
DOMINGO CHAIBU	GWIMBI 2	MACALANGE, N.R.	
DOMINGO MUSTAFA	MILOLA 1	MBAMBA	1 CHINGUNDENJE NET

Appendix 1 cont…

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
DOMINGO WAITI	MILOLA 1	MBAMBA, N.R.	5 GILL NETS
ERINCU CHAIBU	NACATOPE 1	MACALANGE, N.R.	
ERNESTO LUIA	NTUMBULA 2	MBAMBA, N.R.	
ERNESTO MUSSA	GRESTINA 2	CABO DEL GADO	
ERNESTO MUSSA	GRISTINA 2	CABO DEL GADO	
EURICIO PAULO	NACATOPE 2	MARIRIWI	1 CHINGUNDENJE NET
EURICIO SAIDI	NACATOPE 1	MBAMBA	1 CHINGUNDENJE NET
FELIS ANASTASIO	GRESTINA 2	CABO DEL GADO	
FELIS MUTWARANI	NAKATOPE 3	CABO DEL GADO	
FERDELICOS MIGEL	NACATOPE	MBAMBA	8 GILL NETS
FERNANDO JOAO	GWIMBI 2	MACALANGE, N.R.	
FERNANDU ANTONIO	NDAMBALALE	MECULA, N.R	5 GILL NETS
FRANSISCO NILOTA	GRESTINA 2	CABO DEL GADO	
GERALDO ROMENI	NAKATOPE 3	CABO DEL GADO	
GROMICO AMADE	GWIMBI 2	MACALANGE, N.R.	
HACHI IWENI	NTUMBULA 1	MBAMBA, N.R.	2 GILL NETS
HIDANA MAOLIDI	GWIMBI 1	MACALANGE, N.R.	
HISUFI RAIBU*	NTUMBULA	MBAMBA	3 CHINGOMBO NETS
HISUFI SELEMANI	GWIMBI 2	MACALANGE, N.R.	1 CHINGUNDENJE NET
HISUFI TWALIBU	MILOLA 1	MACALANGE, N.R.	5 GILL NETS, 1 CHINGUNDENJE NET
HIWENI AKIM0	MILOLA 1	MBAMBA, N.R.	4 TRAPS
IMED SAIDI	GRESTINA	CABO DEL GADO	2 GILL NETS
ISSA ASANI	MILOLA 1	MBAMBA, N.R.	3 GILL NETS
ISSA ASSOMANI	CHIYANGWASI	MBAMBA, N.R.	
ISSA AUSSI	CHIYANGWASI	MBAMBA, N.R.	
JABILI CHANGA	MILOLA 1	MBAMBA	2 CHINGUNDENJE NETS
JABRU*	MILOLA 1	MBAMBA	6 CHINGOMBO NETS
JAFER FERNANDO	NAKATOPE 3	CABO DEL GADO	
JAIME ACHIMU	NAKATOPE 2	MECULA, N.R.	
JAIME SELEMANI	NAKATOPE 3	CABO DEL GADO	3 INSEVILA TRAPS
JALI*	MILOLA 1	MBAMBA	5 CHINGOMBO NETS
JAMBRU ISSA	MILOLA 1	MBAMBA	3 GILL NETS
JOAO ANTONIO	GWIMBI 1	MACALANGE, N.R.	
JOAO AUGUSTINO	MASSIGULA 2	MBAMBA, N.R.	TRAPS
JOAO JOZE	GESTINA 1	MONTEPUEZ	1 CHINGUNDENJE NET; GILL NETS
JOSE AUSSI	GRESTINA 2	CABO DEL GADO	
JOSE PEDRU	GRESTINA 2	CABO DEL GADO	1 CHINGUNDENJE NET, GILL NETS
JOZE MANGANDA	GWIMBI 1	MBAMBA, N.R.	
JOZE NTILA	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET; GILL NETS
JUAO JOSE	GRESTINA 2	CABO DEL GADO	1 CHINGUNDENJE NET; GILL NETS
JULIO ALI	NACATOPE	MBAMBA	3 TRAPS
JULIO MARIO	NACATOPE	MBAMBA	1 GILL NET

Appendix 1 cont…

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
JULIO RAIMUNDU	MILOLA 1	MBAMBA, N.R.	3 TRAPS
JUMA GACARIAS	MILOLA 1	MBAMBA	7 CHINGOMBO NETS
JUMA GACARIAS	GRESTINA 1	CABO DEL GADO	
KAWINA ALANDI	CHIYANGWASI	MBAMBA, N.R.	
KIXITO MUSSA	NACATOPE	GOMBA/MECULA, N.R	1 GILL NET
LAINI MACHALIWA	MILOLA 1	MBAMBA	3 TRAPS
LAPIZEIRA ISSA	NAKATOPE 3	CABO DEL GADO	
LIFA RACHIDI	GRESTINA 2	CABO DEL GADO	
LIRES AUASSI	GWIMBI 2	MACALANGE, N.R.	
LOPES NATULU	ARAUJI	MBAMBA, N.R.	
LUIS FERNANDO	NACATOPE	MBAMBA	
LUIS HIWENI	MILOLA 1/NDAMBALALE	MBAMBA, N.R.	8 GILL NETS, 1 CHINGUNDENJE NET
LUIS ISSA	GWIMBI 1	MACALANGE, N.R.	
LUIS MATOLA	GWIMBI 2	MACALANGE, N.R.	
LUIS MUSSA	GGRISTINA 2	CABO DEL GADO	
MACCHI ALAI	MILOLA 1	MBAMBA, N.R.	1 TRAP
MACHOLO MILHANI	MASSIGULA 2	MBAMBA, N.R.	TRAPS
MADERU SELEMANI	MILOLA 1	MBAMBA, N.R.	6 GILL NETS
MADERU WAITI	MILOLA	MBAMBA	2 GILL NETS
MAJALIWA LAINI	MILOLA 1	MBAMBA, N.R.	6 TRAPS
MALORE ADAMO	NAKATOPE 2	MECULA, N.R.	
MANGANDA SAIDI	GWIMBI 1	MBAMBA, N.R.	
MANJACHO YASSI	MPALETA 1	MBAMBA, N.R.	
MARIO BERNADO	NACATOPE 2	MBAMBA, N.R.	3 GILL NETS
MARIO SANDALI	MILOLA 1	MBAMBA, N.R.	4 TRAPS, 4 GILL NETS
MARIO ZUBER	GRESTINA 1	CABO DEL GADO	
MARTIO SAIDI	NAKATOPI 1	MBAMBA	3 GILL NETS
MARTIS WEJE	NACATOPE	MBAMBA	
MARXAUTE SAIDE	GRESTINA 2	CABO DEL GADO	
MASENGO JULIO	NAKATOPI 1/MTOALILE	MBAMBA, N.R.	4 GILL NETS
MASSAMBUCA MASIGIR	GRESTINA 1	MBAMBA, N.R.	
MATAKIWA NGOLANGA	NDAMBALALE 1	MBAMBA, N.R.	13 GILL NETS, 10 TRAPS
MAURICIO WAITI	MILOLA 1	MBAMBA, N.R.	6 GILL NETS
MDALA ABASI	MPALETA 1	MBAMBA, N.R.	
MIDO AFAIA	GRESTINA 2	CABO DEL GADO	
MIGEL ACHABA	GWIMBI 1	MACALANGE, N.R.	
MOMADI IASSSINI	GRESTINA 1	MBAMBA, N.R.	
MORI CHAMBE	NACATOPE	MBAMBA	1 CHINGUNDENJE NET; GILL NETS
MORI JABILI	NTUMBULA	MBAMBA	1 CHINGUNDENJE NET; GILL NETS
MTOMULA BUBACALI	NACATOPE 2	MBAMBA, N.R.	4 GILL NETS
MUCA ALUFANI	MILOLA 1	MBAMBA, N.R.	4 TRAPS

Appendix 1 cont…

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
MUEMEDI SAIDI	GWIMBI 1	MACALANGE, N.R.	
MUEMEDI WAITI	GWIMBI 1	MACALANGE, N.R.	
MUSA YASINI	MSANGEZI 1	GOMBA/MECULA, N.R	2 TRAPS
MUSTAFA MASSIVIRI	MILOLA 1/NTUMBULA	MBAMBA, N.R.	4 GILL NETS
NDALA TUALIBU	MILOLA 1	MACALANGE, N.R.	4 GILL NETS
NGONGO MASIVILI	NTUMBULA 1	MBAMBA, N.R.	4 GILL NETS
NHOLE SANDI	NTUMBULA 2	MBAMBA, N.R.	
NIWAYA	LICJANJE	MBAMBA, N.R.	
NOME MATEGEWA	NDAMBALALE	MBAMBA	4 GILL NETS
OSCAR MUSTAFA	MPALETA 1	MBAMBA, N.R.	
OZEBIO WAITI	MILOLA 1	CABO DEL GADO/MBAMBA	5 GILL NETS
PEDRU ASSANE	GRESTINA 2	CABO DEL GADO	
RACHABU SILVA	NDAMBALALE	5 CONGRESSA, MECULA	5 GILL NETS
RACHIDI	CHIYANGWASI	MACALANGE, N.R.	4 GILL NETS
RAFEL BERNADO	GRESTINA 2	CABO DEL GADO	
RAIMUNDO MWTUIGUELA	GRESTINA 2	CABO DEL GADO	
RAIMUNDU MUICATA	GRESTINA 2	CABO DEL GADO	
RAIMUNDU TWALIBU	MILOLA 1	MACALANGE, N.R.	5 GILL NETS, 3 TRAPS
RAJA SIKIRANA	MASSIGULA 2	MBAMBA, N.R.	TRAPS
RAJABU ANTONIO	NDAMBALALE	MECULA, N.R	5 GILL NETS
RAUHIDI SINDI	NTUMBULA 2	MBAMBA, N.R.	
ROZARIO SAIDI	NTUMBULA 2	MBAMBA, N.R.	
SABITI USENI*	NTUMBULA	MBAMBA	8 CHINGOMBO NETS
SADINA SUKIRI	MASSIGULA 2	MBAMBA, N.R.	TRAPS
SAIDI JOSE	GRESTINA 2	CABO DEL GADO	
SAIDI LYAYA*	NACATOPE 2	MBAMBA	10 CHINGOMBO NETS
SAIDI MASSAMBUCA	GRESTINA 1	MBAMBA, N.R.	
SAIDI MVONPE*	NAKATOPE 1	MBAMBA	6 CHINGOMBO NETS
SAIDI REMUS	MASSIGULA 2	MBAMBA, N.R.	
SAIDI SELEMANI*	NAKATOPE	MBAMBA	7 CHINGOMBO NETS
SAIMINI MAURIDU	NTUMBULA 2	MBAMBA, N.R.	
SAMUEL ASSIMO	NAKATOPE 2	MECULA, N.R.	1 TRAP
SAMUEL ISSA	GWIMBI 1	MACALANGE, N.R.	
SANDALI IBU	MILOLA 1	MBAMBA, N.R.	2 GILL NETS, 4 TRAPS, 1 CHINGUNDENJE NET
SEBASTIAO	GRESTINA 1	CABO DEL GADO	
SELIVEIRIO ANTONIO	GRESTINA 1	CABU DEL GADO-MONTEPUEZ	
SEM MGONGO	NTUMBULA	MBAMBA	3 TRAPS
SEMA SAIDI	NTUMBULA 2	MBAMBA, N.R.	
SIDE MACASI	MPALETA 1	MBAMBA, N.R.	
SOMAILI LAZARO	GRISTINA 2	CABO DEL GADO	
SOMAILI PEVEIRIO	GRESTINA 1	CABU DEL GADO	
SUCUSI BACALI	NACATOPE	MBAMBA	4 GILL NETS

Appendix A cont…

NAME	FISHING CAMP	ORIGIN	FISHING GEAR
SUMAILI DUWA	MILOLA 1	MBAMBA, N.R.	4 GILL NETS
SUMAILI SAIDE*	NACATOPE	MBAMBA	4 CHINGOMBO NETS
TENJA SAIDI	NAKATOPE 2	MBAMBA, N.R.	
TEWATEWA SIAMINI	MPOPO	MBAMBA, N.R.	
TRECEIANO RACHIDI	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET
TUALIBO BRITOS	CHIYANGWASI	MACALANGE, N.R.	1 CHINGUNDENJE NET
VALAVALA	NTUMBULA 2	MBAMBA, N.R.	
WAHAJI IMEDI	GRESTINA	CABO DEL GADO	1 GILL NET
WAITI BWANALI	MILOLA 1	MBAMBA, N.R.	2 TRAPS
WAITI MASIVILI	NTUMBULA	MBAMBA	3 GILL NETS
WAITI SELEMANI*	NACATOPE 1	MBAMBA	3 CHINGOMBO NETS
XAVIER ANTONIO	NDAMBALALE	MECULA	10 GILL NETS
YAAYA MULACA	NACATOPE 2	MBAMBA, N.R.	7 GILL NETS
YAFAR SAIDE	CHITOPICHWE	MACALANGE, N.R.	3 GILL NETS
YUMA SANDALI*	NTUMBULA	MBAMBA	3 CHINGOMBO NETS
ZAWADI YASSI	MPALETA 1	MBAMBA, N.R.	
ZIELE JOAO	NAKATOPE 2	MECULA, N.R.	1 CHINGUNDENJE NET
ZURICO PAOLA	NACATOPE	MONTEPUEZ	1 GILL NET

Appendix 2: Preliminary list of local influential fishermen utilizing the study area during 2004 .

Name	Camp	Village
DANDAWILE ARIDI	CHITOPICHWE	MBAMBA, N.R
MIGEL ACHABA	GWIMBI 1	MBAMBA, N.R
CHAIBU ASSINI	CHIYANGWAZI 1	MBAMBA, N.R
JOZE MANGANDA	MPALETA 1	MBAMBA, N.R
NIWAYA	LICJANJE & CHIPUYE	MBAMBA, N.R
MATAKIWA NGOLANGA	NDAMBALALE, MACHAA	MBAMBA, N.R
LOPES NATULU	ARAUJII -	MBAMBA, N.R
ROZARIO SAIDI	.	MBAMBA, N.R
TEWATEWA SIAMINI	MPOPO	MBAMBA, N.R
SANDALI IBU	MILOLA 1 & 2	MBAMBA, N.R
MASAMBUCA MASIGIRI	GRESTINA 1	MBAMBA, N.R
CARLOS AUGUSTO	NAKATOPI 1	MBAMBA, N.R
ABROSIO CHAIBU	GWIMBI	MACALANGE, N.R
CHEFE NGONGO	NTUMBULA	MBAMBA, N.R
MUSA YASINI	MSANGEZI /NAKATOPE 1	MECULA. N.R

Appendix 3:

Ficha de Monitoria / Fish Monitoring Form

Data / Date: _____/ _____/ _____ **Registado por /** Recorder: _____

1. Nome do pescador:
Name of fisherman:

2. Proveniência:
Origin (village, country):

3. Acampamento:
Fishing camp:

4. Arte:
Fishing method:
Nasa Rede Insevila Chigundenje Chingombo
Other:

5. N^0 rede / nasa:
N^0 nets / traps:

6. Malha rede:
Mesh size:

7. Effort
N^0 lances / dia / hora:
N^0 throws/ days/ hours:

8. Captura total (kg):
Catch total (kg):

9. Habitat:

Composição da captura Catch composition		**Peso da amostra (Kg)** Weight of sample (kg)	
Ordem Order	**Espécie (nome local** Species (local name)	**N^0**	**Peso (kg)** Weight (kg)
Total			

Observacoes gerais / Comments

Dados biometricos / Biometric data

Length / Comprimentos (mm)					
Especie: Species		Especie: Species		Especie: Species:	
Class	No.	Class	No.	Class	No
Especie Species		Especie: Species		Especie: Species	