GROWTH AND MORTALITY OF BUKA FISH, *LATES STAPPERSII* (BOULENGER, 1914) IN THE SOUTHERN PART OF LAKE TANGANYIKA, ZAMBIA

BY

NONDE ELVIS

A dissertation submitted to the University of Zambia in partial fulfillment of the requirements for the degree of Master of Science in Tropical Ecology and Biodiversity

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DECLARATION

I, Nonde Elvis, declare that the work contained in this dissertation is my own work and that it has not been previously submitted for any award at this University or any other institutions. All published work or material from other sources included in this report have been specifically acknowledged and adequate reference thereby given.

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CERTIFICATE OF APPROVAL

This dissertation by Nonde Elvis entitled: "The growth and mortality of the, *Lates stappersii* (Boulenger, 1914) in the southern part of Lake Tanganyika, Zambia," has been approved as fulfilling the partial requiremnets for the award of the Degree of Master of Science in Tropical Ecology and Biodiversity of the University of Zambia.

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ABSTRACT

Population growth parameters and mortality rates of *Lates stappersii* were investigated for the southeast and southwest arms of Lake Tanganyika, Zambia from April, 2022 to August, 2022. Exploitation ratio was studied. Furthermore, water quality parameters were investigated. Fish samples were procured from purse-seine fishers in Mpulungu and Nsumbu sectors of the lake. A total of 1,526 specimens with 642 females and 884 males for both sites were collected, examined and analyzed. The von Bertalaffy growth model was used to determine fish growth. The Ford-Walford plots were used to estimate the von Bertalanffy growth parameters (Asymptotic length L_{∞}, and growth coefficient, k). Exploitation ratios (E) were computed from estimated mortality rates (total mortality coefficient, Z; natural mortality coefficient, M and fishing mortality coefficient, F). To test for statistically significant differences, T-test analysis was used.

It was established that there was no significant difference in growth parameters between samples collected from Mpulungu and Nsumbu areas of Lake Tanganyika. No statistical differences were observed in two of the water quality parameters; dissolved oxygen and temperature between the two areas. There was a difference in water transparency between the two areas. It was Further observed that fishing mortalities and exploitation ratios were consistently high and not significantly different between the two areas. The study therefore, established that both areas are inhabited by the same population of *Lates. stappersii*. From these results it is recommended that a fishery management strategy should not redistribute or focus on increasing fishing units in Nsumbu area to those in Mpulungu because this will not result in corresponding catch yields but will only increase the current overexploitation of the stock.

DEDICATION

To my mother Charity Nonde Chongo, and my father Nonde Journes Kapasa

To my late Auntie Jessy Mulenga and Late cousin Johnstonne Mulenga

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LIST OF SYMBOLS

a	Intercept of the regression curve in length- weight relationship
b	Regression coefficient in length-weight relationship
e	Natural logarithm
Φ'	Growth coefficient Performance Index
g	Grammes
mm	Millimeter
n	Number of fish in the sample
L'	Smallest length fully represented in the sample
R^2	Correlation coefficient of the regression line.
k	Growth coefficient
Log_{10}	Logarithm (Raised to base 10)
L_t	Length of the fish at a specific time or age.
L_∞	Asymptotic Length or Length at Infinity that can be attained if the fish grows to an infinity age
t_0	Theoretical age of fish when length is zero
p	Probability
F	Fishing mortality coefficient
Z	Total mortality coefficient
M	Natural mortality coefficient
E	Exploitation ratio

LIST OF ABBREVIATIONS

%	Percent
ASL	Above Sea Level
CAS	Catch Assessment Survey
CIFA	Committee on inland fisheries of Africa
CpUE	Catch per unit of effort
DF	Degrees of freedom
DoF	Department of Fisheries
ELEFAN	Electronic LEngth Frequency ANalysis
FAO	Food and Agricultural Organizations of the United Nations
FL	Fork length
FS	Percentage of Full-Scale accuracy
GDP	Gross Domestic Product
GRZ	Government the Republic of Zambia
LSD	Least significant Differences
LWR	Length-Weight Relationship
SCLA	Statistical Catch Length Assessment
SE	Southeast arm
SL	Standard Length
SW	Southwest arm
TL	Total Length
VBGF	Von Bertalanffy Growth Function

Chapter 1 : INTRODUCTION

1.1 Site description

Lake Tanganyika is situated in the western branch of the Rift Valley system between latitude 3°20' and 8°48' S and between longitude 29° 03' and 31°12' E at an altitude of 773m above sea level (ASL) (Lowe-McConnell, 1975; Jorgensen et al., 2006). Lake Tanganyika together with Lakes Malawi and Victoria form the great rift valley lakes of Africa (Lopez-Rojas et al., 1988). The lake was formed as a result of the tectonic movements in the earth's crust and it is shared by four riparian states: Burundi (8%) in the north-east, Democratic Republic of Congo (45%) in the west, Tanzania (41%) in the east and Zambia (6%) in the south as shown in (Fig 1.1) (Jorgensen et al., 2006).

Figure 1.1: Showing Lake Tanganyika basin

1.2 Limnology of Lake Tanganyika

The morphometric features of Lake Tanganyika are typical of a tectonic lake. The lake has a maximum depth of 1,470m with a mean depth of 570m, this makes it the second deepest lake in the world after Lake Baikal in Siberia, whose maximum depth is 1,741m.

The maximum length of the lake is 673km with a maximum width of 50km. The surface area is 32,900km^2; making it the second largest African lake after Lake Victoria. The lake's full water capacity is 18,900km^3 accounting for about 17% of the freshwater of the world (Coulter, 1970; Lopez-Rojas et al., 1988; Mannini, 1998; Lowe-McConnell, 2003). The Zambian shoreline is 215km long, approximately 12% of the total 1,825km coastline of Lake Tanganyika. The Zambian mean depth is 700m with a surface area of 2000km^2 and 1,140km^3 volume of water (Phiri and Shirakihara, 1999). The lake area has dissolved oxygen up to 200m depth. There are diel variations in oxygen concentrations according to depth (Plisnier et al., 1999).

Lake Tanganyika is a meromictic with permanent density stratification of water with an anoxic monimolimnion. This stratification is mainly dependent on temperature differences. The southern water temperatures vary during the year between ~24.0°C and 28.5°C (Plisnier, 2004) and annual temperature variation offshore is 2°C (25.5-27.5°C) at 10m depth in the south (Coulter, 1997). Temperature of bottom waters is close to 23.4°C. This thermal gradient is linked to a strong gradient of nutrients. The epilimnion is always well mixed, and in addition to wind mixing process, laminar flow, rotating internal currents and turbulence associated with internal waves at the thermocline. The hypolimnion is thermally very homogeneous, anoxic and chemically enriched. Nutrients for biological production are supplied by upwelling and hypolimnion advections nearshore through internal waves. Main phytoplankton maxima at south end are from May to September (Coulter, 1977; Plisnier, 2004)

1.3 Climatic conditions of southern part of Lake Tanganyika

The lake experiences two main seasons: the wet season (October to May) characterized by weak winds, high humidity, considerable precipitation (900mmyear^{-1}) and frequent thunderstorms and the dry season (June to October) characterized by moderate precipitation and strong, regular southerly winds (Jorgensen et al., 2006). Reports indicate that the cool season has a marked decrease in wind velocity from $5.8 \pm 1.6 ms^{-1}$ to $4.0 \pm 1.3 ms^{-1}$. Local records of air temperature from Lake Tanganyika region also show warming that is consistent with global patterns. For instance, a rise of 0.5 - 0.7°C in average annual temperature is consistent with global increase of 0.6± 0.2°C (O' Reilly et al., 2003)

1.4 Fish species composition of Lake Tanganyika

It is estimated that Lake Tanganyika has 325 fish species of which 250 are cichlid species and 75 are non-cichlids species 98% and 60% of which respectively, are endemic to the lake (Jorgensen, et al., 2006; Hattula and Sarvala, 2012).

Although, the lake has highly unique biodiversity of fish species they may be endangered due to overexploitation (Mölsa, 2008). The fish community is found in the littoral and benthic zones of the lake. The pelagic waters range from a 200m depth and above; this zone has six endemic species which include two clupeids *Limnothrissa miodon* (Boulenger, 1906) and *Stolothrissa tanganicae* (Regan, 1917), locally called Kapenta in Zambia, while in Burundi, DRC and Tanzania they are known as Ndagala (Van der Klaap et al., 2014). The four endemic centropomids, *Lates* species include; *Lates angustifrons* (Boulenger, 1906), *Lates mariae* (Steindachner, 1909), *Lates microlepis* (Boulenger, 1898) and *Lates stappersii* (Boulenger, 1914). The other three (3) *Lates* spp are larger and predators of *L. stappersi*. These larger Lates spp inhabit mostly the littoral areas within macrophytes during the early stages of their life until they attain a total length of about 350mm when they start dispersing into offshore areas (Lowe-McConnell., 1975; Pearce, 1995). *L. stappersii* locally called Mukeeke in Burundi and DR.Congo, Migebuka in Tanzania and Mvolo or Buka-Buka/Bukafish in Zambia (Munyandorero, 2001) is completely pelagic and usually lives near the surface in the upper 30m depth.

The stock of young and adult *L. stappersii* both feed on the same foods namely; clupeids, prawns, and shrimps. But young *L. stappersii* take also pelagic phytoplankton and zooplankton (e.g Mesocyclops spp, Kiefer, 1929), Atyid *Limnocardina parvula* (Calman, 1906) followed by the palaemonid. Marked diel vertical feeding migrations influenced by food availability have been observed (Munyandorero and Mwape, 2003). The juveniles are too mobile and usually move between inshore and offshore areas before permanently maintaining the pelagic life-style (Coulter, 1970; Lowe-McConnell, 1975; Mannini, 1998; Mölsa, 2008).

1.5 Lake Tanganyika fisheries

In Lake Tanganyika (Fig1:1), exploitable fisheries resources consist mainly of six pelagic fish species as mentioned above which are endemic to the lake. Commercially, the two clupeid species and *L. stappersii* are the main targets of Lake Tanganyika fisheries, contributing well over 65% and 30% respectively by weight of the total catches from the lake (Hanek et al., 1997; Reynolds, 1999; Mölsä et al., 1999; Munyandorero, 2001). The Zambian Lake Tanganyika fishery is geographically in two distinct areas referred to as the southeast - Mpulungu areas and southwest arm -Nsumbu area (Pearce, 1995). For statistical fisheries data collection and management purposes the fishery has been divided into four (4) strata, (i.e., I. II, III, and IV) since 1964. The first three (3) strata are found in Mpulungu area, and the fourth (4) stratum is located in Nsumbu area(Paffen et al., 1977; DoF, 2012). Statistical records at Department of Fisheries, Chilanga (DoF, 2012; 2013) show that Mpulungu area has a total of 60 fishing villages and 71 landing sites while Nsumbu in the south-western arm has 25 fishing viallges and about 17 landing sites. The 2011 frame survey for Lake Tanganyika, Zambia shows that there are 2,320 total vessels that have advanced equipment and meant for carrying small light fishing boats, the crew of up to more than four of fishers and sometimes are also used in the actual fishing exercise and 2,327 total fishing boats which are relatively smaller ans are do not have complex equipment, usually managed by one or crew of up to 4 members and 8,420 fishermen, presenting an unprecedented doubling of active fishing boats and number of fishers compared to the ones recorded during the 1995 frame survey (Petit and Shipton, 2012; van der Knaap, 2014). The fishing boats are distributed among the strata as follows; stratum I-322, stratum II-635, stratum III-603 and stratum IV-767 (Petit and Shipton, 2012).

According to CAS statistics for Lake Tanganyika by the Department of Fisheries, there is a high number of fishers and fishing boats concentrated in the south-eastern arm compared to the south-western arm (DoF, 2012), implying that there is more fishing pressure in Mpulungu than in Nsumbu area (Mannini, 1998). Further, the assumption is that: there is low fishing effort among fishers residing in fishing villages with fewer fishing boats compared to those whose fishing villages have more fishing boats (DoF, 2012).

The biology and ecology of *L. stappersii* have been reported in some parts of the lake. For instance, Mannini et al., (1996) and Mannini, (1998) generated information on the biology and ecology of *L. stappersii* from a lake-wide survey but this work did not cover the southwest arm, Nsumbu area. Several local studies were conducted; in Burundi, Ellis, (1978) looked at the biology of *L. stappersii,* in Tanzania Chitamwebwa and Kimirei, (2005) generated information on the present fish catch trends at Kigoma while Mulimbwa, (2006) assessed the impact of artisanal fishing on *L. stappersii* in Bujumbura and Kigoma sub-basins of Lake Tanganyika. Kimirei and Mgaya, (2009) also assessed the status of *L. stappersii* in lift-net from Kigoma. From the Zambian part of the lake; Coulter, (1976) looked at the status of lates spp including *L. stappersii*, Pearce (1985) carried out a stock assessment on the pelagic fisheries *L. stappersii*, whose further work in 1995, looked at the effects of expoitation on the fish community in the south of the lake. Musonda (2000) produced localized information on some reproductive aspects of *L. stappersii* in the southern part of Lake Tanganyika, Zambia. Although, reports by Pearce, (1985); Mannini et al., (1996) and Mannini, (1998) generated information about the growth and mortality of *L. stappersii* from the Zambian waters, it is clear that only Mpulungu area was substantially covered in all these studies. There is a lack of information about the growth and mortality from Nsumbu. The area is in stratum IV and has been a very important commercial fishing area for *L. stappersii* since the beginning of purse seining on the pelagic stocks. Yet, there is no past or recent specific/biological and comparable information for the species in the different fishing areas that could be used in assessing whether the southeast and southwest arms of the lake have different and isolated subpopulations or not. Equally, there has been lack of data to assess how populations in these two locations have been responding to extreme fishing pressure. Therefore, this study was embarked on to estimate the growth paramters, mortality rates and exploitation of *L. stappersii* using population parameters with a view to determining whether the two areas are inhabited by the same fish stock. Further, water quality parameters were also determined and compared under this study.

1.6 Problem statement

There is uneven distribution of fishing effort between Mpulungu and Nsumbu areas in the southern part of Lake Tanganyika. There has been lack of evidence that intensive fishing pressure in Mpulungu area does not affect *L. stappersii* stocks in Nsumbu area. Phiri, (1992) recommended the expansion of the fishery in the south-western arm as a way of reducing the fishing pressure in the south-eastern one.

Recent recommnedations towards the management of *L. stappersii* have been advanced to direct or re-distribute some fishing boats operating in Mpulungu area to fishing grounds in Nsumbu area which is speculated to be less heavily exploited (Plisnier, 1995; Mannini, 1998). There is no indication that the *L. stappersii* exploited in Nsumbu area is different from that in Mpulungu area. It may not be correct that giving additional fishing licenses in Nsumbu area or transferring those operating in Mpulungu to Nsumbu would result in significant catch increase if the *L. stappersii* fish stock exploited in Mpulungu is the same as that found in Nsumbu.

For pelagic species, catch per unit of effort (CpUE) and total effort data cannot be used independently as an effective fishery management strategy because evidence shows that for pelagic species such as *L. stappersii*, CpUE is not a good index of abundance as the catchability coefficient can change with stock size and with stock distribution (Pearce, 1995). Therefore, there was a need to conduct a comparative study to estimate population growth and mortality parameters of *L. stappersii* in the Mpulungu and Nsumbu arms of Lake Tanganyika in the Zambia side.

1.7 Objectives

1.7.1 General objective

The overall objective of this study was to investigate and compare the growth and mortality rates of *L. stappersii* in Mpulungu and Nsumbu southern parts of Lake Tanganyika in Zambian side using fish population parameters.

1.7.2 Specific objectives

The specific objectives for this research were:

1. To determine the growth parameters (growth coefficient, k and Asymptotic length,(L_∞) of *L. stappersii* in Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.

2. To estimate the mortality rates (total mortality coefficient, Z; natural mortality, M; fishing mortality, F) of *L. stappersii* in Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.
3. To estimate the exploitation ratios of *L. stappersii* in Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.
4. To determine the water quality parameters (transparency, temperature and dissolved oxygen and pH) in Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.

1.8 Hypotheses of the study

1. There are no differences in the growth parameters (growth coefficient, k and Asymptotic length, L_{∞}) of *L. stappersii* between Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia
2. There is no difference in mortality rates (total mortality coefficient, Z; natural mortality, M; fishing mortality, F) of *L. stappersii* between Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.
3. There is no difference in exploitation ratios of *L. stappersii* between Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.
4. There is no difference in water quality parameters (transparency, temperature, dissolved oxygen and pH) in Mpulungu and Nsumbu areas of Lake Tanganyika, Zambia.

1.9 Significance of the study

It is estimated that 68% of the Zambian population are living below the national poverty line with rural areas mostly affected (Musumali et al., 2009). The population in the two areas keep on increasing, according to the GRZ, (2010) Zambian census the population around Nsumbu area was 48,633 while the population in Mpulungu was at 98,073 (Sweke et al., 2013). The current population records based on the 2022 census report show that the population for Nsumbu area is at 77, 651 with Mpulungu at 153,564 respectively, (GRZ, 2022). The terrain around the lake does not provide enough arable land, so riparian population of the lake basin depend on fishing activities as their mainstay (Reynolds and Hanek, 1997; Munshimbwe and Ng'andu, 2000).

This therefore means that once *L. stappersii* depletes being the main commercial target stock in the southern part of the lake, populations around Nsumbu and Mpulungu areas will face serious food insecurity situation and an increase in poverty levels. Other important contributions of fish production especially to the rural economy includes: employment generation, earnings, and a source of food about 25-40% of animal protein is derived from fish and that fisheries and aquaculture contribute about 3.2% to Zambia's Agricultural Gross Domestic Product (GDP) (GRZ, 2023).

Given the position of Lake Tanganyikas in Zambian capture fisheries; it implies that *L. stappersii* makes a substantial contribution to this figure. It is further estimated that 300,000 people in the country earn part of their income directly as fishers or indirectly as traders, processors and other service providers (boat building and repair, net manufacturing, fuel wood supply, power supply and transportation) (Musumali et al.,2009; Ngoma et al., 2014). According to the The World Bank, (2018) and Bulengela et al., (2020) the main natural resources found in in the lake basin are sources of livelihood and income for over 12 million people. In Zambia alone over one million people now depend on fisheries (GRZ, 2023). In fact, the majority of the communities along Lake Tanganyika basins depend on fishing and agriculture as their primary and often the only source of income and livelihood (Jorgensen et al, 2006). In 2018, according to GRZ, (2021) the production from capture fisheries was estimated at 89,195 metric tonnes. *L. stappersii* alone accounts for about 95% biomass of all catches within the national boundaries of Zambian waters (Plisnier, 1995; Mölsa, 2008).

Lake Tanganyika is recognized as one of the most diverse aquatic ecosystems, with its endemic fauna, making it a world Heritage (Mannini, 1998; Mölsa, 2008) this status is maintained with the help of *L. stappersii* being one of the top predators in this ecosystem. Despite the numerous contributions of the species to the socio-economic status of the populations among the riparian communities, maintainance of the biological diversity and being an endemic species of the lake. The species' stock continues to deplete due to over-exploitation. Therefore, this study found its justification here because information that was generated could be used in the formulation of fishery management policies to ensure rational exploitation of *L. stappersii* as a resource of the Zambian part of Lake Tanganyika.

Chapter 2 : LITERATURE REVIEW

2.1 Growth of Lates stappersii

The Growth of *L. stappersii* from some parts of the lake were reported by some researchers. These studies were respectively conducted in local waters and mostly did not substantially cover all parts of the lake. In Burundi, Ellis used length -frequency data and produced a bimodal distribution formed by the juveniles and adult specimens (Ellis, 1978). While the growth of *L. stappersii* in the Tanzanian side as estimated by Chapman and van Well, (1978) indicated that adult fish generated only one modal. The juveniles' length-frequency distributions yielded two modal series. Around Kigoma area in Tanzania, Chapman and van Well, (1978) estimated the von Bertalanffy growth parameters, Asymptotic length (L_∞ = 450mm) , and growth coefficient (k = 0.40year^{-1}). Pearce, (1985) estimated these growth parameters for Mpulungu area at Asymptotic length, (L_∞ = 480mm), growth coefficient, (k = 0.39year^{-1} and growth performance index, (Φ' = 4.95). An analysis, of the 1995 lake survey of the catch compositions showed that several cohorts could be identified which could include 0+, 1+, 2+ years. Based on the samples obtained in Mpulungu area alone Mannini, (1998) estimated the mean values for fish growth paramters in 1998 study to be about asymptotic length (L_∞ = 510mm), growth coefficient (k= 0.36year^{-1}) and growth performance index (Φ= 5.04)

2.2 Mortality of Lates stappersii

Lates stappersii experiences both natural mortality and fishing mortality. According to Coulter, (1970) Lake Tanganyika is a stable lake largely because of its latitude and great depth. The relatively constant temperature conditions do influence the lake biota profoundly and reduce the magnitude of seasonal checks in growth, reproduction of fish and the variation in abundance of food. Coulter, (1976) noted that environmental factors determine fry survival because phytoplanktonic food supply is predicted by the changes in temperatures and velocity of the wind which have direct effect on mixing of water from the epilimnion and hypolimnion. The mixing effects influences primary productivity of the lake. Mannini, (1998) indicated that the planktonic larval stage may suffer high and variable mortality because of fluctuations in pulsed primary productivity which depends on the prevailing environmental factors.

Previous estimations on fishing mortality for *L. stappersii was* shown to be higher in southern waters of the lake. This was attributed to the small size of the area and high concentration of industrial fishing gears. It was reported that mortaliy due to natural causes such as food shortage was lower given the predatory nature of the species which could allow it to switch between the clupeids if was at low densities with the abundant shrimps (Mannini, 1998). The 1995 study by Aro and Mannini, (1995) reported signs of stock depletion that meant, any further increase of fishing effort (F) was not going to be sustainable. A similar observation was reported during the 1988 assessment in DR. Congo at Uvira part of Lake Tanganyika. The study showed that a stock was heavily exploited and vulnerable to overexploitation in future.

In Kigoma sub-basin (Kazimia), Mulimbwa, (2006) reported that *L. stappersii* stock recruited very early to artisanal fishery, before the size of maturity but the coefficient of total mortality was low, this suggested a moderate fishing pressure in the area at that time. Recently, a *L. stappersii* stock assessment done in Burundi (Roest, 2013) reported that fishing effort per square meter of the area was high. Due to an early recruitment to the fishery and high fishing mortality a cohort of *L. stappersii* stock can only grow up to 350mm at 5 years, then all is usually fished (Ellis, 1978). In case of the southern waters there are indiscrimate fishing gears reported that are not well defined and all fleets take catch from the clupeids and latid stocks (Munyandorero, 2002).

2.3 Water quality parameters

After the establishment of the Lake Tanganyika Research project (LTR) in 1977 by the FAO/FINNIDA, Committee for Inland Fisheries of Africa (CIFA), three of the six objectives were to conduct researches on the hydrodynamics, fish and phyto/zooplankton biology and limnological parameters (Hanek et al., 1997; Mölsa, 2008). Since then, some studies were conducted in the four riparian states by both local and international scholars (Plisnier et al., 1999; Plisnier, 2000; O'Reilly et al., 2003; Descy et al., 2005; Sarvala et al., 2006; Verburg et al., 2006). It is believed that Lake Tanganyika is meromictic permanently stratified with an anoxic monimolimnion (Plisnier, 2004).

This stratification is mainly dependent on temperature differences. The stratification intensity varies according to the season being sharper in the wet season when winds are weak and stronger during dry season. The stratification difference is noticeable along the longitudinal lake axis inferred from shallow stratified layers in the north while the south experiences strong stratification (Plisnier et al., 2009).

During the dry season from May to September the lake experiences strong southeast (SE) trade winds which are thought to bring about mixing and upwelling. Phytoplankton and primary productivity of the lake is to a large extent based on nutrients supplied from the anoxic hypolimnion through these various mixing processes (O'Reilly et al., 2003; Jornsenberg et al., 2006; Sarvala et al., 2006; Plisnier. 2009). Recent reports have indicated that the lakes' surface water temperatures have increased and this is consistent with global weather pattern predictions while the wind velocity has reduced compared to previous records (Lowell- McConnell, 2003, O'Reilley et al 2003, Verburg et al, 2003, Sarvala et al.,2006). These changes are now linked to reduced mixing and diminishing deep-water nutrient inputs to the surface waters, an occurrence believed to have a directly negatively impact on primary productivity and a subsequent decline in fish production (O'Reilly., 2003; Plisnier et al., 2018).

Chitamwebwa and Kimirei, (2005) and Huttula and Sarvala, (2012) have reported that fishing pressure compounded by short-term variability in environmental conditions may affect fish production of the lake. Further limnological works have indicated that water transparency influences the growth and mortality of *L. stappersii* a gregarious visual predator (Mannini, 1998). This is because of its need for light to find food, based on this habit fishers use artificial lighting to attract its prey around their boats and in the process, it ends up being caught in the nets. The study on the limnological variability in Lake Tanganyika Plisnier et al., (2009) found that the occurrence of juveniles of *L. stappersii* was significantly correlated with the transparency of water while the abundance of adult *L. stappersii* was observed to be influenced by both water transparency and dissolved oxygen demands. This probably explains the reason why high densities of *L. stappersii* stock are found in very steep areas of the lake with high water transparency (Mannini, 1998; Plisnier et al., 2009).

Chapter 3 : MATERIALS AND METHODS

3.1 Description of study area

Lake Tanganyika is located in the northern province of Zambia, whose the lake shore has the southeast (SE) arm in Mpulungu district and the southwest (SW) arm in Nsumbu area of Nsama district (fig 3.1). Mpulungu basin lies between latitude -8° 45' 44.42"S and longitude 31°06'50.58" E and remains the only port to Zambia on Lake Tanganyika while Nsumbu Bay in Nsama district lies between latitude -8° 44' 38.18"S and longtitude 30° 22' 57.68"E on the southern extremity of the lake (fig 3.1). The two areas are part of the south lake basin of Lake Tanganyika. The southwest arm is shallower and has gentle sloping shelf while the southeast arm has very steep slopes created by the escarpment (Paffen et al., 1997; Phiri and Shirakihara, 1999)

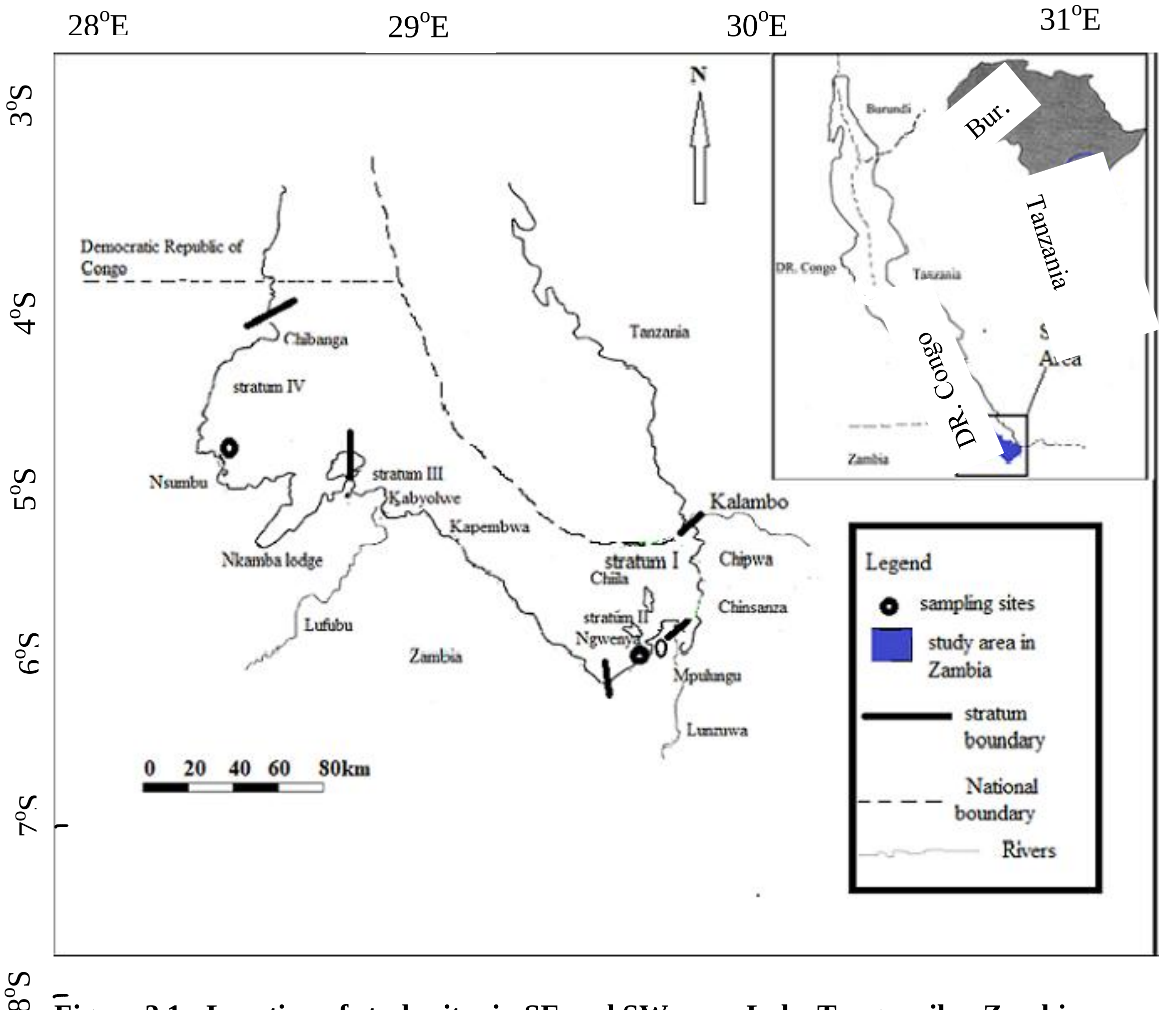


Figure 3.1: Location of study sites in SE and SW arms Lake Tanganyika, Zambia

3.2 Sampling design

A systematic random sampling was used to select the boats from where the samples were obtained. For every sampling day, any boat seen setting out to fish on the lake late in the afternoon was assigned a number 1,2,3,4… in this order for records purpose. Then the following morning when the boats are returning, the first boat to approach the shore was randomly sampled and thereafter every third boat was included to the sample. The pattern of sampling did not follow the order of numbers in which the boats were assigned yesterday. To ensure random sampling and to avoid sampling the same boats which mostly tend to have same fishing grounds, the sampling time was varied by not starting everyday at same time in the morning or late in the afternoon. Sampling was varied between 05:00 hours and 16:00 hours. Further, the samples were procured from a mixed catch that is; unsorted catch which was thought to be a full representation of all sizes for juvenile and adult fish in the population (Aro, 1993). The catches on a particular day influenced the number of boats that were sampled. A total of 69 boats were sampled from each area. For every sampling month a minimum of two hundred specimens from each site was collected.

The sites were set for fish sampling in stratum II for Mpulungu and stratum IV for Nsumbu (DoF, 2012, 2013). Three (3) consecutive days were spent at each stratum, then the fourth (4^{th}) day was used to travel, shift and set up camp on the next site. A total of six (6) days were spent for every sampling month. The sampling commenced in April, 2022 and ended in August, 2022. The study sites were chosen based on the expectation that they have well established fishing villages and landing sites targeting the pelagic stocks of *L. stappersii*, and secondly this achieved an optimal geographical spread for Zambian waters of the lake. Pictorial figures attached at appendices G and H represents some fishing villages/landing sites for Mpulungu and Nsumbu areas.

3.3 Sampling procedure

a) Collection of Fish data

After procurement of fish samples from fishers, the treatment and handling of samples involved storing them in a cool ice box and all specimens were processed within the same day in the laboratory.

b) Water quality parameters

The water quality parameters (transparency, dissolved oxygen (DO), temperature and pH) were regularly sampled between 2-4 times per month throughout the sampling period. The littoral, benthic and pelagic zones were all investigated, however, only data collected from the pelagic zones were included in the report because that is what constitutes the main habitat for the species under consideration. Water quality parameters were all taken aboard a boat and usually the sampling started about 06:00 to 16:00 hours. To monitor the diel variation in dissolved oxygen concentration during the day, the sampling began earlier at 06: 00 hours and ended at 18: 00 hours.

3.4 Collection of fish growth data

3.4.1 Length and weight

Data which were collected include: fork length (FL) and total length (TL) measured to the nearest millimeters (mm) using a measuring board (a 1m ruler) and weight was measured for all specimens to the nearest gramme(g) using an electronic balance based on Aro (1993) , Mannini, (1993). Fork length was measured as the distance from the tip of the snout to the end of the mid-caudal rays while Total length was measured as the distance from the tip of the snout to the furthest tip of the caudal fin as defined by Skelton, (2001). Recording of Fork length (FL), Total length (TL) and weight is shown at Appendix I of this report.

3.4.2 Sex determination

All specimens were dissected longitudinally using a diseecting scalpel along the abdomen for macroscopic inspection of the gonads (Domínguez-Petit ., et al., 2017). Data on the identification of sexes (females and males) were based on Nikolsky, (1963). Example of a specimens for female and male *L. stappersii* are attached at appendix J this report.

3.4.3 Water quality parameters in the field

Water quality paramters were determined regularly during the study period and included: water transparency using Secchi disk, dissolved oxygen (DO) concentration and pH measurements were taken using respective meters. The surface water temperature data collected at the same time of sampling for oxygen using embedded temperature thermometers to the oxygen meters and pH meters for each sampling month.

Water transparency measurements taken by three (3) observers and the mean of the three readings was recorded. A minimum of two (2) trips on the lake were taken for each sampling day and this took place at 09:30hours, 12:00hours and 15:00-16:00 hours. The surface water temperature was in the first month of April was measured with a laboratory thermometer (with an accuracy of ± 0.1°C).

Later in May, the surface water temperature was taken with an electronic thermometer attached to a dissolved oxygen/temperature meter manufactured by (Jenco instruments, Inc.). The probe had a length of about 4m. Dissolved oxygen concentration readings were taken using a hand-held DO/Temperature Meter model 9010M meter of Jenco Instruments, Inc., fitted with a built-in microprocessor. The time of sampling was at 06:00 hours, 12:00 hours and 18:00hours.

The specifications of the 9010M DO/Temperature meter allowed it to measure oxygen in ppm (mgL^{-1}) in the range of 0 to 20.00ppm (mgL^{-1}), resolution 0.01ppm (mgL^{-1}) with an accuracy of ± 0.5 percentage of full-scale accuracy (FS) the meter's range for temperature was between -6.0 to 46.0° C, resolution, 0.1° C with an accuracy ±0.3° C. The calibration was done firstly by probe preparation with a manufacturer's solution and then was quickly calibrated in the air. Before taking the measurents, the DO meter probe was rinsed with distilled water and this was repeated for every recording that was made. pH data were taken only once from each site using a pH/Temperature 9020M meter of Jenco, Instruments, Inc. The sampling was discontinued in June, because the two buffer solutions (i.e., pH 9.7/10.0 and pH 4.0 /6.7) meant for dual calibration of the meter had outlived their shelf life, especially pH 4.0. whose replacement proved difficulty. Appendix J show collection of some water quality parameters.

3.5 Data analysis

In the analysis of data, a T-test was used. The data that were used in the analyses of the results are attached in appendices C, D, E and F of this report. A total of 1,526 specimens of *L. stappersii* with 642 females and 884 male individuals were examined and analyzed during the five (5) months study period.

The total number of specimens for Mpulungu was 698 with 301 females and 397 males whereas, in Nsumbu area a total number of 828 specimens with 341 females and 487 males were analysed.

The total lengths (TL) of female *L. stappersii* specimens used in the analysis for Mpulungu ranged from 180mm to 400mm while body weight ranged from 43g to 405g. The range of male specimens' total length was from 160mm and 360mm while their corresponding weights ranged from 26g to 305g. From Nsumbu area the total length of females was between 190mm and 430mm while the weights ranged from 48g to 483g. Male' total length (TL) ranged from 180mm to 460mm with weights between 38g and 536g respectively.

3.6 Growth parameters

Fish growth can be described by the von Bertalanffy growth function (VBGF) (Mannini, 1998) and that growth in length takes the equation $\mathrm{L_t} = \mathrm{L_\infty}(1 - \mathrm{e}^{-\mathrm{K}(\mathrm{t}-\mathrm{t_0})})$. The length and weight data were used to determine the Length-weight relationship (LWR) of *L. stappersii*. While, the length-frequency data were used to estimate the von Bertalanffy (1938) growth paramters using the Ford-Walford plots.

3.6.1 Length-weight relationship

The constants of the Length-weight relationship (LWR) of the form $W = aL^b$ were determined by non-least squares fit to the equation for both sexes separately as well as for the pooled population using GenStat 18th edition (32 bit) software where; W and L were fish body weight and total length respectively, "a" and "b" being the y-intercept and slope of the regression curve of the length - weight relationship of the fish, respectively. The degree of association between variables (logW and logL) was calculated by determination of coefficient (r^2) from the regression curve. Regression analysis was employed on log-transformed data for males and females separately and the slopes were tested for significant differences between sexes through T-test analysis at ($p< 0.05$).

3.6.2 Length-frequency distribution Structure.

The analysis of the length-frequency distribution was used to determine the size modal distribution from which Histograms were generated. The Histograms are important because they facilitate the identification of the cohort/class strength in the fish stock by way of peaks. Microsoft Excel 2010 software was used to generate both monthly and pooled length-frequency distributions.

3.6.3 von Bertalanffy Growth parameters

The Ford-Waldford plots were used to estimate the von Bertalanffy growth parameters; growth coefficient (k) and asymptotic length (L_∞). The t_o was calculated from the formula by Pauly (1979). $\log_{10} -t_o = -0.3922 - 0.2752\log_{10}\ L_\infty - 1.038\log_{10}\ k$. The growth performance index (Φ') described in Pauly and Munro (1984) was calculated using the relationship $\Phi' = \log_{10}(k) + 2\log_{10}(L_\infty)$. The growth performances (Φ') obtained were compared to test for any significant differences between the two study sites.

3.7 Mortality rates

The total mortality coefficient (Z) was calculated based on the formula $Z = \frac{n.k}{(n+1)\log_e \frac{L-L'}{L-\bar{L}}}$ provided by Ssentongo and Larkin (1973). The natural mortality coefficient (M)was estimated from the empirical relationship derived by Pauly, (1980). $\log_{10} M = -0.066 - 0.279\log_{10} L + 0.6543\log_{10} K + 0.4634 * \log_{10} T$; Where; k *and* L_∞ are the Von-Bertanlanffy growth parameters and $T =$ average temperature for the period sampled. Using the estimated values of Z and M, fishing mortality coefficient (F) was estimated from the formula: $F = Z - M$ provided for by Ssentongo and Larkin, (1973). Mortality coeffiecients for *L. stappersii* from Mpulungu and Nsumbu of Zambia were compared statically to determine any significant differences between the two study sites.

3.8 Exploitation ratio (E)

The exploitation ratios were computed from the following formula $E = \frac{F}{Z}$ by Ssentongo and Larkin, (1973). The exploitation ratios of *L. stappersii* between

Mpulungu and Nsumbu of Lake Tanganyika, Zambia were compared statistically using T-test for any significant differences.

3.9 Water quality parameters

The means for water quality parameters (transparency, temperature, dissolved oxygen and pH) were computed for Mpulungu and Nsumbu part of Lake Tanganyika, Zambia. Any significant differences were tested using the T-test analysis.

Chapter 4 : RESULTS

4.1 Growth

4.1.1 Length-Weight Relationship

The results for transformed Loglength-weight relationship of *L. stappersii* are represented by figures 4.1 to 4.4 for Mpulungu and Nsumbu areas. Table 4.1 depicts the LWR results for both study sites.

In all months studied from the two study sites, strong correlation coefficient was shown in the regression analysis between the weight and length of *L. stappersii*. In Mpulungu, correlation coefficients for female *L. stappersii* were R^2=0.98, 0.92 and 0.80 (for April, May and June) respectively) as shown in fig 4.1. Monthly correlation coefficients from the regression analysis of LWR of male *L. stappersii* for Mpulungu were; April (R^2=0.93), May (R^2=0.92) and the lowest correlation of association was obtained in June (R^2=0.65) as shown by fig 4.2. In Nsumbu area correlation coefficients for female *L. stappersii* were R^2 =0.86, 0.94 and 0.93 for April, May and June respectively fig 4.3. Male *L. stappersii* from Nsumbu also had strong correlation of association as depicted in fig 4.4 April (R^2=0.85), May (R^2=0.92) and June (R^2=0.91) with the least association being R^2 =0.85 for April.

4.1.1.1 Female *L. stappersii* for Mpulungu

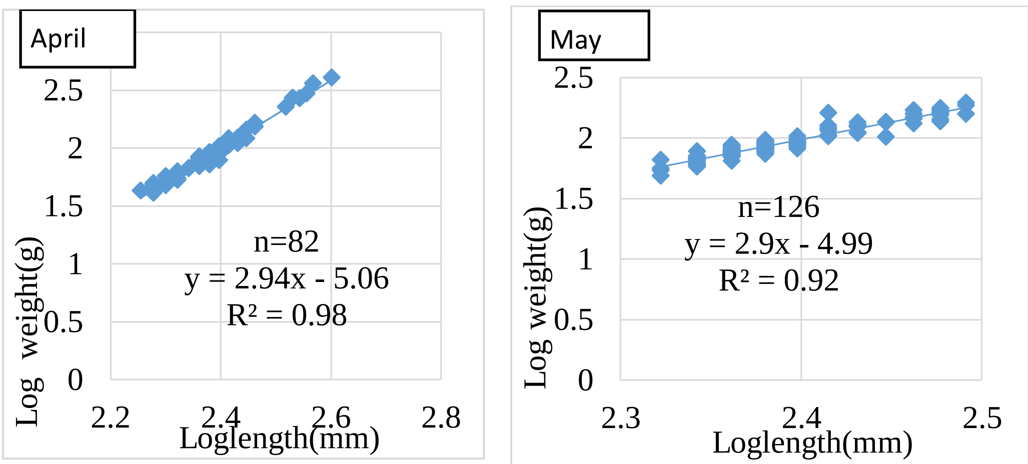


Figure 4.1: Loglength-logweight relationship of female *L. stappersii* for Mpulungu study site from April and May, 2022 respectively.

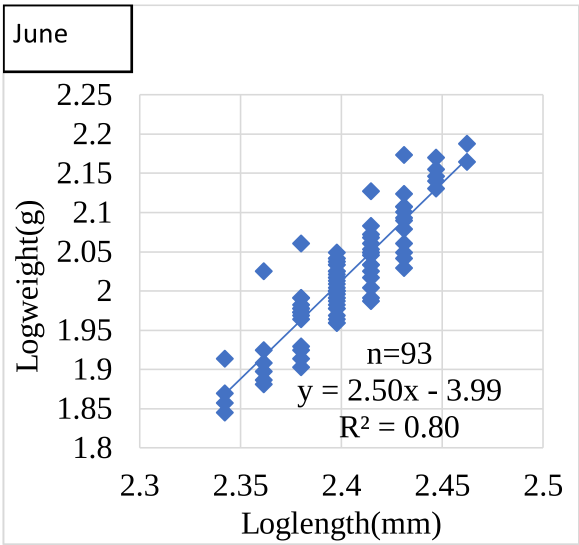
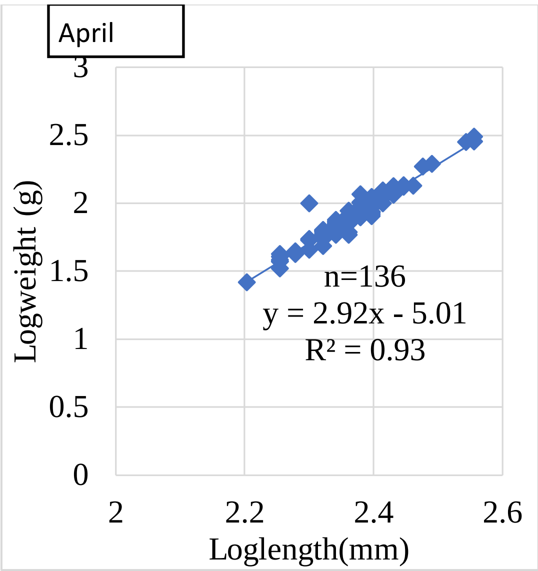


Figure 4.1, cont' Loglength-logweight relationship of female *L. stappersii* for June, 2022 Mpulungu study site

4.1.1.2 Male *L. stappersii* for Mpulungu



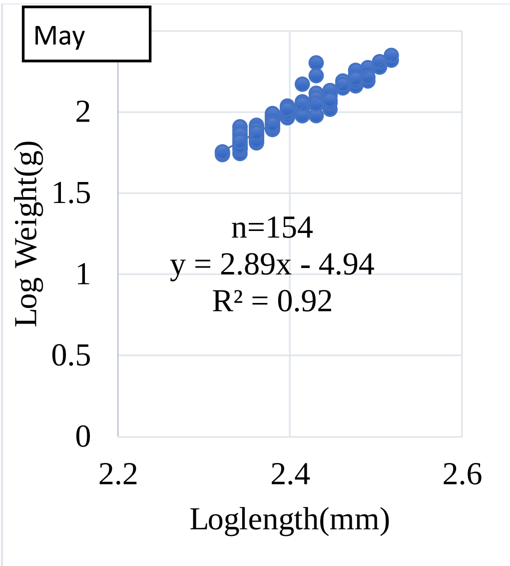


Figure 4.2: Loglength-logweight relationship of male *L. stappersii* for Mpulungu study site for April and May, 2022 respectively.

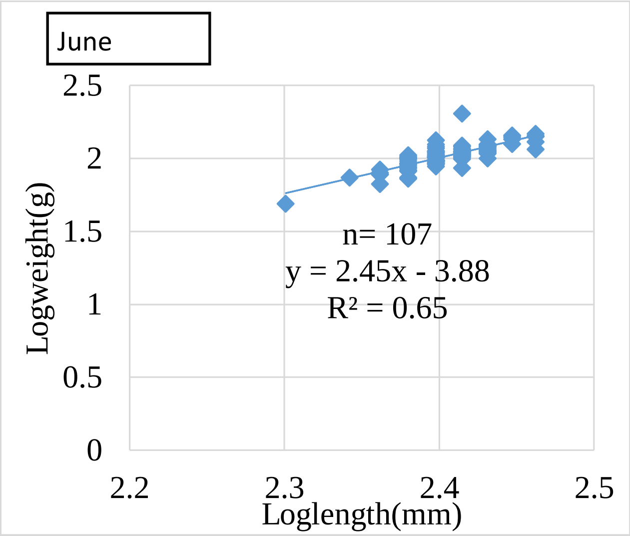
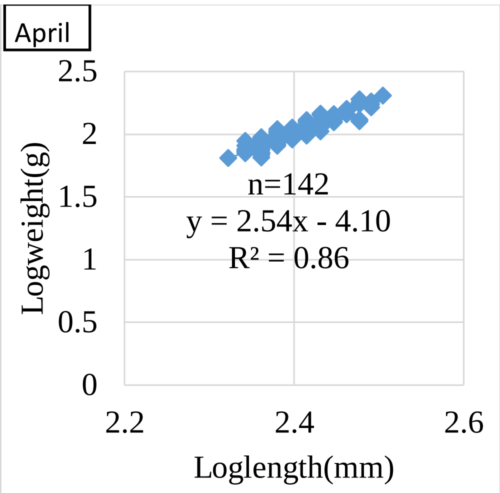


Figure 4.2, cont' Loglength-logweight relationship of male *L. stappersii* for Mpulungu study site for June, 2022

4.1.1.3 Female *L. stappersii* for Nsumbu area



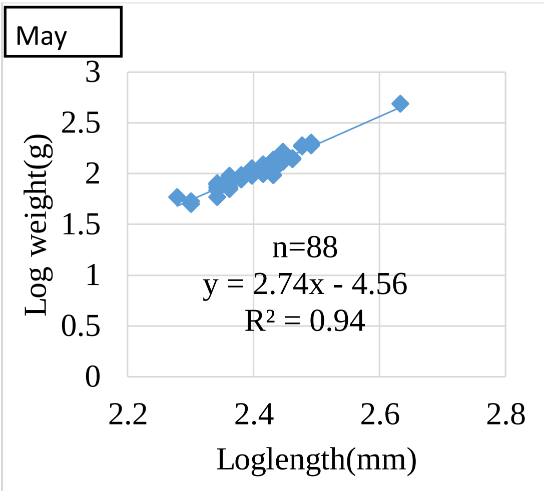


Figure 4.3: Loglength-logweight relationship of female *L. stappersii* for Nsumbu study site from April to June, 2022 respectively.

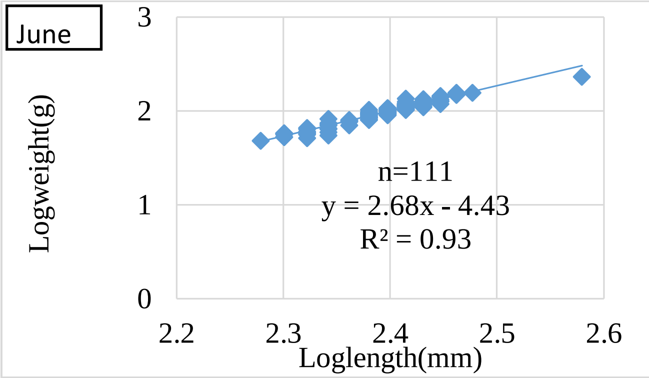


Figure 4.3, cont' Loglength-logweight relationship of female *L. stappersii* for Nsumbu study site for June, 2022.

4.1.1.4 Male *L. stappersii* for Nsumbu area

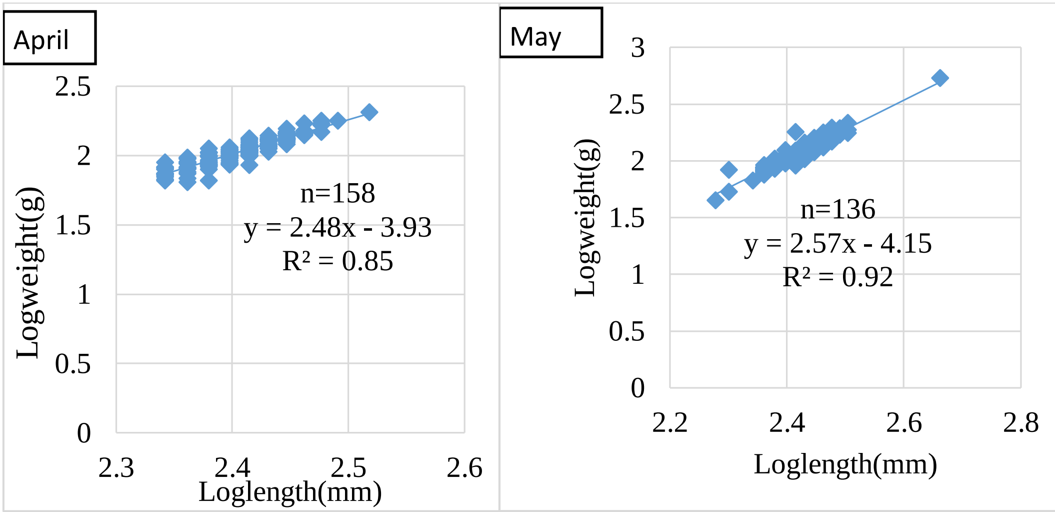


Figure 4.4: Loglength-logweight relationship of male *L. stappersii* for Nsumbu study site from April to May, 2022 respectively.

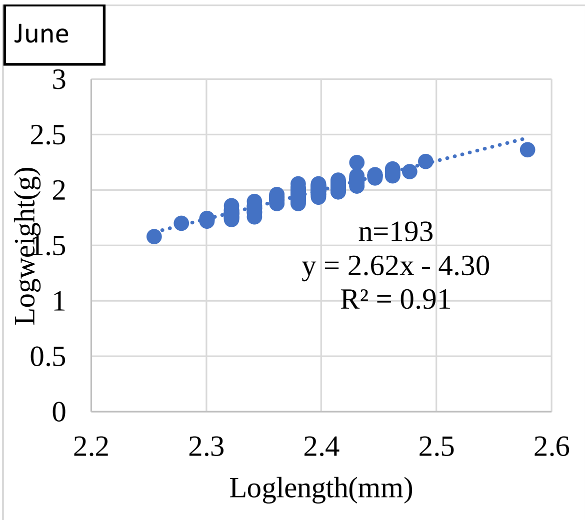


Figure 4.4, cont' Loglength-logweight relationship of male *L. stappersii* for Nsumbu study site for June, 2022

A T-test analysis of slopes generated from the log-transformed LWR for the two study sites indicated that there were no significant differences between the sexes because the p-value for female *L. stappersii* was greater than ($p>0.05$) [T-test = 0.52] also the male counterparts gave a larger p-value ($p>0.05$) [T-test = 0.41].

Table 4.1: The LWR of *L. stappersii* collected from April to June, 2022 for Mpulungu and Nsumbu part of Lake Tanganyika, Zambia.

Mpulungu						**Nsumbu**				
Month	Sex	n	a	b	R^2	Sex	n	a	b	R^2
April	Female	82	0.01	2.94	0.98	Female	142	0.02	2.54	0.86
	Male	136	0.01	2.92	0.93	Male	158	0.02	2.48	0.85
May	Female	126	0.01	2.91	0.92	Female	88	0.01	2.74	0.94
	Male	154	0.01	2.89	0.92	Male	136	0.02	2.57	0.92
June	Female	93	0.02	2.51	0.80	Female	111	0.02	2.68	0.93
	Male	107	0.02	2.45	0.65	Male	193	0.01	2.62	0.91

a" = intercept of the regression curve of the length and weight, *b*" = slope of the regression curve of the length-weight relationship n = number of specimens in the sample and R^2 = correlation coefficient of the regression line.

4.1.2 Length-frequency distribution structure

The results for histograms that were generated independently of each sex are shown in figure (4.5) which depicts a modal distribution for female *L. stappersii* in month April for Mpulungu.

It also shows modal distribution for females for May from Nsumbu area. Other histograms for other months for both areas have been included at appendix K of this report.

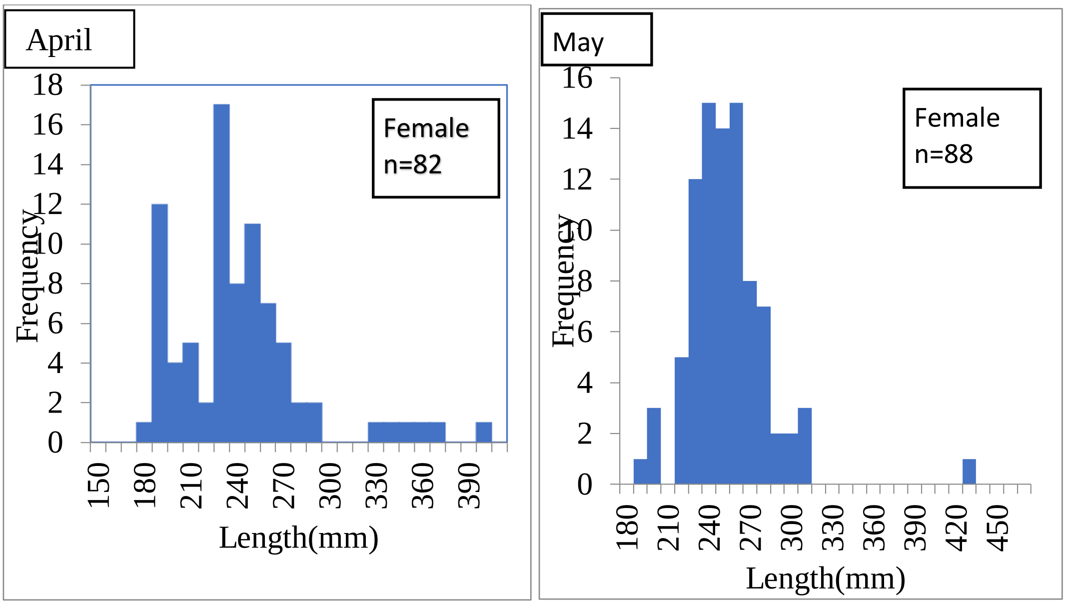


Figure 4.5: Length- frequency histograms of female *L. stappersii* for April, Mpulungu area and May, Nsumbu area 2022.

4.1.3 Growth parameters (L_∞ and k)

The von Bertalanffy Growth Function (VBGF) parameters; the asymptotic length (L_∞), growth coefficient (k) obtained from the Ford-Walford plot are summarized in tables 4.2 and 4.3.

4.1.4 Asymptotic length (L_∞),

Monthly analysis of asymptotic length (L_∞)for Mpulungu indicates that female *L. stappersii* in April, May and June had L_∞ = 300mm, L_∞ = 316mm and L_∞ = 310mm respectively while from Nsumbu the highest attainable asymptote lengths for April, May and June were L_∞ = 322mm, L_∞ = 310mm and L_∞ = 302mm respectively. However, very large specimens with maximum lengths of 400mm in

April and 430mm in May were recorded from Mpulungu and Nsumbu respectively, but were not included in the rearranged data for Ford-Walford plots because of their few numbers in the samples. Comparative analysis of specimens from Mpulungu and specimens from Nsumbu using T-test statistics showed that there was no significant difference between the southeast and southwest arms ($p > 0.05$) [T-test: $p = 0.81$].

The asymptotic lengths of male *L. stappersii* for Mpulungu area were $L_\infty = 320\text{mm}, 342\text{mm}$ and 318mm for April, May and June respectively. Nsumbu had $L_\infty = 314\text{mm}, 317\text{mm}$ and 320mm for April, May and June respectively. Equally, some single specimens had maximum lengths which measured up to 340mm and 460mm for Mpulungu and Nsumbu respectively, however, their small number in the samples made them to be considered as outliers during analysis purposes. T-test analysis revealed no significant difference in asymptote lengths between the south east and south west arms ($p > 0.05$) [T-test: $p = 0.35$].

4.1.5 The growth coefficient (k)

Table 4.2 shows the mean k values for female species from Mpulungu area were between $k = 0.71$ for April, $k = 0.75$, May $k = 0.73$, June respectively. In Nsumbu the highest growth coefficient occurred in both May ($k = 0.83$) and June ($k = 0.83$) with April having a lower value $k = 0.67$ table 4.2) There was no significant difference observed between Mpulungu and Nsumbu arms ($P > 0.05$) [T-test: $p = 0.44$). The growth coefficients (k) of male *L. stappersii* for Mpulungu area for April, May and June were k= 0.74, 0.58 and 0.75 respectively (table 4.3), while the April, May and June k values for Nsumbu area were; $k = 0.72$, $k = 0.77$ and $k = 0.83$ respectively (table 4.3). A comparative analysis indicated that there was no significant difference in the growth coefficient (k) between Mpulungu and Nsumbu areas ($p > 0.05$) [T-test: $p = 0.44$].

4.1.6 The growth performance index (Φ')

The T-test statistical analysis results of the growth performance index (Φ') revealed that there was a significant difference in females between Mpulungu and Nsmbu ($p < 0.05$) [T-test: $p = 0.03$]. The results obtained for April, May and June in Mpulungu were Φ' = 4. 81, 4.87 and 4.8 respectively (table 4.2), whereas, Nsumbu results were, Φ' = 4.84, 4.93 and 4. 88) for April, May and June respectively given by (table 4.2).

Statistically, the male counterparts between the two study sites showed no significant difference ($p > 0.05$) [T-test: $p = 0.66$], the results for Mpulungu were; Φ' = 4.90, 4.83 and 4.88 for April, May and June respectively (table 4.3), and in Nsumbu the Φ' values obtained were Φ' = 4.85, April, Φ' = 4.89, May and Φ' = 4. 93, June respectively (table 4.3).

Table 4.2: Growth parameters of female *L. stappersii* for Mpulungu and Nsumbu from April, May and June, 2022.

Growth parameters						
Month	**Mpulungu area**			**Nsumbu area**		
	L_∞	k	Φ'	L_∞	k	Φ'
April	300	0.71	4.8	322	0.67	4.84
May	316	0.75	4.87	310	0.83	4.93
June	310	0.73	4.84	302	0.83	4.88

L_∞ = Asymptotic length k= growth coefficient Φ'= growth performance index

Table 4.3: Growth parameters of male *L. stappersii* for Mpulungu and Nsumbu from April to June, 2022

Growth parameters						
Month	**Mpulungu area**			**Nsumbu area**		
	L_∞	k	Φ'	L_∞	k	Φ'
April	320	0.78	4.90	314	0.72	4.85
May	342	0.58	4.83	317	0.77	4.89
June	318	0.75	4.88	320	0.83	4.93

L_∞ = Asymptotic length k= growth coefficient Φ'= growth performance index

4.2 Mortality rates

Tables 4.4 and 4.5 show the results of mortality rates of *L. stappersii*. The mean monthly comparisons in mortalities of *L. stappersii* for Mpulungu and Nsumbu areas are represented by figures 4.6 to 4.7.

4.2.1 Total mortality coefficient (Z)

The monthly female total mortality coefficient results for Mpulungu were from Z = 1.24year^{1} for April; Z = 1.59year^{-1}, June to Z = 1.86year^{-1} for May. For Nsumbu area, April had highest value Z= 1.37year^{-1} followed by June, Z=1. 30year^{-1} and a lower value was obtained in May, Z=1.15year^{-1} (table 4.4). A comparative T-test analysis showed that there was no significant difference between the total mortality coefficients in Mpulungu and Nsumbu ($p > 0.05$) [T-test: p= 0.35].

There was no significant difference in male total mortality coefficient between the two study sites because the p-value ($p > 0.05$) [T-test: p = 0.53]. Monthly results for April, May and June are shown in (table 4.5) for both Mpulungu and Nsumbu areas respectively.

4.2.2 Natural mortality (M)

The estimated female natural mortalities (M) of *L. stappersii* for the two study sites were relatively similar over the three months period included in the analysis. The values around Mpulungu area ranged from 0.65year^{-1} to 0.67year^{-1} and that of Nsumbu area was between 0.61year^{-1} and 0. 70year^{-1} (table 4.4). After conducting a test for any significant differences in the observations. It was noted that there were no differences in the natural mortalities ($p > 0.05$) [T-test: p = 0.74]. Similarly, the male specimens yielded no significant differences between the two study sites after the observations were subjected to a T-test analysis ($p > 0.05$) [T-test: p = 0.52]. Estimated values lied between 0.55year^{-1} and 0.68year^{-1} for Mpulungu area while a range of values from 0.64year^{-1} to 0.69year^{-1} were obtained for Nsumbu (table 4.5).

4.2.3 Fishing mortality (Z).

Fishing mortality coefficients for females within each study sites as shown by tables 4.4 and 4.5 on a monthly basis were as follows; for Mpulungu area April yielded a lower value F = 0.59year^{-1}, followed by June, F = 0. 93year^{-1} with May having the highest fishing mortality of F = 1. 19year^{1}, whereas, Nsumbu had F = 0.76year^{-1}, 0.45year^{-1} and 0.60year^{-1} for April, May and June respectively (table 4.4). Statistical analysis found that no significant differences occurred between the two study sites ($p > 0.05$) [T-test: p = 0.38]. For male *L. stappersii* mortalities due to fishing (F) on a month-to-month consideration were for instance, in Mpulungu April, May and June had F = 0.47year^{-1}, 1.04year^{-1} and 1.03year^{-1} respectively (table 4.5), while results from Nsumbu area were F = 0.89year^{-1}, 0.32year^{1} and 0.82year^{-1} for April, May and June respectively table (4.5). A comparative statistical analysis of the results indicated that there were no significant differences between the samples obtained from the two sites.

Table 4.4: Monthly mortality rates of female *L. stappersii* for Mpulungu and Nsumbu study sites for April, May and June, 2022.

Mortality coefficients						
Month	**Mpulungu area**			**Nsumbu area**		
	Z (Year^{-1})	M (Year^{-1})	F (Year^{-1})	Z (Year^{-1})	M (Year^{-1})	F (Year^{-1})
April	1.24	0.66	0.59	1.37	0.61	0.76
May	1.86	0.67	1.19	1.15	0.70	0.45
June	1.58	0.64	0.93	1.30	0.70	0.60

(Z=total mortality coefficient; M= natural mortality coefficient; F= fishing mortality coefficient)

Table 4.5: Monthly mortality rates of male *L. stappersii* for Mpulungu and Nsumbu study sites for April, May and June, 2022.

Mortality coefficients						
Month	**Mpulungu area**			**Nsumbu area**		
	Z (Year^{-1})	M (Year^{-1})	F (Year^{-1})	Z (Year^{-1})	M (Year^{-1})	F (Year^{-1})
April	1.30	0.69	0.47	1.54	0.64	0.89
May	1.60	0.55	1.04	0.99	0.67	0.33
June	1.68	0.65	1.03	1.51	0.69	0.82

(Z= total mortality coefficient; M= natural mortality coefficient; F= fishing mortality coefficient)

The mean monthly total mortalities for each study site were noted, in Mpulungu area for female specimen was higher in May, followed by month June with a lowest value recorded in April while in Nsumbu the higher value was recorded in April, then June and lower value was obtained in May as shown by (fig 4.6).

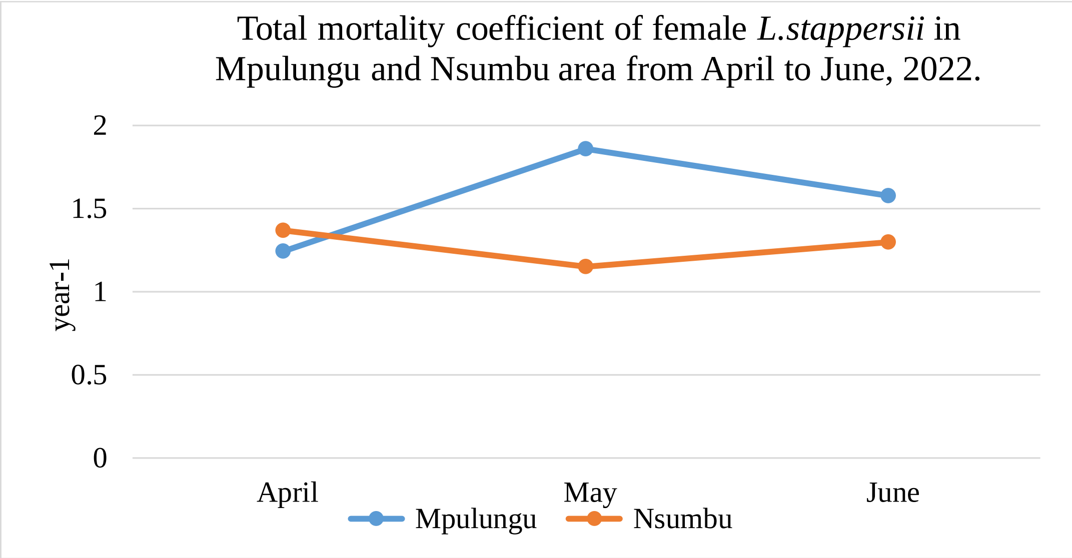


Figure 4.6: Monthly total mortality coefficient of female *L. stappersii* for Mpulungu and Nsumbu area from April to June, 2022.

In Mpulungu area, male *L. stappersii* showed the highest total mortality coefficient in June, followed by month May and April having recorded a lowest value. The male specimens for Nsumbu area had April and June which recorded higher values while a lower value was recorded in May as shown in (fig 4.7).

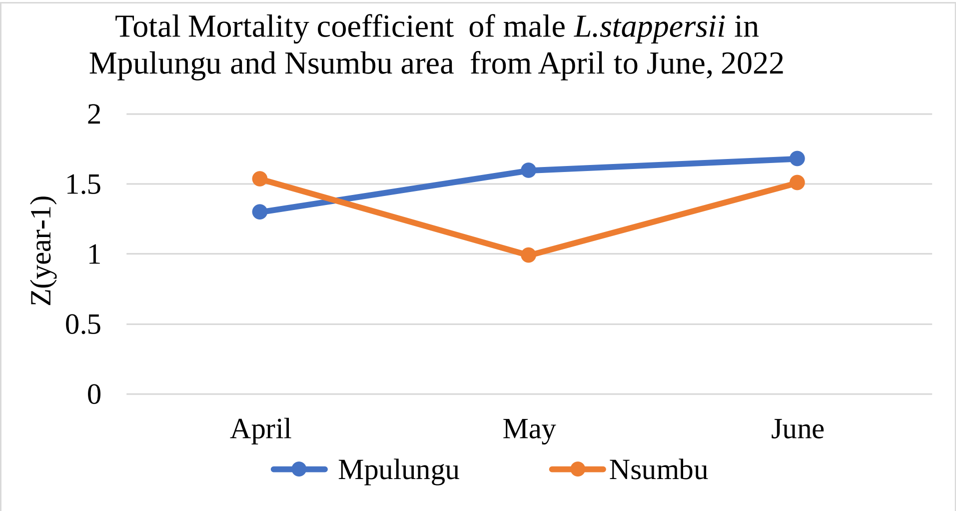


Figure 4.7: Monthly total mortality coeffiecient of male *L. stappersii* in Mpulungu and Nsumbu areas from April to June, 2022.

4.2.4 Exploitation ratios (E)

The exploitation results from the two sites for both female and male *L. starppersii* are depicted in table 4.6 and table 4.7. The mean monthly comparisons of the exploitation ratios between Mpulungu and Nsumbu are shown by (fig 4.8 and 4.9).

Monthly exploitation ratios as shown by the figures for April, May and June E = 0.47, E = 0.64 and E = 0.59 for Mpulungu respectively. The exploitation ratios from Nsumbu area in April, May and June were E = 0.56, 0.39 and 0.46 accordingly (table 4.6). A statistical T-test analysis did not show any significant differences with the values that were obtained between the two sites ($p > 0.05$) [T-test: $p = 0.42$].

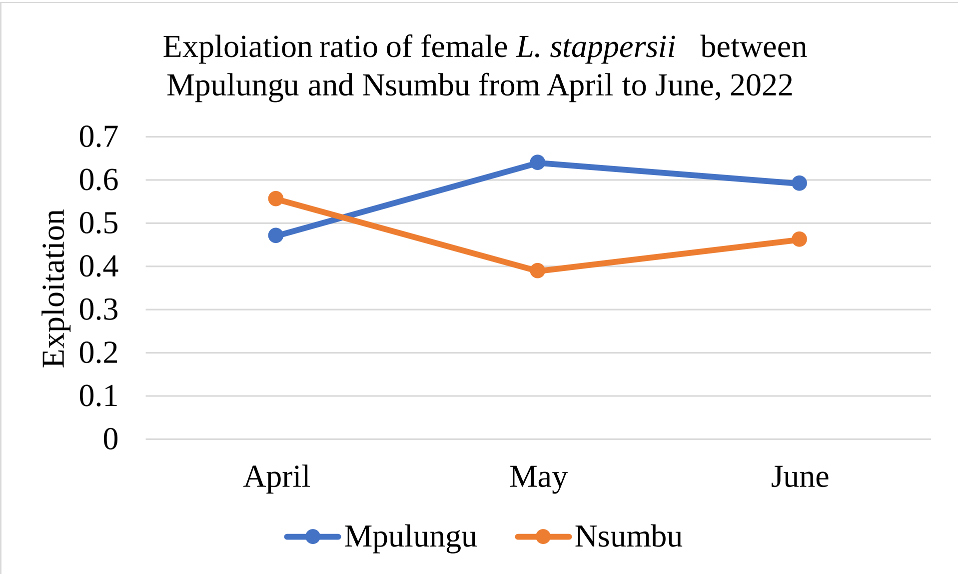


Figure 4.8: Monthly comparisons in exploitation ratios (E) of female *L. stappersii* for Mpulungu and Nsumbu areas from April to June, 2022.

Equally, the comparative statistical analysis of the male counterparts did not show any differences between the samples from Mpulungu and Nsumbu ($p > 0.05$) [T-test: $p = 0.53$]. Monthly exploitation values from Mpulungu ranged from E = 0.47 April, through E = 0.61 in June up to E = 0.65 in May. In Nsumbu, the estimations were; April E = 0.58, May E = 0.33 and June E = 0.54 (table 4.7). Figure 4. 9 depicts exploitation ratios of male *L. stappersii* for both sites.

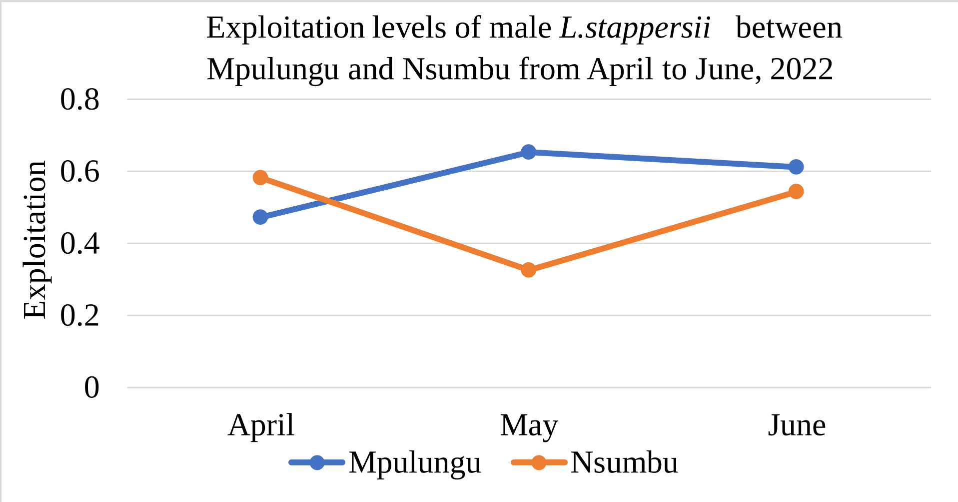


Figure 4.9: Monthly comparisons of exploitation ratios (E) of male *L. stappersii* for Mpulungu and Nsumbu areas from April to June, 2022.

Table 4.6: The exploitation ratios of female *L. stappersii* for Mpulungu and Nsumbu study sites for April, May and June, 2022.

Month	**Mpulungu** (Female, *L. stappersii*)			**Nsumbu** (Female, *L. stappersii*)		
	F	Z	$E = \frac{F}{Z}$	F	Z	$E = \frac{F}{Z}$
April	0.59	1.24	0.45	0.76	1.37	0.56
May	1.19	1.86	0.64	0.45	1.15	0.39
June	0.93	1.58	0.59	0.60	1.30	0.46

Table 4.7: Monthly exploitation ratios of male *L. stappersii* for Mpulungu and Nsumbu study sites for April, May and June, 2022

Month	**Mpulungu** (Male, *L. stappersii*)			**Nsumbu** (Male, *L. stappersii*)		
	F	Z	$E = \frac{F}{Z}$	F	Z	$E = \frac{F}{Z}$
April	0.47	1.30	0.47	0.89	1.54	0.58
May	1.04	1.60	0.65	0.32	0.99	0.33
June	1.03	1.68	0.61	0.82	1.51	0.54

4.3 Water quality parameters

Table 4.8 represents the environmental parameters that were investigated to determine water quality for Mpulungu and Nsumbu areas on the southern part of Lake Tanganyika, Zambia from April, 2022 to August, 2022. Statistical analysis of data showed that there were no significant differences between Mpulungu and Nsumbu for dissolved oxygen concentration (DO) in the surface water ($p > 0.05$) [T-test: $p = 0.18$;] and in surface water temperature(°C) ($p > 0.05$) [T-test: $p = 0.09$] of that part of lake. But a discrepancy was noted in water transparency parameter which indicated that there was a difference between the two study sites ($P < 0.05$) [T-test: $p = 0.05$]. This study faced some limitations in analyzing a pH parameter because only a single month mean datum for each site was recorded in May. This single datum for Mpulungu was (pH = 9.14) and Nsumbu (pH = 8.28) respectively. The sampling was discontinued due to failure in the pH meter. Monthly comparisons between Mpulungu and Nsumbu for temperature, transparency and dissolved oxygen are represented in figures (4.10 to 4.12.)

4.3.1 Temperature

The average surface water temperatures for Mpulungu and Nsumbu were 26.30°C and 25.56°C, respectively. Mean monthly records for Mpulungu area ranged from 24.36°C to 28.0°C with the lowest and highest means recorded in July, April and May respectively table 4.8. While the range of means for Nsumbu areas were from 23.08°C, July to 27.06°C in April (table 4.8).

4.3.2 Water transparency

The monthly mean transparency in the Mpulungu was 6.47m with a range 4.0m to 9.20m while, the monthly mean from Nsumbu was 7.32m with range between 4.67 and 10.90m (table 4.8). On certain days, recorded values were beween 7.75m up and 15m in both Mpulugu and Nsumbu areas.

4.3.3 Dissolved oxygen.

Diel variations of dissolved oxygen (DO) concentration in the surface water from both arms of the southern part of the lake were investigated. Mean monthly dissolved oxygen concentration for Mpulungu was $6.77 mgL^{-1}$, with a range between 4.87 and

8.68mgL^{-1}, while Nsumbu mean monthly reading was 7.19mgL^{-1} , with a range of 5.68mgL^{-1} to 8.99mgL^{-1} (table 4.8).

Some daily variations were observed from each study site, especially on wind days with strong waves when values as high as 12.0mgL^{-1}, 13.0mgL^{-1}, 14.0mgL^{-1} 15.0mgL^{-1} and 16.0 mgL^{-1} were recorded. Data for the first sampling month are missing because of the technical faults that a DO meter developed and by the time it became operational the month had already elapsed,

Table 4.8: Mean monthly water quality parameters for Mpulungu and Nsumbu Lake Tanganyika, Zambia-2022.

	Environmental Parameters							
Month	**Mpulungu area**				**Nsumbu area**			
	DO (mgL^{-1})	Temp (°C)	Transp (m)	pH	DO mgL^{-1})	Temp (°C)	Transp (m)	pH
April	-	28	4.16		-	27.06	4.67	
May	4.87	28	7.33	9.1	5.68	26.80	8.14	8.28
June	6.66	26.59	4		6.50	25.73	5.33	
July	6.85	24.36	7.65		7.59	23.08	7.58	
August	8.68	24.54	9.20		8.98	25.12	10.90	

(DO= dissolved oxygen; Temp (°C) = surface water temperature; Transp (m) = water transparency; pH= potential hydrogen concentration)

Figures 4.10 to 4.12 show the monthly comparisons of water quality parameters (dissolved oxygen, water transparency and surface water temperature) over the sampling period between Mpulungu and Nsumbu areas.

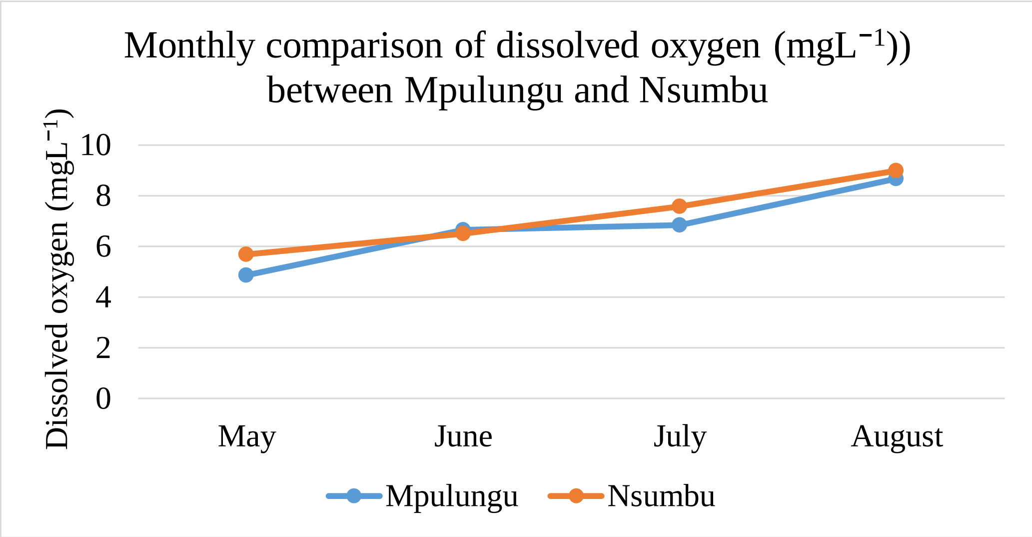


Figure 4.10: Monthly comparisons of dissolved oxygen (mgL^{-1}) for Mpulungu and Nsumbu from April to August, 2022.

Water transparency comparisons between the study sites were as illustrated in (fig 4.11).

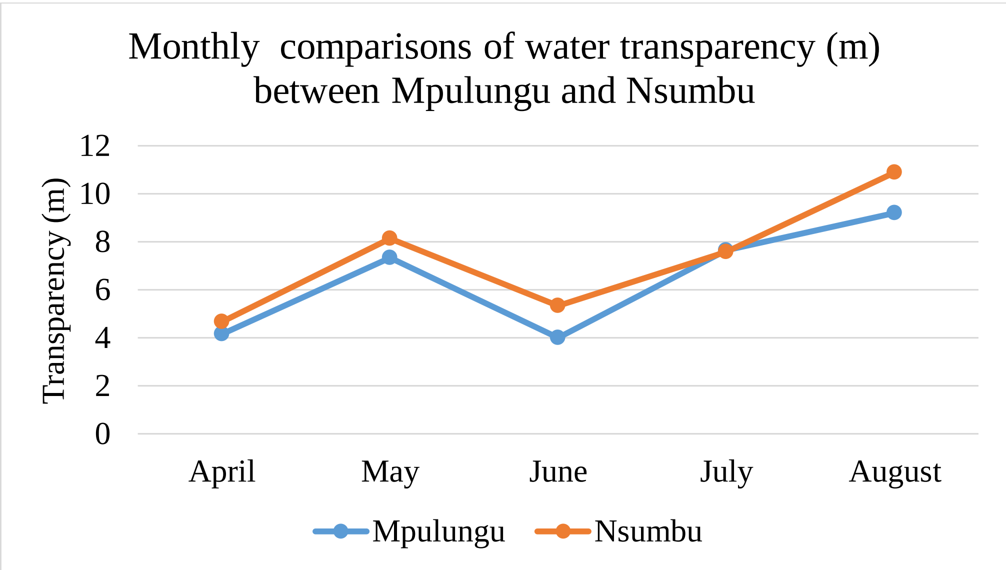


Figure 4.11: Monthly comparison of water transparency(m) for Mpulungu and Nsumbu from April to August, 2022.

Below is (fig 4.12) showing the water surface temperature as was recorded ($^{\circ}C$) over a sampling period for April, May, June, July and August from both Mpulungu and Nsumbu areas.

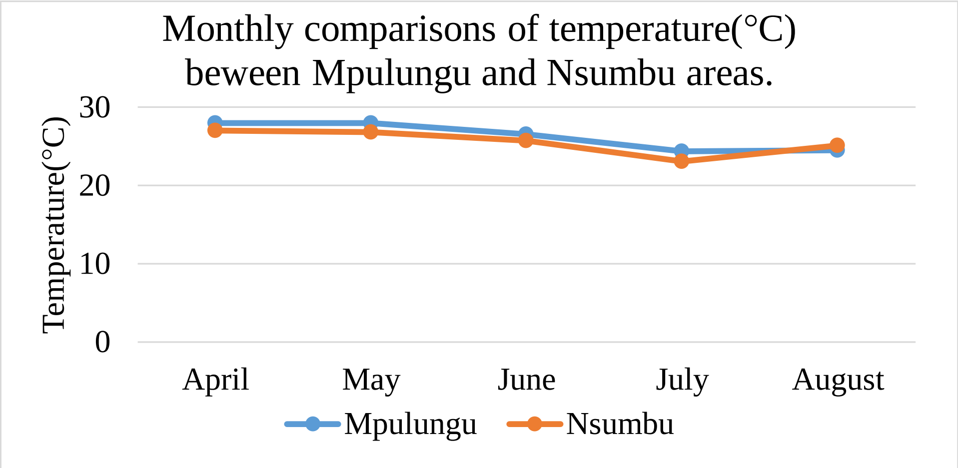


Figure 4.12: Monthly comparisons of surface water temperatue(°C) for Mpulungu and Nsumbu from April to August, 2022.

Chapter 5 : DISCUSSION

5.1 Growth Parameters

The growth parameters and mortality rates result for *L. stappersii* are only shown for April, May and June, 2022. Howver, this study was conducted up to August, 2022 but did not have samples to collect for July and August months because of non avalibality of the fish around this period. Therefore, the two months were not included in the data that was analyzed for growth and mortality.

5.1.1 Length-Weight Relationship.

The analysis of growth from the Length-Weight Relationship (LWR), of the 'b' values under this study did not show significant difference between Mpulungu and Nsumbu areas. The findings here were consistent with those by (Munyandorero and Mwape, 2003) based on their review of the 1960-1972 records. Growth of fish is usually indicated by the increase in length and weight which is an appropriate characteristic to determine the population parameters at a particular time. The LWR substantially depend on the population, season and environmental conditions. Other factors that influence LWR are; sex, state of the stomach content between the time of sampling and processing especially with *L. stappersii* which is a predator of easily digestible prey (Froese, 1998). Spawning is another factor which affect the LWR, the period for this study coincided with the spawning time for *L. stappersii* and the fish tends to accumulate extra fats as energy reserve for the process. This occurs due to abundant prey normally associated with secondary phytoplankton production promoted by the rain season and the onset of the first primary production induced by the southerly east winds (O'Reilly et al., 2003; Jorgensen et al., 2006; Plisnier et al., 2009; Naithani et al., 2011).

5.1.2 Length-Frequency distribution structure

Observations made on the artisanal catch compositions during this study conforms to what is reported in Mannini, (1998) that the fishery of purse seine, ring nets and other modified ring nets from the southern part of Lake Tanganyika in Zambia exploits mainly the adult stock of the population. Mannini (1998) showed Mpulungu had a unimodal distribution with few outliers on both sides. The findings of this work show a single peak with few outliers on both sides of the distribution. However, from the survey catch data by Mannini, (1998) a bimodal distribution was noticeable.

The implication of the results is that; fish of the young ages are normally underrepresented in the samples because the controlling institutions have minimum prescribed landing sizes and all operators have to adhere to avoid penalties, this implies that even if the catches involve smaller sizes, fishermen are reluctant to bring their catch to the landing sites for fear of lawful prosecutions. According to Mannini. (1998) most of the adult *L. stappersii* die off between 5th and 6th year. This explains the non availability large specimens recorded in this study and hence their low contribution. Zambian fishery is sustained by immigration from the less exploited areas north of the industrial fishing grounds (MÖlsa, 2008). Any unsustainable exploitation in such areas imply a decline in catch yields recorded by the Zambian fleet. This study has shown that size modal distributions of lengths for the adult stock is in a 240 - 250mm class interval which is a clear sign of a declining stock when compared to the previously reported lengths at first capture (L_c). This study further discovered that currently there are no industrial fleets operating, however, operators have split into several artisanal fisheries to adaptively cope up with daily operations and also to adaptively the reduced stock of *L. stappersii*.

5.1.3 Growth parameters

The findings of this study indicated that the average asymptotic length(L_∞) for females was 310mm and males, 332mm for Mpulungu and Nsumbu areas. These values are below what was reported by Mannini (1998) whose asymptotic length (L_∞ (mm) for a combined sex for Mpulungu alone was estimated at $L_\infty = 510\text{mm}$. Furthermore, reports from other parts of the lake by other authors mentioned in this report by Chapman and vanWell, (1978) and Pearce (1985) contain relatively higher values ($L_\infty = 450\text{mm}$ and 480mm respectively. The corresponding mean growth coefficients (k) values of female *L. stappersii* under this study were k = 0.73 and 0.78 for Mpulungu and Nsumbu respectively. Whereas, the mean values of male *L. stappersii* were (k = 0.69year^{-1} and 0.77year^{-1}) for Mpulungu and Nsumbu respectively. Comparatively, the growth coefficients obtained under this study from both sites were higher than those of other authors for instance Mannini. (1998)

estimation was at k = 0.42year^{-1}, Chapman and vanWell, (1978) was k = 0.40year^{-1} and Pearce (1985) had k = 0.39 year^{-1}. The variation in the results that is, the decrease in the asymptotic length(L_∞) and an observed increase in the growth coeffeinct mighty suggest a change the life-history of the species.

The increase in growth coefficient, (k) could be an evolutionary attempt by the species to keep pace with increasing fishing pressure and variability in the environment. The higher k ensures that the species grows faster, matures earlier and exploits a broader range of resources, compared with the stock observed by Kolding et al., (1992). Pauly, (1980) aptly referred to growth coefficient (k) as a stress-factor indicator for how population characteristics and environmental parameters (such as high temperature, low density of food, disease and status in some peeking order) may affect the growth performance of a fish species. Additionally, Pauly, (1984) indicated strong correlation between growth coefficient (k) and length-at maturity (L_c); implying that higher growth coeffiecnt (k) values induce early sexual maturation of fish. In case of *L. stappersii*, the length at maturity has been shown to be around 234mm for both sexes and separate mean lengths at maturity about size 237mm with a range at L_c, between 214 -260mm for females while males males mature at 255mm with a range within 213-298mm. This study reports the von Bertalanffy growth parameters separately for each sex, this is due to the fact that maturation and subsequent growth usually differs between males and females because of the different physiological processes that the process have in the two sexes hence the necessity of taking into account sex ratio, though this aspect has not been evaluated in detail in this study.

The female growth performance indices (Φ') of *L. stappersii* from the two study sites were found to be mean, 4.84 range 4.81- 4. 87 and mean, 4.88, range 4.84 - 4.93 for Mpulungu and Nsumbu respectively. The means and range of growth performance for male *L. stappersii* were as follows; mean = 4.85, 4.83- 4.90 for Mpulungu and mean = 4.89, 4.85 - 4.94) for Nsumbu. The growth performance indices (Φ') for this study is lower than those reported by Mannini, (1998) and Pearce, (1985) whose values were: Φ' = 5.04 and 4.95 respectively.

The analysis of females showed that there was a significant difference in the growth performances between the Mpulungu and Nsumbu area. Possible causes for the differences observed in the growth performance indices of female *L. stappersii* could in part be due to the incomplete sampling of a complete size range. According to Pauly, (1980) the growth performance index (Φ') is expected to vary among species and among populations of the same species, since, external factors such as, temperature and food availability may stimulate or inhibit growth.

Distributions of age and sizes are quantitatively related to the specific catchability of the gear used in different fisheries (Rotchet, 1998). The males did not have significant differences between the two areas. Growth pattern variability in a given exploited species such as *L. stappersii* might as well arise from the genetic and phenotypic plasticity in response to the interactions between present environmental characteristics and fishing pressure. But in this study, the water quality paramters (dissolved oxygen and temperature) did not generate significant differences except for water transparency which showed a significant difference between the study sites. It means therefore that the differences observed in this study and that of previous works could only be attributed to ecological conditions of the lake between that period and the present period that might have favored the growth of this species differently.

5.1.4 Mortality rates

The mean total mortality coefficient of females was 1.56year^{-1} and 1.27year^{-1} for Mpulungu and Nsumbu areas respectively while the means for males were 1.53year^{-1} and 1.34year^{1} respectively. The combined sex mean value was 1.43year^{-1} with a range of 1.27 – 1.56year^{-1}. These values are lower than the values obtained by Mannini, (1998) whose mean was 2.1year^{-1} with a range of 1.99 - 2.22year^{-1} for combined sex from Mpulungu southern part of Lake Tanganyika.

The natural mortality coefficients estimated here were also on average lower to that of Manini (1998) M=0.8year^{-1} for Mpulungu area. Similarly, the mean fishing mortality coefficients estimated here F = 0. 76year^{-1} was comparatively smaller to the ones tabulated in the review by Munyandorero and Mwape (2003) whose 1960 – 1972 study showed F = 1.55 year^{-1} and that of 1994 – 1995 was F = 1.20year^{-1}. Variations observed could be attributed to several factors which include: the method of sampling as to whether the commercial catch data from industrial, artisanal or traditional fishery were used or data was specifically obtained by survey method using the Lake Tanganyika research vessel. Usually, samples obtained by commercial and survey methods tend to target particular fishing grounds and the catch contains all sizes. But artisanal and traditional catches are biased towards minimum acceptable sizes in of landing. Further, the variations could have been due to the differences in methods of analysis. This study employed the Ford-Walford Plot to obtain the von Beretalanffy growth Function (VBGF) parameters whereas, most of the cited literature here had used either the Electronic Length Frequency Analysis (ELEFAN I) or Sherpard Composition Length Analysis (SCLA) analyses packages to obtain the von Bertalanffy growth function parameters and estimated the mortality coefficients using the same packages. Careful observations indicate that the values obtained from the Ford-Walford Plot tend to be underestimated while values from these fisheries statistical analysis packages have chances of overestimating the parameters.

Mortality of fish is caused by both biotic and abiotic factors. Biotic factors include diseases, food shortages, old age, predation (cannibalism and parasitism) competition (intra- and interspecific) while abiotic factors include; environmental stress (changes in temperature and dissolved oxygen concentration) and fishing activities. Environmental factors are thought to play a critical role in the pelagic environments causing long term fluctuations in fish stock productivity and in upwelling systems characterized by pulsed primary production and such is not an exception for Lake Tanganyika, where it is believed that the planktonic larval phase of fish can suffer a high and variable mortality (Mannini, 1998) under stressful conditions. The finding of this study indicates that fishing mortalities (F) have a preponderance in the mortality of *L. stappersii* compared to natural mortality (M).

Conversely, emerging information on biotic factors such as; food shortage due to disturbed pulsed primary productivity, diseases, pollution, intraspecific and interspecific competitions might have an impact on the species populations especially that limnological data are showing an upward increase in the temperature of the water in the lake and reduced wind velocity (O'Reilly et al., 2003; Jorgensen et al., 2006; Verburg et al., 2006; Plisnier et al., 2009). Further, records by Chitamwebwa and Kimirei, (2005) and Mulimbwa (2006) on the *L.stappersii* stock are in conforminty with the findings in this study that fishing mortalities probably have been the overall factor in controlling the mortality of the species. In 1994

L.stappersii made up 96% of the total industrial catch in Zambia however, catch per unit of effort (CpUE) has since continued to reduce (Haambiya et al., 2015) up to this present time. A major cause behind this decline is believed to be a seven-fold rise of the industrial fishing effort which occurred with the shifting of industrial fishing units from Burundi into Zambian waters (Mölsa, 2008). The major challenge has been fishing mortality in the southern area. The low density of the clupeids being a main prey is not a problem because this can can efficiently be replaced in the diet with the abundant shrimps (Mannini, 1998).

Moreover, the feeding ecology of *L. stappersii* is more of an opportunistic one largely determined by the prevalence of a particular prey by Munyandorero and Mwape, (2003). This study has shown that the mortality rates between Mpulungu and Nsumbu areas are not significant. Females ($p > 0.05$) [T-test: $p= 0.35$] and males ($p > 0.05$) [T-test: $p = 0.53$] respectively.

5.1.5 Exploitation ratios (E)

The mean exploitation ratios of *L. stappersii* in Mpulungu and that rof Nsumbu were above 0.50. Reports mentioned above contain relatively higher means values compared to what was found under this study. The overall observation is that the southern part of the lake is heavily exploited. Further, the relative low exploitation values could also be explained in part by what Munyandorero, (2002) said about the traditional, artisanal and semi-industrial fleets which inflict specific fishing mortality on the pelagic fish stocks of southern the part Lake Tanganyika, Zambia. To cope up with the declining *L. stappersii* stocks the fleets are highly modified and are illegal by law (Munyandorero, 2002). Around 1983 the southern part of the lake saw an increase in commercial fishing units from 3 to 23. But all these subsequently withdrew due to declining profitability and a heightened stiff competition from artisanal fishers that they once monopolized. During the period (Haambiya et al., 2015) undrertook their study, 90% of the industrial fishing units had completely stopped operations due to economic constraints posed by unprofitable returns from fishing. As a counterplan to this problem the commercial operators switched and started buying fish directly from fishermen operating with all sorts of modified nets which include; Ringnets, "*Mutobi*", hooks and long lines. As a result, this shift in the behaviour of fishermen has proportionally increased the fishing pressure on the stock. For instance, Van der Knaap et al., (2014) frame surveys of 1997 and 2011 indicate that there was almost 100%-fold increase in the active fishing units from (4118 to 8430 boats) and a corresponding increase in fishers who were supposed to form the crews respectively. The decline observed in the catch for *L. stappersii* was actually predicted sometime back by Mannini (1998) and Molsa (2008) especially that the Zambian fishery is dependent on the immigrations from other lightly fished areas like the Tanzanian waters.

Observations made by Kimirei and Mgaya, (2009) warned of worsened decline and a possible collapse of the entire fishery for *L. stappersii* if unsustainable fishing practices continued to an uncontrollable and unreasonable levels in the four riparian countries. Therefore, the visibly lower values obtained for exploitation ratios in this study compared to other records were to some extent affected by the methods employed by fishermen in capturing the fish. Mostly, the catches are supposed to contain all the sizes with a bias towards the large sized specimens however, this is not the case because of restrictions by law enforcing officers from the marine police and Department of Fisheries (DoF), Zambia who have a prescribed minimum landing size for fish sellers and cold room processors. The non-availability of large specimens in sample populations of this study, is a confirmation of an overexploited *L. stappersii* stock for the Zambian fishery.

Previous record by Mannini et al., (1996) show that the mean total length for *L. stappersii* ranged from 450mm to 470mm, but this study did not record specimens with this length. Some thoughts around the actual cause of decline in catchable stocks of *L. stappersii* in southern waters exist. First, is the significant and the eventual withdrawal of the commercial fishing units due to low catch per unit of effort (CpUE), increased duration of fishing trips and abundant juveniles accounting for most of the catch (Haambiya et al; 2015). Secondly, social factors such as demographic growth (population increase) with its corresponding high demand for cheap source of animal proteins (investment-driven) are the leading causes for the decline of the *L. stappersii* stocks (Haambiya et al; 2015). There is ample evidence for overexploitation of many fisheries in the region of Great Rift Valley lakes and this is of global importance because of its threat to inland water biodiversity (Allan et al., 2015). Firstly, intensive fishing of targeted species leads to marked declines in catch per unit effort (CpUE) and size of individuals captured that are reported by almost every piece of study conducted (Allan et al., 2005). Most likely, overfishing is primarily responsible for the decline of a number of fish species prior to the contributions of habitat alteration and pollution globally (Odada et al., 2004; Allan et al., 2005). There are normally sequential declines of species of large size especially piscivores which applies to the stock of *L. stappersii*. For instance, the sizes at maturity and unit effort (CpUE) have been shown to reduce for *L. stappersii* by Mannini, (1998); Mölsa, (2008) and Roest, (2013).

An example of a high-value individual target species that were historically influenced by overexpolitaion include: the Nile perch of Lake Victoria (*Lates niloticus* (Linnaeus, 1758). The stock of *L. stappersii* for a long time has been a major target species from the Zambian fishery on Lake Tanganyika. Because of the continued fishing pressure, the stock has correspondingly declined. The catch is now characterized by very small fish sizes. A mixture of different types of fish locally called "*Mutununu*" now contributes significantly to the overall catch from the fishery as a substitute.

5.1.6 Water quality parameters

This study has established that the environmental parameters analyzed for water quality between Mpulungu and Nsumbu areas did not show any significant differences in two of the parameters that is: dissolved oxygen concentration over the sampling period for surface waters was 4.49mgL^{-1}, and 8.98mgL^{-1} at the two sites. Other reports indicate that oxygenation level can reach down to a depth of 150 - 250m on the southern part of the lake (Plisnier, 2000). This is possible because of the strong mixing and upwelling activities (Plisnier et al., 1999; Plisnier, 2004; Jorgensen, et al; 2006). Some daily variations were observed from each study site, especially on windy days with strong wave values as high as 12.0mgL^{-1}, 13.0mgL^{-1}, 14.0mgL^{-1} 15mgL^{-1}.0 and 16.0mgL^{-1} being recorded. Similar observations were also noted by Plisnier et al., (1999) that some temporary incursions of DO were possible in lower depths due to turbulence.

The surface water temperature range for the Mpulungu area was between 24.36°C and 28.0°C while the range in Nsumbu area was from 23.08°C to 27.06°C. The findings are consistent with several studies like ones provided by Naithani et al., (2007) which reported that water temperature in the lake varied from 24°C to 28°C in the surface layer to around 23.5°C in the bottom layer. Similar findings exist by Stenuite et al., (2009) whose average water temperatures in the euphotic zone ranged from 24.6°C to 26.8°C with lower values being recorded in the dry season. According to Plisnier, (2004); Sarvala et al., (2006); Huttula and Sarvala, (2012); Plisnier et al., (2018) an important limnological characteristic of the lake is the permanent density stratification of the water. This stratification is mainly dependent on temperature differences. Plisnier (2004) found that the surface water temperature varies during the year between 24.0°C and 28.5°C in the south while the temperature of the bottom is close to 23.4°C.

The main seasons around the lake are 4-5months long (May -September) 'dry season' characterized by cooler dry weather and fairly constant southeasterly trade winds and 'wet season' season for the rest of the year during which the winds are weaker and mainly from the northeast direction (Naithani et al., 2007). What happens between May - June, south east trade winds drive warm epilimnion water towards the north of the lake whose effects is accumulation of the warm water in the north it is known to be mainly a surface process. Conversely, more water flows in the opposite direction to the south as deep currents causing a well-known compensating upwelling in the southern coast (Plisnier, et al., 1999; Naithani et al., 2007).

The upwelling was detected by Plisnier (2004) through the measurement of colder and nutrient rich water that averaged 24.4°C at the surface during the dry season compared to 27.2°C during the wet season at Mpulungu. The effects of mixing which occurs during upwelling due to internal waves were observed under this study around June to July, during which the surface of the lake around the same period is covered in a yellowish powdery substance known by the locals as '*mutuba*' an occurrence associated with high food availability for the cichlids as noted from the plumpness of the fish caught. Based on fishermen's experience (personal communication) this natural phenomenon is witnessed annually and about the same time. This is in line with earlier assertions by several authors that the southeast trade winds induce primary phytoplankton productivity between the end of wet season and the onset of dry seasons e.g. (Plisnier et al., 1999; O'Reilly et al., 2003; Jorgensen et al., 2006).

During the period of upwelling and mixing, the average transparency normally decreases (Plsinier, et al., 1999) with a range of 8-10m compared to wet seasons with 12-18m. The water transparency for this study was a bit lower than the ones stated above, the mean value for Mpulungu was 6.47m with a range of 4.0 – 9. 20m and Nsumbu had mean value of 7.32m, range was between 4.67 – 10.90m. The differences could be explained by the differences in the statistical tool used, this study used the means while Plisnier et al., (1999) used the median values. Mixing and turbulence reduces average water transparency, also the visual acuity of different observers involved during sampling could be the cause of further variations in the reported values.

Even though, the pH parameter was not monitored throughout the study period, its fluctuations in Lake Tanganyika have been observed to remain relatively constant around 8.66 to 9.12 around Mpulungu Plisnier et al., (1999). Further, Stenuite et al., (2009) obtained a range of pH values between 8.1-8.7 which further corroborates with what this study has reported. The high pH values are associated with quick uptake of hydrogen carbonate (HCO_3^-) ions through photosynthesis by phytoplankton (Plisnier et al., 1999). However, Plisnier et al., (1999) reports that Lake Tanganyika has high buffering capacity and as such pH changes are not as rapid as other parameters. Lake Tanganyika is not a homogeneous and stable system during the annual period. It is believed to experience random patchiness during which very variable observations are noted in the water transparency on short time scale or hours resulting from patchiness in nutrients linked to internal waves and turbulence (Plisnier et al., 1999) and similar observations were recorded during this study. Further, source of variations in the values of water transparency could be the angle of the sun or solar radiations impinging on the water surface, photo-inhibition by scattering and absorbing particles both from abiotic and biotic matter which further reduce light available for downward observation, also visual acuity for an individual observer and vertical migration of grazers (zooplanktons) and/ or movement of water (Wetzel, 1975; Kalff, 2002).

Chapter 6 : CONCLUSIONS AND RECOMMENDATIONS.

6.1 Conclusions

As intensive fishing pressure becomes an increasingly central issue for every exploitable fish stock in all inland fisheries. It is important to understand how a particular fish population stock like that of *L. stappersii* responds to different fishing efforts experienced at local level with similar environmental conditions.

By investigating population growth parameters (asymptotic length, L_∞ growth coefficient, k) of *L. stappersii*. The overall mean values for Mpulungu and Nsumbu were: L_∞ = 318mm and 314mm with corresponding k values 0.72year^{-1} and 0.77year^{1} respectively. This study established that there were no significant differences in the growth parameters of *L. stappersii* between Mpulungu and Nsumbu of the fishery. The overall growth of *L. stappersii* in Zambian waters was estimated at L_∞= 316mm; k = 0.75year^{-1}.

The mortality rates were computed. The overall mean mortality of *L. stappersii* (Z) for Mpulungu and Nsumbu were as follows: Z = 1. 54year^{-1} and 1.31year^{-1}, respectively. A comparative analysis indicated that there were no significant differences in mortality rates of *L. stappersii* between Mpulungu and Nsumbu areas. The overall mortality of *L. stappersii* from the Zambian side of the lake was estimated at Z = 1.42year^{-1}.

In order to establish the extent and sustainable exploitation of the *L. stappersii* stock, the exploitation ratios from the two sites were estimated. The overall mean values were for Mpulungu and Nsumbu areas as follows: E = 0.57 and 0.48 respectively. No significant differences existed in the exploitation of *L. stappersii* stock between the Mpulungu and Nsumbu areas. The overall exploitation mean value estimated for the Zambian side of the Lake Tanganyika was E = 0.53. Further analysis of monthly exploitation ratios for each site suggested that the stock was overexploited. Evidence of overexploitation lies in: craft and illegal modification of the fishing gears by fishermen as well as the withdrawal of large commercial fishing units from the lake. The trends of the growth parameters of *L. stappersii* over the years from 1963 to 2003 have been estimated within the range of L_∞= 450mm to 470mm and k values

0.39 – 0.40year$^{-1.}$ while the mortality rates over the same period has been within the range of Z = 0.57 – 2.35year^{-1}.

The asymptotic length , L_∞ continues to reduce with a corresponding increase in the growth coefficient, k, as shown in this study. The trends in mortality rates shows the mean values have remained high but static due to modified exploitation methods.

Some water qaulity parameters were investigated between the two sites. The study established that the two sites did not differ in oxygen and temperature, except for water transparency. All the parameters obtained were very close and highly consistent with reports from other authors mentioned above, suggesting that the *L. stappersii* fish on the Zambian side is exposed to similar environmental conditions. Although, there is uneven distribution of fishing efforts between Mpulungu and Nsumbu areas, evidence under this study has shown that the Mpulungu and Nsumbu areas are inhabited by the same stock of the *L. stappersii* and in both areas the stock is overexploited. Therefore, the illusion that allowing additional fishing units in Nsumbu area as a management strategy will not result in significant fish output and will increase the extent of overfishing.

6.2 Recommendations

This study was conducted from April to August, 2022, future studies need to find out the occupancy and distribution of *L. stappersii* especially between July- October, over a twelve (12) month sampling period. Because during this study fish samples were not collected for July and August. This will be helpful in solving the long-held puzzle as to whether *L. stappersii* stock go down to greater depths where current fishing gears cannot reach, a notion commonly held by all fisherfolks or could this disappearance prove Phiri and Shirakihara, (1999) of mass emigration of *L. stappersii* out of the southern waters during dry season. Detection and tracking methods can be used to trace the accurate location of the stock during this period.

Future studies need to target all age (size) classes of *L. stappersii* particularly on aspects of population growth parameters, mortality and exploitation. The information will be helpful when coming up with good strategies for sustainable management of the *L. stappersii* stock in Lake Tanganyika.

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APPENDICES

Appendix A: compilation of fishery data of *Lates stappersii* for Mpulungu area.

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1	19-04-22	*Lates stappersii*	160	180	43	F	A
2	19-04-22	*Lates stappersii*	170	190	46	F	IM
3	19-04-22	*Lates stappersii*	170	190	50	F	IM
4	19-04-22	*Lates stappersii*	170	190	41	F	A
5	19-04-22	*Lates stappersii*	170	190	45	F	IM
6	19-04-22	*Lates stappersii*	170	190	43	F	IM
7	19-04-22	*Lates stappersii*	170	190	49	F	A
8	19-04-22	*Lates stappersii*	170	190	47	F	R
9	19-04-22	*Lates stappersii*	170	190	42	F	A
10	19-04-22	*Lates stappersii*	170	190	47	F	A
11	19-04-22	*Lates stappersii*	170	190	43	F	A
12	19-04-22	*Lates stappersii*	170	190	46	F	A
13	19-04-22	*Lates stappersii*	170	190	41	F	IM
14	19-04-22	*Lates stappersii*	180	200	48	F	IM
15	19-04-22	*Lates stappersii*	180	200	57	F	R
16	19-04-22	*Lates stappersii*	180	200	52	F	A
17	19-04-22	*Lates stappersii*	180	200	51	F	A
18	19-04-22	*Lates stappersii*	190	210	59	F	R
19	19-04-22	*Lates stappersii*	190	210	60	F	A
20	19-04-22	*Lates stappersii*	190	210	63	F	A
21	19-04-22	*Lates stappersii*	190	210	53	F	A
22	19-04-22	*Lates stappersii*	190	210	55	F	A
23	10-04-22	*Lates stappersii*	200	220	67	F	R
24	12-04-22	*Lates stappersii*	200	220	67	F	R
25	10-04-22	*Lates stappersii*	210	230	83	F	R
26	10-04-22	*Lates stappersii*	210	230	82	F	R
27	10-04-22	*Lates stappersii*	210	230	78	F	R
28	10-04-22	*Lates stappersii*	210	230	85	F	RR

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
29	10-04-22	*Lates stappersii*	210	230	80	F	R
30	10-04-22	*Lates stappersii*	210	230	70	F	A
31	10-04-22	*Lates stappersii*	210	230	70	F	RR
32	11-04-22	*Lates stappersii*	210	230	80	F	R
33	11-04-22	*Lates stappersii*	210	230	75	F	R
34	11-04-22	*Lates stappersii*	210	230	75	F	A
35	11-04-22	*Lates stappersii*	210	230	84	F	R
36	11-04-22	*Lates stappersii*	210	230	72	F	R
37	12-04-22	*Lates stappersii*	210	230	80	F	R
38	12-04-22	*Lates stappersii*	210	230	79	F	R
39	12-04-22	*Lates stappersii*	210	230	72	F	R
40	12-04-22	*Lates stappersii*	210	230	82	F	A
41	12-04-22	*Lates stappersii*	210	230	80	F	R
42	10-04-22	*Lates stappersii*	220	240	88	F	R
43	10-04-22	*Lates stappersii*	220	240	89	F	RR
44	11-04-22	*Lates stappersii*	220	240	92	F	R
45	11-04-22	*Lates stappersii*	220	240	72	F	A
46	11-04-22	*Lates stappersii*	220	240	78	F	R
47	12-04-22	*Lates stappersii*	220	240	91	F	RR
48	12-04-22	*Lates stappersii*	220	240	79	F	R
49	12-04-22	*Lates stappersii*	220	240	88	F	RR
50	10-04-22	*Lates stappersii*	230	250	98	F	R
51	10-04-22	*Lates stappersii*	230	250	92	F	R
52	10-04-22	*Lates stappersii*	230	250	104	F	RR
53	10-04-22	*Lates stappersii*	230	250	93	F	RR
54	10-04-22	*Lates stappersii*	230	250	89	F	R
55	11-04-22	*Lates stappersii*	230	250	95	F	R
56	11-04-22	*Lates stappersii*	230	250	102	F	A
57	11-04-22	*Lates stappersii*	230	250	79	F	R
58	12-04-22	*Lates stappersii*	230	250	93	F	R
59	12-04-22	*Lates stappersii*	230	250	93	F	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
60	12-04-22	*Lates stappersii*	230	250	93	F	R
61	10-04-22	*Lates stappersii*	240	260	121	F	RR
62	10-04-22	*Lates stappersii*	240	260	112	F	SP
63	10-04-22	*Lates stappersii*	240	260	106	F	SP
64	10-04-22	*Lates stappersii*	240	260	109	F	R
65	10-04-22	*Lates stappersii*	240	260	113	F	A
66	11-04-22	*Lates stappersii*	240	260	107	F	R
67	12-04-22	*Lates stappersii*	240	260	110	F	RR
68	10-04-22	*Lates stappersii*	250	270	121	F	R
69	10-04-22	*Lates stappersii*	250	270	123	F	R
70	10-04-22	*Lates stappersii*	250	270	120	F	A
71	10-04-22	*Lates stappersii*	250	270	110	F	R
72	12-04-22	*Lates stappersii*	250	270	123	F	RR
73	10-04-22	*Lates stappersii*	260	280	144	F	R
74	10-04-22	*Lates stappersii*	260	280	122	F	SP
75	10-04-22	*Lates stappersii*	270	290	153	F	A
76	10-04-22	*Lates stappersii*	270	290	165	F	A
77	11-04-22	*Lates stappersii*	310	330	227	F	R
78	11-04-22	*Lates stappersii*	320	340	271	F	A
79	11-04-22	*Lates stappersii*	330	350	269	F	R
80	11-04-22	*Lates stappersii*	340	360	296	F	R
81	11-04-22	*Lates stappersii*	350	370	363	F	SP
82	11-04-22	*Lates stappersii*	380	400	405	F	R
83	03-05-22	*Lates stappersii*	290	310	196	F	SP
84	03-05-22	*Lates stappersii*	290	310	159	F	SP
85	10-05-22	*Lates stappersii*	290	310	186	F	SP
86	02-05-22	*Lates stappersii*	280	300	161	F	R
87	03-05-22	*Lates stappersii*	280	300	143	F	SP
88	03-05-22	*Lates stappersii*	280	300	162	F	SP
89	03-05-22	*Lates stappersii*	280	300	170	F	SP
90	03-05-22	*Lates stappersii*	280	300	155	F	RR

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
91	03-05-22	*Lates stappersii*	280	300	138	F	RR
92	03-05-22	*Lates stappersii*	280	300	169	F	SP
93	10-05-22	*Lates stappersii*	280	300	177	F	R
94	02-05-22	*Lates stappersii*	270	290	170	F	R
95	03-05-22	*Lates stappersii*	270	290	158	F	RR
96	03-05-22	*Lates stappersii*	270	290	148	F	SP
97	03-05-22	*Lates stappersii*	270	290	132	F	RR
98	10-05-22	*Lates stappersii*	270	290	144	F	RR
99	03-05-22	*Lates stappersii*	260	280	135	F	SP
100	03-05-22	*Lates stappersii*	260	280	136	F	RR
101	03-05-22	*Lates stappersii*	250	270	135	F	SP
102	03-05-22	*Lates stappersii*	250	270	111	F	R
103	03-05-22	*Lates stappersii*	250	270	124	F	SP
104	03-05-22	*Lates stappersii*	250	270	124	F	SP
105	10-05-22	*Lates stappersii*	250	270	124	F	RR
106	10-05-22	*Lates stappersii*	250	270	128	F	RR
107	10-05-22	*Lates stappersii*	250	270	110	F	RR
108	03-05-22	*Lates stappersii*	240	260	162	F	RR
109	03-05-22	*Lates stappersii*	240	260	120	F	SP
110	03-05-22	*Lates stappersii*	240	280	102	F	R
111	03-05-22	*Lates stappersii*	240	260	127	F	RR
112	03-05-22	*Lates stappersii*	240	260	103	F	R
113	03-05-22	*Lates stappersii*	240	260	115	F	SP
114	10-05-22	*Lates stappersii*	240	260	105	F	R
115	02-05-22	*Lates stappersii*	230	250	93	F	SP
116	02-05-22	*Lates stappersii*	230	250	85	F	R
117	03-05-22	*Lates stappersii*	230	250	103	F	A
118	03-05-22	*Lates stappersii*	230	250	92	F	A
119	03-05-22	*Lates stappersii*	230	250	86	F	A
120	03-05-22	*Lates stappersii*	230	250	97	F	R
121	10-05-22	*Lates stappersii*	230	250	90	F	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
122	10-05-22	*Lates stappersii*	230	250	82	F	A
123	10-05-22	*Lates stappersii*	230	250	91	F	R
124	02-05-22	*Lates stappersii*	220	240	82	F	RR
125	02-05-22	*Lates stappersii*	220	240	84	F	RR
126	02-05-22	*Lates stappersii*	220	240	90	F	RR
127	02-05-22	*Lates stappersii*	220	240	81	F	R
128	02-05-22	*Lates stappersii*	220	240	81	F	RR
129	02-05-22	*Lates stappersii*	220	240	82	F	R
130	02-05-22	*Lates stappersii*	220	240	82	F	R
131	02-05-22	*Lates stappersii*	220	240	80	F	SP
132	02-05-22	*Lates stappersii*	220	240	79	F	RR
133	02-05-22	*Lates stappersii*	220	240	78	F	A
134	02-05-22	*Lates stappersii*	220	240	83	F	RR
135	02-05-22	*Lates stappersii*	220	240	79	F	R
136	02-05-22	*Lates stappersii*	220	240	86	F	R
137	02-05-22	*Lates stappersii*	220	240	84	F	R
138	02-05-22	*Lates stappersii*	220	240	84	F	A
139	03-05-22	*Lates stappersii*	220	240	84	F	R
140	03-05-22	*Lates stappersii*	220	240	92	F	R
141	03-05-22	*Lates stappersii*	220	240	85	F	A
142	03-05-22	*Lates stappersii*	220	240	94	F	R
143	03-05-22	*Lates stappersii*	220	240	90	F	R
144	03-05-22	*Lates stappersii*	220	240	74	F	R
145	03-05-22	*Lates stappersii*	220	240	88	F	R
146	03-05-22	*Lates stappersii*	220	240	96	F	SP
147	03-05-22	*Lates stappersii*	220	240	89	F	R
148	03-05-22	*Lates stappersii*	220	240	91	F	R
149	03-05-22	*Lates stappersii*	220	240	91	F	R
150	10-05-22	*Lates stappersii*	220	240	86	F	R
151	10-05-22	*Lates stappersii*	220	240	82	F	A
152	10-05-22	*Lates stappersii*	220	240	76	F	A

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
153	10-05-22	*Lates stappersii*	220	240	91	F	R
154	10-05-22	*Lates stappersii*	220	240	85	F	R
155	02-05-22	*Lates stappersii*	210	230	76	F	R
156	02-05-22	*Lates stappersii*	210	230	70	F	A
157	02-05-22	*Lates stappersii*	210	230	70	F	RR
158	02-05-22	*Lates stappersii*	210	230	83	F	RR
159	02-05-22	*Lates stappersii*	210	230	79	F	R
160	02-05-22	*Lates stappersii*	210	230	79	F	RR
161	02-05-22	*Lates stappersii*	210	230	77	F	R
162	02-05-22	*Lates stappersii*	210	230	79	F	RR
163	02-05-22	*Lates stappersii*	210	230	80	F	R
164	02-05-22	*Lates stappersii*	210	230	76	F	R
165	02-05-22	*Lates stappersii*	210	230	76	F	R
166	02-05-22	*Lates stappersii*	210	230	74	F	R
167	02-05-22	*Lates stappersii*	210	230	86	F	R
168	02-05-22	*Lates stappersii*	210	230	74	F	A
169	02-05-22	*Lates stappersii*	210	230	77	F	A
170	03-05-22	*Lates stappersii*	210	230	78	F	R
171	03-05-22	*Lates stappersii*	210	230	65	F	R
172	03-05-22	*Lates stappersii*	210	230	70	F	R
173	03-05-22	*Lates stappersii*	210	230	78	F	R
174	03-05-22	*Lates stappersii*	210	230	70	F	A
175	03-05-22	*Lates stappersii*	210	230	72	F	RR
176	03-05-22	*Lates stappersii*	210	230	72	F	R
177	03-05-22	*Lates stappersii*	210	230	84	F	RR
178	03-05-22	*Lates stappersii*	210	230	75	F	A
179	03-05-22	*Lates stappersii*	210	230	73	F	A
180	03-05-22	*Lates stappersii*	210	230	88	F	RR
181	03-05-22	*Lates stappersii*	210	230	73	F	R
182	03-05-22	*Lates stappersii*	210	230	77	F	R
183	10-05-22	*Lates stappersii*	210	230	78	F	A

MPULUNGU AREA							
No	Date	Species	FL (mm)	TL (mm)	Wgt (g)	Sex	Gonad state
184	10-05-22	*Lates stappersii*	210	230	77	F	A
185	10-05-22	*Lates stappersii*	210	230	73	F	A
186	10-05-22	*Lates stappersii*	210	230	79	F	R
187	10-05-22	*Lates stappersii*	210	230	74	F	R
188	02-05-22	*Lates stappersii*	200	220	59	F	A
189	02-05-22	*Lates stappersii*	200	220	70	F	R
190	02-05-22	*Lates stappersii*	200	220	61	F	R
191	02-05-22	*Lates stappersii*	200	220	68	F	RR
192	02-05-22	*Lates stappersii*	200	220	71	F	RR
193	02-05-22	*Lates stappersii*	200	220	60	F	R
194	02-05-22	*Lates stappersii*	200	220	67	F	RR
195	02-05-22	*Lates stappersii*	200	220	62	F	R
196	02-05-22	*Lates stappersii*	200	220	67	F	RR
197	02-05-22	*Lates stappersii*	200	220	68	F	R
198	02-05-22	*Lates stappersii*	200	220	68	F	A
199	02-05-22	*Lates stappersii*	200	220	71	F	R
200	03-05-22	*Lates stappersii*	200	220	78	F	A
201	03-05-22	*Lates stappersii*	200	220	58	F	A
202	03-05-22	*Lates stappersii*	200	220	61	F	A
203	03-05-22	*Lates stappersii*	200	220	67	F	R
204	10-05-22	*Lates stappersii*	200	220	65	F	A
205	02-05-22	*Lates stappersii*	190	210	56	F	R
206	03-05-22	*Lates stappersii*	190	210	54	F	A
207	03-05-22	*Lates stappersii*	190	210	49	F	A
208	03-05-22	*Lates stappersii*	190	210	66	F	RR
209	13-06-22	*Lates stappersii*	200	220	70	F	A
210	14-06-22	*Lates stappersii*	200	220	82	F	A
211	14-06-22	*Lates stappersii*	200	220	74	F	R
212	14-06-22	*Lates stappersii*	200	220	72	F	R
213	13-06-22	*Lates stappersii*	210	230	79	F	A
214	13-06-22	*Lates stappersii*	210	230	84	F	RR

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
215	14-06-22	*Lates stappersii*	210	230	81	F	SP
216	14-06-22	*Lates stappersii*	210	230	76	F	R
217	14-06-22	*Lates stappersii*	210	230	77	F	R
218	14-06-22	*Lates stappersii*	210	230	106	F	RR
219	13-06-22	*Lates stappersii*	220	240	98	F	R
220	13-06-22	*Lates stappersii*	220	240	85	F	A
221	13-06-22	*Lates stappersii*	220	240	95	F	R
222	13-06-22	*Lates stappersii*	220	240	94	F	R
223	13-06-22	*Lates stappersii*	220	240	94	F	R
224	14-06-22	*Lates stappersii*	220	240	94	F	R
225	14-06-22	*Lates stappersii*	220	240	95	F	SP
226	14-06-22	*Lates stappersii*	220	240	93	F	R
227	14-06-22	*Lates stappersii*	220	240	92	F	SP
228	14-06-22	*Lates stappersii*	220	240	98	F	R
229	14-06-22	*Lates stappersii*	220	240	96	F	R
230	14-06-22	*Lates stappersii*	220	240	82	F	RR
231	14-06-22	*Lates stappersii*	220	240	84	F	RR
232	14-06-22	*Lates stappersii*	220	240	80	F	RR
233	14-06-22	*Lates stappersii*	220	240	115	F	SP
234	13-06-22	*Lates stappersii*	230	250	105	F	RR
235	13-06-22	*Lates stappersii*	230	250	100	F	SP
236	13-06-22	*Lates stappersii*	230	250	98	F	R
237	13-06-22	*Lates stappersii*	230	250	96	F	R
238	13-06-22	*Lates stappersii*	230	250	103	F	SP
239	13-06-22	*Lates stappersii*	230	250	106	F	SP
240	13-06-22	*Lates stappersii*	230	250	91	F	SP
241	13-06-22	*Lates stappersii*	230	250	95	F	SP
242	13-06-22	*Lates stappersii*	230	250	91	F	R
243	13-06-22	*Lates stappersii*	230	250	106	F	R
244	13-06-22	*Lates stappersii*	230	250	108	F	SP
245	14-06-22	*Lates stappersii*	230	250	100	F	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
246	14-06-22	*Lates stappersii*	230	250	100	F	R
247	14-06-22	*Lates stappersii*	230	250	98	F	R
248	14-06-22	*Lates stappersii*	230	250	106	F	RR
249	14-06-22	*Lates stappersii*	230	250	92	F	SP
250	14-06-22	*Lates stappersii*	230	250	109	F	SP
251	14-06-22	*Lates stappersii*	230	250	95	F	R
252	14-06-22	*Lates stappersii*	230	250	99	F	R
253	14-06-22	*Lates stappersii*	230	250	104	F	RR
254	14-06-22	*Lates stappersii*	230	250	102	F	RR
255	14-06-22	*Lates stappersii*	230	250	104	F	SP
256	14-06-22	*Lates stappersii*	230	250	109	F	RR
257	14-06-22	*Lates stappersii*	230	250	110	F	RR
258	14-06-22	*Lates stappersii*	230	250	97	F	R
259	14-06-22	*Lates stappersii*	230	250	99	F	R
260	14-06-22	*Lates stappersii*	230	250	108	F	RR
261	14-06-22	*Lates stappersii*	230	250	110	F	SP
262	14-06-22	*Lates stappersii*	230	250	112	F	RR
263	14-06-22	*Lates stappersii*	230	260	108	F	RR
264	14-06-22	*Lates stappersii*	230	250	101	F	RR
265	14-06-22	*Lates stappersii*	230	250	100	F	SP
266	14-06-22	*Lates stappersii*	230	250	100	F	R
267	14-06-22	*Lates stappersii*	230	250	93	F	R
268	13-06-22	*Lates stappersii*	240	260	101	F	SP
269	13-06-22	*Lates stappersii*	240	260	104	F	SP
270	13-06-22	*Lates stappersii*	240	260	118	F	SP
271	13-06-22	*Lates stappersii*	240	260	112	F	R
272	13-06-22	*Lates stappersii*	240	260	108	F	RR
273	13-06-22	*Lates stappersii*	240	260	112	F	R
274	13-06-22	*Lates stappersii*	240	260	97	F	RR
275	13-06-22	*Lates stappersii*	240	260	98	F	SP
276	14-06-22	*Lates stappersii*	240	260	106	F	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
277	14-06-22	*Lates stappersii*	240	260	121	F	SP
278	14-06-22	*Lates stappersii*	240	260	115	F	SP
279	14-06-22	*Lates stappersii*	240	260	117	F	RR
280	14-06-22	*Lates stappersii*	240	260	111	F	R
281	14-06-22	*Lates stappersii*	240	260	113	F	SP
282	14-06-22	*Lates stappersii*	240	260	134	F	R
283	13-06-22	*Lates stappersii*	250	270	126	F	SP
284	13-06-22	*Lates stappersii*	250	270	124	F	SP
285	13-06-22	*Lates stappersii*	250	270	133	F	SP
286	13-06-22	*Lates stappersii*	250	270	110	F	SP
287	13-06-22	*Lates stappersii*	250	270	123	F	SP
288	14-06-22	*Lates stappersii*	250	270	149	F	RR
289	14-06-22	*Lates stappersii*	250	270	128	F	RR
290	14-06-22	*Lates stappersii*	250	270	120	F	RR
291	14-06-22	*Lates stappersii*	250	270	107	F	SP
292	14-06-22	*Lates stappersii*	250	270	115	F	SP
293	14-06-22	*Lates stappersii*	250	270	128	F	SP
294	14-06-22	*Lates stappersii*	250	270	112	F	SP
295	13-06-22	*Lates stappersii*	260	280	140	F	SP
296	13-06-22	*Lates stappersii*	260	280	138	F	RR
297	13-06-22	*Lates stappersii*	260	280	135	F	SP
298	13-06-22	*Lates stappersii*	260	280	143	F	R
299	14-06-22	*Lates stappersii*	260	280	148	F	RR
300	13-06-22	*Lates stappersii*	270	290	154	F	SP
301	13-06-22	*Lates stappersii*	270	290	146	F	SP
302	19-04-22	*Lates stappersii*	140	160	26	M	A
303	19-04-22	*Lates stappersii*	160	180	33	M	A
304	19-04-22	*Lates stappersii*	160	180	37	M	A
305	19-04-22	*Lates stappersii*	160	180	42	M	IM
306	19-04-22	*Lates stappersii*	160	180	38	M	IM
307	19-04-22	*Lates stappersii*	160	180	37	M	A

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
308	19-04-22	*Lates stappersii*	160	180	40	M	IM
309	19-04-22	*Lates stappersii*	170	190	42	M	A
310	19-04-22	*Lates stappersii*	170	190	43	M	IM
311	19-04-22	*Lates stappersii*	170	190	44	M	A
312	19-04-22	*Lates stappersii*	180	200	45	M	IM
313	19-04-22	*Lates stappersii*	180	200	53	M	A
314	19-04-22	*Lates stappersii*	180	200	99	M	IM
315	19-04-22	*Lates stappersii*	180	200	54	M	A
316	19-04-22	*Lates stappersii*	180	200	53	M	A
317	11-04-22	*Lates stappersii*	190	210	59	M	R
318	11-04-22	*Lates stappersii*	190	220	58	M	A
319	11-04-22	*Lates stappersii*	190	210	62	M	R
320	12-04-22	*Lates stappersii*	190	210	62	M	R
321	19-04-22	*Lates stappersii*	190	210	57	M	R
322	19-04-22	*Lates stappersii*	190	200	54	M	A
323	19-04-22	*Lates stappersii*	190	210	63	M	R
324	19-04-22	*Lates stappersii*	190	210	54	M	A
325	19-04-22	*Lates stappersii*	190	210	58	M	R
326	19-04-22	*Lates stappersii*	190	210	61	M	R
327	19-04-22	*Lates stappersii*	190	210	48	M	A
328	19-04-22	*Lates stappersii*	190	210	55	M	A
329	19-04-22	*Lates stappersii*	190	210	56	M	A
330	19-04-22	*Lates stappersii*	190	210	58	M	R
331	19-04-22	*Lates stappersii*	190	210	63	M	A
332	10-04-22	*Lates stappersii*	200	220	75	M	RR
333	11-04-22	*Lates stappersii*	200	220	62	M	R
334	11-04-22	*Lates stappersii*	200	220	69	M	R
335	11-04-22	*Lates stappersii*	200	220	72	M	RR
336	11-04-22	*Lates stappersii*	200	220	70	M	A
337	11-04-22	*Lates stappersii*	200	220	66	M	A
338	11-04-22	*Lates stappersii*	200	230	61	M	A

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
339	11-04-22	*Lates stappersii*	200	220	61	M	A
340	12-04-22	*Lates stappersii*	200	220	73	M	RR
341	12-04-22	*Lates stappersii*	200	220	70	M	A
342	12-04-22	*Lates stappersii*	200	220	65	M	R
343	19-04-22	*Lates stappersii*	200	220	64	M	R
344	19-04-22	*Lates stappersii*	200	220	68	M	R
345	19-04-22	*Lates stappersii*	200	220	61	M	A
346	10-04-22	*Lates stappersii*	210	230	77	M	RR
347	10-04-22	*Lates stappersii*	210	230	81	M	RR
348	10-04-22	*Lates stappersii*	210	230	73	M	RR
349	11-04-22	*Lates stappersii*	210	230	77	M	RR
350	11-04-22	*Lates stappersii*	210	230	70	M	RR
351	11-04-22	*Lates stappersii*	210	230	74	M	RR
352	11-04-22	*Lates stappersii*	210	230	79	M	RR
353	11-04-22	*Lates stappersii*	210	230	75	M	RR
354	11-04-22	*Lates stappersii*	210	230	73	M	R
355	11-04-22	*Lates stappersii*	210	230	70	M	R
356	11-04-22	*Lates stappersii*	210	230	79	M	RR
357	11-04-22	*Lates stappersii*	210	230	77	M	RR
358	11-04-22	*Lates stappersii*	210	230	75	M	RR
359	11-04-22	*Lates stappersii*	210	230	70	M	R
360	11-04-22	*Lates stappersii*	210	230	81	M	R
361	11-04-22	*Lates stappersii*	210	230	77	M	R
362	11-04-22	*Lates stappersii*	210	230	79	M	A
363	11-04-22	*Lates stappersii*	210	230	58	M	A
364	11-04-22	*Lates stappersii*	210	230	79	M	A
365	11-04-22	*Lates stappersii*	210	230	76	M	A
366	11-04-22	*Lates stappersii*	210	230	73	M	A
367	11-04-22	*Lates stappersii*	210	230	75	M	M
368	11-04-22	*Lates stappersii*	210	230	75	M	A
369	12-04-22	*Lates stappersii*	210	230	73	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
370	12-04-22	*Lates stappersii*	210	230	75	M	RR
371	12-04-22	*Lates stappersii*	210	230	76	M	R
372	12-04-22	*Lates stappersii*	210	230	87	M	RR
373	12-04-22	*Lates stappersii*	210	230	79	M	RR
374	12-04-22	*Lates stappersii*	210	230	87	M	R
375	12-04-22	*Lates stappersii*	210	230	78	M	RR
376	10-04-22	*Lates stappersii*	220	250	86	M	RR
377	10-04-22	*Lates stappersii*	220	250	86	M	RR
378	10-04-22	*Lates stappersii*	220	240	100	M	RR
379	11-04-22	*Lates stappersii*	220	240	87	M	R
380	11-04-22	*Lates stappersii*	220	240	83	M	R
381	11-04-22	*Lates stappersii*	220	240	90	M	R
382	11-04-22	*Lates stappersii*	220	240	90	M	RR
383	11-04-22	*Lates stappersii*	220	250	86	M	RR
384	11-04-22	*Lates stappersii*	220	250	80	M	A
385	11-04-22	*Lates stappersii*	220	250	82	M	R
386	11-04-22	*Lates stappersii*	220	240	81	M	RR
387	11-04-22	*Lates stappersii*	220	240	78	M	RR
388	11-04-22	*Lates stappersii*	220	240	82	M	A
389	12-04-22	*Lates stappersii*	220	240	89	M	R
390	12-04-22	*Lates stappersii*	220	240	94	M	R
391	12-04-22	*Lates stappersii*	220	240	89	M	RR
392	12-04-22	*Lates stappersii*	220	240	84	M	A
393	12-04-22	*Lates stappersii*	220	240	101	M	RR
394	12-04-22	*Lates stappersii*	220	240	87	M	RR
395	12-04-22	*Lates stappersii*	220	240	78	M	RR
396	12-04-22	*Lates stappersii*	220	240	91	M	A
397	12-04-22	*Lates stappersii*	220	240	86	M	RR
398	12-04-22	*Lates stappersii*	220	240	90	M	R
399	19-04-22	*Lates stappersii*	220	240	86	M	SP
400	10-04-22	*Lates stappersii*	230	245	88	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
401	10-04-22	*Lates stappersii*	230	250	96	M	RR
402	10-04-22	*Lates stappersii*	230	250	103	M	RR
403	10-04-22	*Lates stappersii*	230	250	102	M	SP
404	10-04-22	*Lates stappersii*	230	250	84	M	RR
405	10-04-22	*Lates stappersii*	230	250	96	M	A
406	11-04-22	*Lates stappersii*	230	250	100	M	RR
407	11-04-22	*Lates stappersii*	230	250	99	M	R
408	11-04-22	*Lates stappersii*	230	250	96	M	R
409	12-04-22	*Lates stappersii*	230	250	102	M	R
410	12-04-22	*Lates stappersii*	230	250	99	M	R
411	12-04-22	*Lates stappersii*	230	250	100	M	RR
412	12-04-22	*Lates stappersii*	230	250	86	M	R
413	12-04-22	*Lates stappersii*	230	250	99	M	A
414	12-04-22	*Lates stappersii*	230	250	107	M	A
415	12-04-22	*Lates stappersii*	230	250	110	M	RR
416	12-04-22	*Lates stappersii*	230	250	92	M	RR
417	11-04-22	*Lates stappersii*	240	260	116	M	A
418	12-04-22	*Lates stappersii*	240	260	123	M	R
419	12-04-22	*Lates stappersii*	240	260	123	M	RR
420	12-04-22	*Lates stappersii*	240	260	99	M	sp
421	12-04-22	*Lates stappersii*	240	240	116	M	RR
422	19-04-22	*Lates stappersii*	240	260	108	M	RR
423	10-04-22	*Lates stappersii*	250	270	132	M	RR
424	10-04-22	*Lates stappersii*	250	270	123	M	SP
425	10-04-22	*Lates stappersii*	250	270	126	M	SP
426	10-04-22	*Lates stappersii*	250	270	131	M	A
427	10-04-22	*Lates stappersii*	250	270	121	M	R
428	12-04-22	*Lates stappersii*	250	270	132	M	RR
429	12-04-22	*Lates stappersii*	250	270	114	M	SP
430	10-04-22	*Lates stappersii*	260	280	131	M	R
431	10-04-22	*Lates stappersii*	260	280	135	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
432	10-04-22	*Lates stappersii*	270	290	134	M	SP
433	10-04-22	*Lates stappersii*	280	300	184	M	R
434	11-04-22	*Lates stappersii*	290	310	194	M	Sp
435	11-04-22	*Lates stappersii*	330	350	280	M	R
436	11-04-22	*Lates stappersii*	340	360	282	M	A
437	11-04-22	*Lates stappersii*	340	360	307	M	RR
438	10-05-22	*Lates stappersii*	310	330	206	M	SP
439	10-05-22	*Lates stappersii*	310	330	220	M	SP
440	03-05-22	*Lates stappersii*	300	320	201	M	RR
441	10-05-22	*Lates stappersii*	300	320	187	M	RR
442	10-05-22	*Lates stappersii*	300	320	202	M	SP
443	03-05-22	*Lates stappersii*	290	310	180	M	SP
444	03-05-22	*Lates stappersii*	290	310	154	M	SP
445	03-05-22	*Lates stappersii*	290	310	180	M	SP
446	10-05-22	*Lates stappersii*	290	310	180	M	SP
447	10-05-22	*Lates stappersii*	290	310	186	M	SP
448	10-05-22	*Lates stappersii*	290	310	162	M	RR
449	02-05-22	*Lates stappersii*	280	300	143	M	SP
450	03-05-22	*Lates stappersii*	280	300	168	M	RR
451	03-05-22	*Lates stappersii*	280	300	144	M	R
452	03-05-22	*Lates stappersii*	280	300	156	M	SP
453	03-05-22	*Lates stappersii*	280	300	152	M	SP
454	10-05-22	*Lates stappersii*	280	300	178	M	RR
455	10-05-22	*Lates stappersii*	280	300	158	M	RR
456	02-05-22	*Lates stappersii*	270	290	141	M	SP
457	02-05-22	*Lates stappersii*	270	290	139	M	SP
458	03-05-22	*Lates stappersii*	270	290	146	M	SP
459	03-05-22	*Lates stappersii*	270	290	146	M	RR
460	10-05-22	*Lates stappersii*	270	290	153	M	SP
461	10-05-22	*Lates stappersii*	270	290	146	M	SP
462	03-05-22	*Lates stappersii*	260	280	131	M	SP

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
463	03-05-22	*Lates stappersii*	260	280	125	M	RR
464	03-05-22	*Lates stappersii*	260	280	132	M	SP
465	03-05-22	*Lates stappersii*	260	280	134	M	RR
466	03-05-22	*Lates stappersii*	260	280	115	M	RR
467	03-05-22	*Lates stappersii*	260	280	103	M	R
468	03-05-22	*Lates stappersii*	260	280	130	M	R
469	03-05-22	*Lates stappersii*	260	280	113	M	R
470	10-05-22	*Lates stappersii*	260	280	134	M	RR
471	10-05-22	*Lates stappersii*	260	280	117	M	SP
472	03-05-22	*Lates stappersii*	250	270	198	M	RR
473	03-05-22	*Lates stappersii*	250	270	109	M	R
474	03-05-22	*Lates stappersii*	250	270	113	M	RR
475	03-05-22	*Lates stappersii*	250	270	94	M	SP
476	10-05-22	*Lates stappersii*	250	270	166	M	SP
477	10-05-22	*Lates stappersii*	250	270	129	M	RR
478	10-05-22	*Lates stappersii*	250	270	121	M	R
479	10-05-22	*Lates stappersii*	250	270	111	M	RR
480	02-05-22	*Lates stappersii*	240	260	108	M	SP
481	03-05-22	*Lates stappersii*	240	260	147	M	SP
482	03-05-22	*Lates stappersii*	240	260	102	M	R
483	03-05-22	*Lates stappersii*	240	260	94	M	A
484	03-05-22	*Lates stappersii*	240	260	111	M	SP
485	03-05-22	*Lates stappersii*	240	260	114	M	SP
486	03-05-22	*Lates stappersii*	240	260	107	M	SP
487	10-05-22	*Lates stappersii*	240	260	111	M	RR
488	10-05-22	*Lates stappersii*	240	260	99	M	R
489	10-05-22	*Lates stappersii*	240	260	94	M	SP
490	10-05-22	*Lates stappersii*	240	260	111	M	RR
491	02-05-22	*Lates stappersii*	230	250	91	M	SP
492	03-05-22	*Lates stappersii*	230	250	100	M	R
493	03-05-22	*Lates stappersii*	230	250	95	M	R

MPULUNGU AREA							
No	Date	Species	FL (mm)	TL (mm)	Wgt (g)	Sex	Gonad state
494	03-05-22	*Lates stappersii*	230	250	108	M	R
495	03-05-22	*Lates stappersii*	230	250	99	M	R
496	03-05-22	*Lates stappersii*	230	250	95	M	R
497	03-05-22	*Lates stappersii*	230	250	100	M	R
498	03-05-22	*Lates stappersii*	230	250	98	M	R
499	03-05-22	*Lates stappersii*	230	250	106	M	A
500	10-05-22	*Lates stappersii*	230	250	103	M	RR
501	10-05-22	*Lates stappersii*	230	250	103	M	RR
502	02-05-22	*Lates stappersii*	220	240	77	M	R
503	02-05-22	*Lates stappersii*	220	240	88	M	SP
504	02-05-22	*Lates stappersii*	220	240	78	M	R
505	02-05-22	*Lates stappersii*	220	240	85	M	R
506	02-05-22	*Lates stappersii*	220	240	86	M	SP
507	02-05-22	*Lates stappersii*	220	240	82	M	SP
508	02-05-22	*Lates stappersii*	220	240	83	M	R
509	02-05-22	*Lates stappersii*	220	240	85	M	A
510	02-05-22	*Lates stappersii*	220	240	90	M	SP
511	02-05-22	*Lates stappersii*	220	240	82	M	A
512	02-05-22	*Lates stappersii*	220	240	84	M	R
513	02-05-22	*Lates stappersii*	220	240	87	M	R
514	03-05-22	*Lates stappersii*	220	240	93	M	R
515	03-05-22	*Lates stappersii*	220	240	90	M	R
516	03-05-22	*Lates stappersii*	220	240	91	M	R
517	03-05-22	*Lates stappersii*	220	240	97	M	R
518	03-05-22	*Lates stappersii*	220	240	96	M	A
519	03-05-22	*Lates stappersii*	220	240	86	M	R
520	03-05-22	*Lates stappersii*	220	240	81	M	SP
521	03-05-22	*Lates stappersii*	220	240	83	M	A
522	03-05-22	*Lates stappersii*	220	240	93	M	R
523	03-05-22	*Lates stappersii*	220	240	94	M	R
524	10-05-22	*Lates stappersii*	220	240	96	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
525	10-05-22	*Lates stappersii*	220	240	81	M	A
526	10-05-22	*Lates stappersii*	220	240	85	M	A
527	10-05-22	*Lates stappersii*	220	240	84	M	A
528	10-05-22	*Lates stappersii*	220	240	83	M	R
529	02-05-22	*Lates stappersii*	210	230	80	M	R
530	02-05-22	*Lates stappersii*	210	230	72	M	RR
531	02-05-22	*Lates stappersii*	210	230	80	M	R
532	02-05-22	*Lates stappersii*	210	230	78	M	SP
533	02-05-22	*Lates stappersii*	210	230	71	M	SP
534	02-05-22	*Lates stappersii*	210	230	69	M	RR
535	02-05-22	*Lates stappersii*	210	230	66	M	SP
536	02-05-22	*Lates stappersii*	210	230	75	M	SP
537	02-05-22	*Lates stappersii*	210	230	71	M	SP
538	02-05-22	*Lates stappersii*	210	230	69	M	SP
539	02-05-22	*Lates stappersii*	210	230	70	M	RR
540	02-05-22	*Lates stappersii*	210	220	67	M	R
541	02-05-22	*Lates stappersii*	210	230	66	M	SP
542	02-05-22	*Lates stappersii*	210	230	69	M	RR
543	02-05-22	*Lates stappersii*	210	230	64	M	R
544	02-05-22	*Lates stappersii*	210	230	72	M	RR
545	02-05-22	*Lates stappersii*	210	230	69	M	A
546	03-05-22	*Lates stappersii*	210	230	77	M	R
547	03-05-22	*Lates stappersii*	210	230	79	M	R
548	03-05-22	*Lates stappersii*	210	230	77	M	R
549	03-05-22	*Lates stappersii*	210	230	78	M	SP
550	03-05-22	*Lates stappersii*	210	230	82	M	RR
551	03-05-22	*Lates stappersii*	210	230	72	M	RR
552	10-05-22	*Lates stappersii*	210	230	79	M	R
553	10-05-22	*Lates stappersii*	210	230	67	M	A
554	10-05-22	*Lates stappersii*	210	230	76	M	A
555	10-05-22	*Lates stappersii*	210	230	76	M	A

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
556	10-05-22	*Lates stappersii*	210	230	79	M	A
557	10-05-22	*Lates stappersii*	210	230	75	M	A
558	10-05-22	*Lates stappersii*	210	230	78	M	A
559	10-05-22	*Lates stappersii*	210	230	66	M	A
560	10-05-22	*Lates stappersii*	210	230	77	M	A
561	10-05-22	*Lates stappersii*	210	230	74	M	A
562	02-05-22	*Lates stappersii*	200	220	63	M	R
563	02-05-22	*Lates stappersii*	200	220	61	M	R
564	02-05-22	*Lates stappersii*	200	220	66	M	R
565	02-05-22	*Lates stappersii*	200	220	63	M	RR
566	02-05-22	*Lates stappersii*	200	220	55	M	SP
567	02-05-22	*Lates stappersii*	200	220	59	M	A
568	02-05-22	*Lates stappersii*	200	220	59	M	A
569	02-05-22	*Lates stappersii*	200	220	63	M	SP
570	02-05-22	*Lates stappersii*	200	220	61	M	A
571	02-05-22	*Lates stappersii*	200	220	58	M	A
572	03-05-22	*Lates stappersii*	200	220	71	M	R
573	03-05-22	*Lates stappersii*	200	220	76	M	R
574	03-05-22	*Lates stappersii*	200	220	60	M	A
575	03-05-22	*Lates stappersii*	200	220	61	M	R
576	03-05-22	*Lates stappersii*	200	220	76	M	RR
577	03-05-22	*Lates stappersii*	200	220	80	M	A
578	03-05-22	*Lates stappersii*	200	220	72	M	R
579	03-05-22	*Lates stappersii*	200	220	68	M	A
580	03-05-22	*Lates stappersii*	200	220	80	M	RR
581	03-05-22	*Lates stappersii*	200	220	63	M	A
582	03-05-22	*Lates stappersii*	200	220	72	M	RR
583	10-05-22	*Lates stappersii*	200	220	63	M	A
584	10-05-22	*Lates stappersii*	200	220	59	M	A
585	10-05-22	*Lates stappersii*	200	220	63	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
586	10-05-22	*Lates stappersii*	200	220	61	M	A
587	10-05-22	*Lates stappersii*	200	220	65	M	A
588	02-05-22	*Lates stappersii*	190	210	56	M	R
589	02-05-22	*Lates stappersii*	190	210	54	M	A
590	02-05-22	*Lates stappersii*	190	210	55	M	A
591	03-05-22	*Lates stappersii*	190	210	56	M	RR
592	13-06-22	*Lates stappersii*	180	200	49	M	R
593	14-06-22	*Lates stappersii*	200	220	74	M	R
594	13-06-22	*Lates stappersii*	210	230	80	M	R
595	13-06-22	*Lates stappersii*	210	230	67	M	A
596	14-06-22	*Lates stappersii*	210	230	84	M	A
597	14-06-22	*Lates stappersii*	210	230	78	M	RR
598	14-06-22	*Lates stappersii*	210	230	78	M	R
599	13-06-22	*Lates stappersii*	220	240	83	M	SP
600	13-06-22	*Lates stappersii*	220	240	86	M	A
601	13-06-22	*Lates stappersii*	220	240	92	M	R
602	13-06-22	*Lates stappersii*	220	240	91	M	R
603	13-06-22	*Lates stappersii*	220	240	99	M	RR
604	13-06-22	*Lates stappersii*	220	240	96	M	A
605	13-06-22	*Lates stappersii*	220	240	103	M	SP
606	13-06-22	*Lates stappersii*	220	240	99	M	A
607	13-06-22	*Lates stappersii*	220	240	93	M	R
608	13-06-22	*Lates stappersii*	220	240	74	M	SP
609	13-06-22	*Lates stappersii*	220	240	73	M	SP
610	13-06-22	*Lates stappersii*	220	240	89	M	SP
611	13-06-22	*Lates stappersii*	220	240	82	M	SP
612	14-06-22	*Lates stappersii*	220	240	105	M	RR
613	14-06-22	*Lates stappersii*	220	240	99	M	R
614	14-06-22	*Lates stappersii*	220	240	92	M	RR
615	14-06-22	*Lates stappersii*	220	240	102	M	RR
616	14-06-22	*Lates stappersii*	220	240	100	M	R

MPULUNGU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
617	14-06-22	*Lates stappersii*	220	240	86	M	A
618	14-06-22	*Lates stappersii*	220	240	87	M	SP
619	13-06-22	*Lates stappersii*	230	250	97	M	SP
620	13-06-22	*Lates stappersii*	230	250	95	M	R
621	13-06-22	*Lates stappersii*	230	250	96	M	R
622	13-06-22	*Lates stappersii*	230	250	112	M	SP
623	13-06-22	*Lates stappersii*	230	250	133	M	RR
624	13-06-22	*Lates stappersii*	230	250	112	M	RR
625	13-06-22	*Lates stappersii*	230	250	94	M	SP
626	13-06-22	*Lates stappersii*	230	250	92	M	SP
627	13-06-22	*Lates stappersii*	230	250	91	M	SP
628	13-06-22	*Lates stappersii*	230	250	88	M	A
629	13-06-22	*Lates stappersii*	230	250	97	M	R
630	13-06-22	*Lates stappersii*	230	250	96	M	SP
631	14-06-22	*Lates stappersii*	230	250	105	M	SP
632	14-06-22	*Lates stappersii*	230	250	104	M	SP
633	14-06-22	*Lates stappersii*	230	250	96	M	RR
634	14-06-22	*Lates stappersii*	230	250	98	M	RR
635	14-06-22	*Lates stappersii*	230	250	106	M	SP
636	14-06-22	*Lates stappersii*	230	250	102	M	RR
637	14-06-22	*Lates stappersii*	230	250	103	M	R
638	14-06-22	*Lates stappersii*	230	250	113	M	RR
639	14-06-22	*Lates stappersii*	230	250	102	M	SP
640	14-06-22	*Lates stappersii*	230	250	94	M	R
641	14-06-22	*Lates stappersii*	230	250	103	M	A
642	14-06-22	*Lates stappersii*	230	250	110	M	R
643	14-06-22	*Lates stappersii*	230	250	109	M	RR
644	14-06-22	*Lates stappersii*	230	250	118	M	SP
645	14-06-22	*Lates stappersii*	230	250	97	M	RR
646	14-06-22	*Lates stappersii*	230	250	101	M	SP
647	14-06-22	*Lates stappersii*	230	250	96	M	R

MPULUNGU AREA							
No	Date	Species	FL (mm)	TL (mm)	Wgt (g)	Sex	Gonad state
648	14-06-22	*Lates stappersii*	230	250	125	M	RR
649	14-06-22	*Lates stappersii*	230	250	92	M	R
650	14-06-22	*Lates stappersii*	230	250	121	M	RR
651	13-06-22	*Lates stappersii*	240	260	111	M	RR
652	13-06-22	*Lates stappersii*	240	260	110	M	RR
653	13-06-22	*Lates stappersii*	240	260	112	M	SP
654	13-06-22	*Lates stappersii*	240	260	110	M	SP
655	13-06-22	*Lates stappersii*	240	260	204	M	RR
656	13-06-22	*Lates stappersii*	240	260	86	M	A
657	13-06-22	*Lates stappersii*	240	260	103	M	SP
658	13-06-22	*Lates stappersii*	240	260	99	M	SP
659	13-06-22	*Lates stappersii*	240	260	111	M	SP
660	14-06-22	*Lates stappersii*	240	260	123	M	SP
661	14-06-22	*Lates stappersii*	240	260	106	M	R
662	14-06-22	*Lates stappersii*	240	260	116	M	RR
663	14-06-22	*Lates stappersii*	240	260	117	M	SP
664	14-06-22	*Lates stappersii*	240	260	106	M	SP
665	14-06-22	*Lates stappersii*	240	260	108	M	SP
666	14-06-22	*Lates stappersii*	240	260	104	M	R
667	14-06-22	*Lates stappersii*	240	260	112	M	R
668	14-06-22	*Lates stappersii*	240	260	109	M	RR
669	14-06-22	*Lates stappersii*	240	260	102	M	SP
670	14-06-22	*Lates stappersii*	240	260	112	M	SP
671	14-06-22	*Lates stappersii*	240	260	121	M	SP
672	14-06-22	*Lates stappersii*	240	260	106	M	SP
673	14-06-22	*Lates stappersii*	240	260	105	M	SP
674	14-06-22	*Lates stappersii*	240	260	105	M	SP
675	13-06-22	*Lates stappersii*	250	270	121	M	SP
676	13-06-22	*Lates stappersii*	250	270	100	M	SP
677	13-06-22	*Lates stappersii*	250	270	125	M	SP
678	13-06-22	*Lates stappersii*	250	270	113	M	SP

MPULUNGU AREA							
No	**Date**	***Species***	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
679	13-06-22	*Lates stappersii*	250	270	112	M	A
680	13-06-22	*Lates stappersii*	250	270	110	M	SP
681	13-06-22	*Lates stappersii*	250	270	121	M	SP
682	13-06-22	*Lates stappersii*	250	270	108	M	SP
683	14-06-22	*Lates stappersii*	250	270	124	M	SP
684	14-06-22	*Lates stappersii*	250	270	125	M	SP
685	14-06-22	*Lates stappersii*	250	270	115	M	SP
686	14-06-22	*Lates stappersii*	250	270	118	M	SP
687	14-06-22	*Lates stappersii*	250	270	122	M	SP
688	14-06-22	*Lates stappersii*	250	270	136	M	SP
689	14-06-22	*Lates stappersii*	250	270	125	M	R
690	13-06-22	*Lates stappersii*	260	280	140	M	SP
691	13-06-22	*Lates stappersii*	260	280	126	M	SP
692	14-06-22	*Lates stappersii*	260	280	144	M	SP
693	14-06-22	*Lates stappersii*	260	280	136	M	RR
694	13-06-22	*Lates stappersii*	270	290	116	M	SP
695	13-06-22	*Lates stappersii*	270	290	148	M	SP
696	13-06-22	*Lates stappersii*	270	290	130	M	SP
697	13-06-22	*Lates stappersii*	270	290	142	M	R
698	14-06-22	*Lates stappersii*	270	290	143	M	SP

Appendix B: compilation of fishery data of *Lates stappersii* for Nsumbu study area.

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
699	14-04-22	*Lates stappersii*	300	320	202	F	RR
700	14-04-22	*Lates stappersii*	290	310	181	F	SP
701	15-04-22	*Lates stappersii*	290	310	162	F	R
702	15-04-22	*Lates stappersii*	290	310	172	F	SP
703	15-04-22	*Lates stappersii*	280	300	188	F	R
704	15-04-22	*Lates stappersii*	280	300	130	F	RR
705	15-04-22	*Lates stappersii*	280	300	126	F	SP
706	16-04-22	*Lates stappersii*	280	300	172	F	R
707	16-04-22	*Lates stappersii*	280	300	178	F	R
708	14-04-22	*Lates stappersii*	270	290	151	F	SP
709	14-04-22	*Lates stappersii*	270	290	157	F	RR
710	14-04-22	*Lates stappersii*	270	290	152	F	RR
711	15-04-22	*Lates stappersii*	270	290	143	F	RR
712	14-04-22	*Lates stappersii*	260	280	133	F	R
713	15-04-22	*Lates stappersii*	260	280	142	F	RR
714	15-04-22	*Lates stappersii*	260	280	124	F	RR
715	15-04-22	*Lates stappersii*	260	280	126	F	RR
716	16-04-22	*Lates stappersii*	260	280	130	F	R
717	16-04-22	*Lates stappersii*	260	280	143	F	RR
718	16-04-22	*Lates stappersii*	260	280	143	F	RR
719	16-04-22	*Lates stappersii*	260	280	130	F	A
720	14-04-22	*Lates stappersii*	250	270	114	F	R
721	14-04-22	*Lates stappersii*	250	270	121	F	RR
722	15-04-22	*Lates stappersii*	250	270	121	F	RR
723	15-04-22	*Lates stappersii*	250	270	128	F	RR
724	15-04-22	*Lates stappersii*	250	270	112	F	R
725	15-04-22	*Lates stappersii*	250	270	120	F	R
726	15-04-22	*Lates stappersii*	250	270	114	F	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
727	15-04-22	*Lates stappersii*	250	270	115	F	RR
728	15-04-22	*Lates stappersii*	250	270	120	F	RR
729	15-04-22	*Lates stappersii*	250	270	118	F	RR
730	15-04-22	*Lates stappersii*	250	270	122	F	RR
731	15-04-22	*Lates stappersii*	250	270	123	F	A
732	15-04-22	*Lates stappersii*	250	270	128	F	RR
733	15-04-22	*Lates stappersii*	250	270	144	F	RR
734	16-04-22	*Lates stappersii*	250	270	141	F	SP
735	16-04-22	*Lates stappersii*	250	270	124	F	RR
736	16-04-22	*Lates stappersii*	250	270	105	F	R
737	14-04-22	*Lates stappersii*	240	260	111	F	SP
738	15-04-22	*Lates stappersii*	240	260	110	F	R
739	15-04-22	*Lates stappersii*	240	260	108	F	SP
740	15-04-22	*Lates stappersii*	240	260	114	F	RR
741	15-04-22	*Lates stappersii*	240	260	116	F	RR
742	15-04-22	*Lates stappersii*	240	260	101	F	RR
743	15-04-22	*Lates stappersii*	240	260	97	F	R
744	15-04-22	*Lates stappersii*	240	260	98	F	SP
745	15-04-22	*Lates stappersii*	240	260	119	F	RR
746	15-04-22	*Lates stappersii*	240	260	102	F	A
747	15-04-22	*Lates stappersii*	240	260	112	F	R
748	15-04-22	*Lates stappersii*	240	260	124	F	A
749	15-04-22	*Lates stappersii*	240	260	101	F	RR
750	15-04-22	*Lates stappersii*	240	260	98	F	R
751	15-04-22	*Lates stappersii*	240	260	129	F	RR
752	15-04-22	*Lates stappersii*	240	260	110	F	SP
753	15-04-22	*Lates stappersii*	240	260	105	F	SP
754	15-04-22	*Lates stappersii*	240	260	105	F	R
755	16-04-22	*Lates stappersii*	240	260	126	F	R
756	16-04-22	*Lates stappersii*	240	260	115	F	RR
757	16-04-22	*Lates stappersii*	240	260	118	F	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
758	14-04-22	*Lates stappersii*	230	250	94	F	R
759	14-04-22	*Lates stappersii*	230	250	94	F	RR
760	15-04-22	*Lates stappersii*	230	250	99	F	RR
761	15-04-22	*Lates stappersii*	230	250	106	F	RR
762	15-04-22	*Lates stappersii*	230	250	106	F	R
763	15-04-22	*Lates stappersii*	230	250	101	F	R
764	15-04-22	*Lates stappersii*	230	250	90	F	SP
765	15-04-22	*Lates stappersii*	230	260	98	F	SP
766	15-04-22	*Lates stappersii*	230	250	103	F	RR
767	15-04-22	*Lates stappersii*	230	250	96	F	A
768	15-04-22	*Lates stappersii*	230	250	97	F	R
769	15-04-22	*Lates stappersii*	230	250	90	F	A
770	15-04-22	*Lates stappersii*	230	250	93	F	R
771	15-04-22	*Lates stappersii*	230	250	103	F	R
772	15-04-22	*Lates stappersii*	230	250	95	F	A
773	15-04-22	*Lates stappersii*	230	250	110	F	RR
774	15-04-22	*Lates stappersii*	230	250	101	F	R
775	15-04-22	*Lates stappersii*	230	250	97	F	SP
776	15-04-22	*Lates stappersii*	230	250	95	F	RR
777	15-04-22	*Lates stappersii*	230	250	107	F	R
778	16-04-22	*Lates stappersii*	230	250	106	F	R
779	16-04-22	*Lates stappersii*	230	250	112	F	RR
780	16-04-22	*Lates stappersii*	230	250	100	F	RR
781	16-04-22	*Lates stappersii*	230	250	93	F	R
782	16-04-22	*Lates stappersii*	230	250	105	F	R
783	14-04-22	*Lates stappersii*	220	240	84	F	R
784	14-04-22	*Lates stappersii*	220	240	80	F	RR
785	15-04-22	*Lates stappersii*	220	240	87	F	R
786	15-04-22	*Lates stappersii*	220	240	87	F	A
787	15-04-22	*Lates stappersii*	220	240	100	F	RR
788	15-04-22	*Lates stappersii*	220	240	92	F	A

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
789	15-04-22	*Lates stappersii*	220	240	92	F	R
790	15-04-22	*Lates stappersii*	220	240	84	F	R
791	15-04-22	*Lates stappersii*	220	240	88	F	R
792	15-04-22	*Lates stappersii*	220	240	82	F	SP
793	15-04-22	*Lates stappersii*	220	240	93	F	RR
794	15-04-22	*Lates stappersii*	220	240	98	F	SP
795	15-04-22	*Lates stappersii*	220	240	92	F	A
796	15-04-22	*Lates stappersii*	220	240	98	F	R
797	15-04-22	*Lates stappersii*	220	240	103	F	R
798	15-04-22	*Lates stappersii*	220	240	94	F	A
799	16-04-22	*Lates stappersii*	220	240	109	F	SP
800	16-04-22	*Lates stappersii*	220	240	105	F	SP
801	16-04-22	*Lates stappersii*	220	240	105	F	SP
802	16-04-22	*Lates stappersii*	220	240	104	F	R
803	16-04-22	*Lates stappersii*	220	240	96	F	R
804	16-04-22	*Lates stappersii*	220	240	99	F	R
805	16-04-22	*Lates stappersii*	220	240	98	F	A
806	14-04-22	*Lates stappersii*	210	230	70	F	RR
807	14-04-22	*Lates stappersii*	210	230	77	F	RR
808	14-04-22	*Lates stappersii*	210	230	84	F	RR
809	14-04-22	*Lates stappersii*	210	230	71	F	RR
810	14-04-22	*Lates stappersii*	210	230	75	F	R
811	14-04-22	*Lates stappersii*	210	230	65	F	R
812	14-04-22	*Lates stappersii*	210	230	84	F	RR
813	14-04-22	*Lates stappersii*	210	230	68	F	RR
814	14-04-22	*Lates stappersii*	210	230	74	F	R
815	15-04-22	*Lates stappersii*	210	230	81	F	A
816	15-04-22	*Lates stappersii*	210	230	85	F	A
817	15-04-22	*Lates stappersii*	210	230	69	F	SP
818	15-04-22	*Lates stappersii*	210	230	77	F	R
819	15-04-22	*Lates stappersii*	210	240	85	F	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
820	15-04-22	*Lates stappersii*	210	230	81	F	R
821	15-04-22	*Lates stappersii*	210	230	87	F	R
822	15-04-22	*Lates stappersii*	210	230	89	F	R
823	15-04-22	*Lates stappersii*	210	230	71	F	R
824	15-04-22	*Lates stappersii*	210	230	81	F	R
825	15-04-22	*Lates stappersii*	210	230	77	F	A
826	15-04-22	*Lates stappersii*	210	230	78	F	A
827	15-04-22	*Lates stappersii*	210	230	92	F	A
828	15-04-22	*Lates stappersii*	210	230	82	F	R
829	16-04-22	*Lates stappersii*	210	230	94	F	A
830	16-04-22	*Lates stappersii*	210	230	88	F	R
831	16-04-22	*Lates stappersii*	210	230	75	F	A
832	14-04-22	*Lates stappersii*	200	220	72	F	R
833	15-04-22	*Lates stappersii*	200	220	70	F	R
834	15-04-22	*Lates stappersii*	200	220	74	F	R
835	15-04-22	*Lates stappersii*	200	230	71	F	R
836	15-04-22	*Lates stappersii*	200	220	75	F	RR
837	15-04-22	*Lates stappersii*	200	220	80	F	A
838	16-04-22	*Lates stappersii*	200	220	88	F	R
839	16-04-22	*Lates stappersii*	200	220	72	F	A
840	16-04-22	*Lates stappersii*	190	210	64	F	A
841	15-04-22	*Lates stappersii*	310	330	205	M	RR
842	14-04-22	*Lates stappersii*	290	310	177	M	SP
843	14-04-22	*Lates stappersii*	280	300	166	M	A
844	15-04-22	*Lates stappersii*	280	300	178	M	RR
845	15-04-22	*Lates stappersii*	280	300	170	M	RR
846	15-04-22	*Lates stappersii*	280	300	147	M	RR
847	14-04-22	*Lates stappersii*	270	290	142	M	SP
848	15-04-22	*Lates stappersii*	270	290	145	M	R
849	15-04-22	*Lates stappersii*	270	290	150	M	RR
850	16-04-22	*Lates stappersii*	270	290	140	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
851	16-04-22	*Lates stappersii*	270	290	170	M	R
852	16-04-22	*Lates stappersii*	270	290	143	M	R
853	16-04-22	*Lates stappersii*	270	290	142	M	RR
854	15-04-22	*Lates stappersii*	260	280	134	M	R
855	15-04-22	*Lates stappersii*	260	280	131	M	RR
856	15-04-22	*Lates stappersii*	260	280	132	M	R
857	15-04-22	*Lates stappersii*	260	280	130	M	R
858	15-04-22	*Lates stappersii*	260	280	120	M	RR
859	15-04-22	*Lates stappersii*	260	280	137	M	RR
860	15-04-22	*Lates stappersii*	260	280	138	M	R
861	15-04-22	*Lates stappersii*	260	280	128	M	RR
862	15-04-22	*Lates stappersii*	260	280	139	M	RR
863	15-04-22	*Lates stappersii*	260	280	131	M	R
864	15-04-22	*Lates stappersii*	260	280	144	M	RR
865	15-04-22	*Lates stappersii*	260	280	143	M	RR
866	15-04-22	*Lates stappersii*	260	280	140	M	R
867	15-04-22	*Lates stappersii*	260	280	131	M	RR
868	16-04-22	*Lates stappersii*	260	280	156	M	SP
869	16-04-22	*Lates stappersii*	260	280	145	M	SP
870	16-04-22	*Lates stappersii*	260	280	148	M	SP
871	16-04-22	*Lates stappersii*	260	280	130	M	RR
872	16-04-22	*Lates stappersii*	260	280	124	M	R
873	16-04-22	*Lates stappersii*	260	280	142	M	RR
874	14-04-22	*Lates stappersii*	250	270	117	M	R
875	15-04-22	*Lates stappersii*	250	270	120	M	RR
876	15-04-22	*Lates stappersii*	250	270	112	M	RR
877	15-04-22	*Lates stappersii*	250	270	115	M	R
878	15-04-22	*Lates stappersii*	250	270	112	M	SP
879	15-04-22	*Lates stappersii*	250	270	116	M	RR
880	15-04-22	*Lates stappersii*	250	270	130	M	RR
881	15-04-22	*Lates stappersii*	250	270	126	M	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
882	15-04-22	*Lates stappersii*	250	270	106	M	RR
883	15-04-22	*Lates stappersii*	250	270	119	M	RR
884	16-04-22	*Lates stappersii*	250	270	139	M	R
885	16-04-22	*Lates stappersii*	250	270	134	M	R
886	16-04-22	*Lates stappersii*	250	270	130	M	SP
887	16-04-22	*Lates stappersii*	250	270	121	M	R
888	16-04-22	*Lates stappersii*	250	270	130	M	R
889	16-04-22	*Lates stappersii*	250	270	128	M	RR
890	16-04-22	*Lates stappersii*	250	270	112	M	R
891	14-04-22	*Lates stappersii*	240	260	113	M	A
892	14-04-22	*Lates stappersii*	240	260	103	M	RR
893	14-04-22	*Lates stappersii*	240	260	129	M	A
894	14-04-22	*Lates stappersii*	240	260	114	M	RR
895	14-04-22	*Lates stappersii*	240	260	99	M	R
896	14-04-22	*Lates stappersii*	240	260	120	M	R
897	14-04-22	*Lates stappersii*	240	260	100	M	R
898	14-04-22	*Lates stappersii*	240	260	99	M	R
899	15-04-22	*Lates stappersii*	240	260	117	M	R
900	15-04-22	*Lates stappersii*	240	260	85	M	A
901	15-04-22	*Lates stappersii*	240	260	118	M	RR
902	15-04-22	*Lates stappersii*	240	260	118	M	RR
903	15-04-22	*Lates stappersii*	240	260	110	M	RR
904	15-04-22	*Lates stappersii*	240	260	104	M	RR
905	15-04-22	*Lates stappersii*	240	260	109	M	R
906	15-04-22	*Lates stappersii*	240	260	108	M	R
907	15-04-22	*Lates stappersii*	240	260	107	M	RR
908	15-04-22	*Lates stappersii*	240	260	104	M	A
909	15-04-22	*Lates stappersii*	240	260	108	M	R
910	15-04-22	*Lates stappersii*	240	260	110	M	R
911	15-04-22	*Lates stappersii*	240	260	105	M	R
912	15-04-22	*Lates stappersii*	240	260	114	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
913	15-04-22	*Lates stappersii*	240	260	106	M	R
914	15-04-22	*Lates stappersii*	240	260	113	M	RR
915	16-04-22	*Lates stappersii*	240	260	124	M	RR
916	16-04-22	*Lates stappersii*	240	260	132	M	RR
917	16-04-22	*Lates stappersii*	240	260	107	M	R
918	16-04-22	*Lates stappersii*	240	260	102	M	R
919	16-04-22	*Lates stappersii*	240	260	110	M	R
920	16-04-22	*Lates stappersii*	240	260	100	M	R
921	16-04-22	*Lates stappersii*	240	260	116	M	R
922	16-04-22	*Lates stappersii*	240	260	115	M	R
923	14-04-22	*Lates stappersii*	230	250	88	M	SP
924	15-04-22	*Lates stappersii*	230	250	91	M	SP
925	15-04-22	*Lates stappersii*	230	250	88	M	A
926	15-04-22	*Lates stappersii*	230	250	96	M	R
927	15-04-22	*Lates stappersii*	230	250	103	M	RR
928	15-04-22	*Lates stappersii*	230	250	100	M	R
929	15-04-22	*Lates stappersii*	230	250	86	M	R
930	15-04-22	*Lates stappersii*	230	250	97	M	A
931	15-04-22	*Lates stappersii*	230	250	97	M	RR
932	15-04-22	*Lates stappersii*	230	250	87	M	R
933	15-04-22	*Lates stappersii*	230	250	100	M	R
934	15-04-22	*Lates stappersii*	230	250	106	M	R
935	15-04-22	*Lates stappersii*	230	250	107	M	R
936	15-04-22	*Lates stappersii*	230	250	109	M	R
937	15-04-22	*Lates stappersii*	230	250	110	M	A
938	16-04-22	*Lates stappersii*	230	250	86	M	A
939	16-04-22	*Lates stappersii*	230	250	111	M	R
940	16-04-22	*Lates stappersii*	230	250	114	M	R
941	16-04-22	*Lates stappersii*	230	250	105	M	R
942	16-04-22	*Lates stappersii*	230	250	101	M	R
943	16-04-22	*Lates stappersii*	230	250	103	M	R

NSUMBU AREA							
No	Date	Species	FL (mm)	TL (mm)	Wgt (g)	Sex	Gonad state
944	16-04-22	*Lates stappersii*	230	250	98	M	R
945	16-04-22	*Lates stappersii*	230	250	95	M	R
946	16-04-22	*Lates stappersii*	230	250	96	M	R
947	14-04-22	*Lates stappersii*	220	240	79	M	R
948	14-04-22	*Lates stappersii*	220	240	90	M	SP
949	14-04-22	*Lates stappersii*	220	240	100	M	RR
950	14-04-22	*Lates stappersii*	220	240	66	M	SP
951	14-04-22	*Lates stappersii*	220	240	89	M	RR
952	15-04-22	*Lates stappersii*	220	240	98	M	A
953	15-04-22	*Lates stappersii*	220	240	87	M	R
954	15-04-22	*Lates stappersii*	220	240	84	M	R
955	15-04-22	*Lates stappersii*	220	240	83	M	A
956	15-04-22	*Lates stappersii*	220	240	84	M	RR
957	15-04-22	*Lates stappersii*	220	240	98	M	A
958	15-04-22	*Lates stappersii*	220	240	99	M	A
959	15-04-22	*Lates stappersii*	220	240	104	M	RR
960	15-04-22	*Lates stappersii*	220	240	92	M	R
961	16-04-22	*Lates stappersii*	220	240	112	M	SP
962	16-04-22	*Lates stappersii*	220	240	104	M	R
963	16-04-22	*Lates stappersii*	220	240	105	M	RR
964	16-04-22	*Lates stappersii*	220	230	81	M	R
965	16-04-22	*Lates stappersii*	220	240	86	M	R
966	14-04-22	*Lates stappersii*	210	230	74	M	A
967	14-04-22	*Lates stappersii*	210	230	68	M	R
968	14-04-22	*Lates stappersii*	210	230	64	M	A
969	14-04-22	*Lates stappersii*	210	230	76	M	SP
970	15-04-22	*Lates stappersii*	210	230	81	M	A
971	15-04-22	*Lates stappersii*	210	230	80	M	A
972	15-04-22	*Lates stappersii*	210	230	80	M	R
973	15-04-22	*Lates stappersii*	210	230	87	M	R
974	15-04-22	*Lates stappersii*	210	230	89	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
975	15-04-22	*Lates stappersii*	210	230	95	M	A
976	15-04-22	*Lates stappersii*	210	230	90	M	A
977	16-04-22	*Lates stappersii*	210	230	87	M	RR
978	16-04-22	*Lates stappersii*	210	230	87	M	A
979	16-04-22	*Lates stappersii*	210	230	88	M	R
980	16-04-22	*Lates stappersii*	210	230	95	M	R
981	16-04-22	*Lates stappersii*	210	230	82	M	R
982	16-04-22	*Lates stappersii*	210	230	96	M	RR
983	16-04-22	*Lates stappersii*	210	230	80	M	A
984	16-04-22	*Lates stappersii*	210	230	88	M	R
985	16-04-22	*Lates stappersii*	210	230	88	M	R
986	14-04-22	*Lates stappersii*	200	220	66	M	R
987	14-04-22	*Lates stappersii*	200	220	72	M	A
988	15-04-22	*Lates stappersii*	200	220	74	M	R
989	15-04-22	*Lates stappersii*	200	220	80	M	R
990	15-04-22	*Lates stappersii*	200	220	67	M	R
991	15-04-22	*Lates stappersii*	200	220	82	M	R
992	15-04-22	*Lates stappersii*	200	220	79	M	R
993	15-04-22	*Lates stappersii*	200	220	73	M	RR
994	15-04-22	*Lates stappersii*	200	220	70	M	R
995	16-04-22	*Lates stappersii*	200	220	82	M	A
996	16-04-22	*Lates stappersii*	200	220	74	M	A
997	16-04-22	*Lates stappersii*	200	240	86	M	A
998	16-04-22	*Lates stappersii*	200	220	89	M	R
999	08-05-22	*Lates stappersii*	170	190	58	F	A
1000	08-05-22	*Lates stappersii*	180	200	53	F	A
1001	08-05-22	*Lates stappersii*	180	200	53	F	A
1002	08-05-22	*Lates stappersii*	180	200	50	F	R
1003	06-05-22	*Lates stappersii*	200	220	72	F	A
1004	06-05-22	*Lates stappersii*	200	220	80	F	A
1005	06-05-22	*Lates stappersii*	200	220	77	F	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1006	08-05-22	*Lates stappersii*	200	220	68	F	R
1007	08-05-22	*Lates stappersii*	200	220	58	F	R
1008	06-05-22	*Lates stappersii*	210	230	70	F	A
1009	06-05-22	*Lates stappersii*	210	230	83	F	R
1010	06-05-22	*Lates stappersii*	210	230	84	F	R
1011	06-05-22	*Lates stappersii*	210	230	80	F	A
1012	06-05-22	*Lates stappersii*	210	230	80	F	R
1013	06-05-22	*Lates stappersii*	210	230	73	F	A
1014	06-05-22	*Lates stappersii*	210	230	90	F	R
1015	06-05-22	*Lates stappersii*	210	230	88	F	R
1016	07-05-22	*Lates stappersii*	210	230	94	F	RR
1017	07-05-22	*Lates stappersii*	210	230	84	F	A
1018	08-05-22	*Lates stappersii*	210	230	89	F	RR
1019	08-05-22	*Lates stappersii*	210	230	92	F	R
1020	06-05-22	*Lates stappersii*	220	240	90	F	R
1021	06-05-22	*Lates stappersii*	220	240	90	F	R
1022	06-05-22	*Lates stappersii*	220	240	92	F	RR
1023	06-05-22	*Lates stappersii*	220	240	88	F	A
1024	06-05-22	*Lates stappersii*	220	240	90	F	R
1025	06-05-22	*Lates stappersii*	220	240	94	F	R
1026	06-05-22	*Lates stappersii*	220	240	93	F	RR
1027	07-05-22	*Lates stappersii*	220	240	94	F	SP
1028	07-05-22	*Lates stappersii*	220	240	92	F	R
1029	07-05-22	*Lates stappersii*	220	240	92	F	R
1030	07-05-22	*Lates stappersii*	220	240	96	F	RR
1031	07-05-22	*Lates stappersii*	220	240	95	F	RR
1032	08-05-22	*Lates stappersii*	220	240	93	F	A
1033	08-05-22	*Lates stappersii*	220	240	89	F	A
1034	08-05-22	*Lates stappersii*	220	240	87	F	A
1035	06-05-22	*Lates stappersii*	230	250	101	F	SP
1036	06-05-22	*Lates stappersii*	230	250	98	F	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1037	06-05-22	*Lates stappersii*	230	250	104	F	RR
1038	06-05-22	*Lates stappersii*	230	250	109	F	RR
1039	06-05-22	*Lates stappersii*	230	250	111	F	SP
1040	07-05-22	*Lates stappersii*	230	250	105	F	RR
1041	07-05-22	*Lates stappersii*	230	250	112	F	RR
1042	07-05-22	*Lates stappersii*	230	250	105	F	RR
1043	07-05-22	*Lates stappersii*	230	250	104	F	RR
1044	08-05-22	*Lates stappersii*	230	250	99	F	R
1045	08-05-22	*Lates stappersii*	230	250	103	F	R
1046	08-05-22	*Lates stappersii*	230	250	101	F	RR
1047	08-05-22	*Lates stappersii*	230	250	94	F	A
1048	08-05-22	*Lates stappersii*	230	250	101	F	R
1049	06-05-22	*Lates stappersii*	240	260	118	F	A
1050	06-05-22	*Lates stappersii*	240	260	120	F	SP
1051	06-05-22	*Lates stappersii*	240	260	121	F	SP
1052	06-05-22	*Lates stappersii*	240	260	110	F	RR
1053	06-05-22	*Lates stappersii*	240	260	110	F	RR
1054	07-05-22	*Lates stappersii*	240	260	111	F	RR
1055	07-05-22	*Lates stappersii*	240	260	122	F	RR
1056	08-05-22	*Lates stappersii*	240	260	101	F	SP
1057	08-05-22	*Lates stappersii*	240	260	121	F	RR
1058	08-05-22	*Lates stappersii*	240	260	98	F	R
1059	08-05-22	*Lates stappersii*	240	260	108	F	R
1060	08-05-22	*Lates stappersii*	240	260	108	F	RR
1061	08-05-22	*Lates stappersii*	240	260	112	F	SP
1062	08-05-22	*Lates stappersii*	240	260	105	F	SP
1063	08-05-22	*Lates stappersii*	240	260	103	F	RR
1064	06-05-22	*Lates stappersii*	250	270	117	F	R
1065	07-05-22	*Lates stappersii*	250	270	129	F	R
1066	07-05-22	*Lates stappersii*	250	270	96	F	RR
1067	07-05-22	*Lates stappersii*	250	270	136	F	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1068	07-05-22	*Lates stappersii*	250	270	124	F	RR
1069	08-05-22	*Lates stappersii*	250	270	107	F	R
1070	08-05-22	*Lates stappersii*	250	270	120	F	R
1071	08-05-22	*Lates stappersii*	250	270	132	F	SP
1072	07-05-22	*Lates stappersii*	260	280	136	F	SP
1073	07-05-22	*Lates stappersii*	260	280	135	F	SP
1074	08-05-22	*Lates stappersii*	260	280	129	F	R
1075	08-05-22	*Lates stappersii*	260	280	133	F	R
1076	08-05-22	*Lates stappersii*	260	280	148	F	SP
1077	08-05-22	*Lates stappersii*	260	280	131	F	SP
1078	08-05-22	*Lates stappersii*	260	280	163	F	SP
1079	08-05-22	*Lates stappersii*	270	290	141	F	RR
1080	08-05-22	*Lates stappersii*	270	290	138	F	SP
1081	07-05-22	*Lates stappersii*	280	300	183	F	SP
1082	08-05-22	*Lates stappersii*	280	300	187	F	SP
1083	07-05-22	*Lates stappersii*	290	310	195	F	SP
1084	07-05-22	*Lates stappersii*	290	310	199	F	R
1085	08-05-22	*Lates stappersii*	290	310	187	F	RR
1086	08-05-22	*Lates stappersii*	400	430	483	F	SP
1087	08-05-22	*Lates stappersii*	170	190	45	M	A
1088	08-05-22	*Lates stappersii*	180	200	83	M	A
1089	08-05-22	*Lates stappersii*	180	200	53	M	A
1090	08-05-22	*Lates stappersii*	200	220	67	M	A
1091	06-05-22	*Lates stappersii*	210	230	78	M	A
1092	06-05-22	*Lates stappersii*	210	230	80	M	R
1093	06-05-22	*Lates stappersii*	210	230	81	M	R
1094	06-05-22	*Lates stappersii*	210	230	83	M	A
1095	06-05-22	*Lates stappersii*	210	230	81	M	A
1096	06-05-22	*Lates stappersii*	210	230	81	M	A
1097	06-05-22	*Lates stappersii*	210	230	87	M	A
1098	06-05-22	*Lates stappersii*	210	230	83	M	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1099	06-05-22	*Lates stappersii*	210	230	86	M	RR
1100	06-05-22	*Lates stappersii*	210	230	87	M	R
1101	06-05-22	*Lates stappersii*	210	230	78	M	A
1102	06-05-22	*Lates stappersii*	210	230	87	M	A
1103	07-05-22	*Lates stappersii*	210	230	87	M	RR
1104	07-05-22	*Lates stappersii*	210	230	84	M	A
1105	07-05-22	*Lates stappersii*	210	230	88	M	R
1106	07-05-22	*Lates stappersii*	210	230	80	M	A
1107	08-05-22	*Lates stappersii*	210	230	75	M	A
1108	08-05-22	*Lates stappersii*	210	230	92	M	R
1109	08-05-22	*Lates stappersii*	210	230	87	M	R
1110	08-05-22	*Lates stappersii*	210	230	79	M	A
1111	08-05-22	*Lates stappersii*	210	230	87	M	A
1112	06-05-22	*Lates stappersii*	220	240	88	M	R
1113	06-05-22	*Lates stappersii*	220	240	103	M	SP
1114	06-05-22	*Lates stappersii*	220	240	96	M	R
1115	06-05-22	*Lates stappersii*	220	240	100	M	SP
1116	06-05-22	*Lates stappersii*	220	240	94	M	R
1117	07-05-22	*Lates stappersii*	220	240	104	M	SP
1118	07-05-22	*Lates stappersii*	220	240	101	M	R
1119	07-05-22	*Lates stappersii*	220	240	98	M	RR
1120	07-05-22	*Lates stappersii*	220	240	96	M	R
1121	07-05-22	*Lates stappersii*	220	240	102	M	SP
1122	07-05-22	*Lates stappersii*	220	240	95	M	R
1123	07-05-22	*Lates stappersii*	220	240	87	M	R
1124	07-05-22	*Lates stappersii*	220	240	93	M	R
1125	08-05-22	*Lates stappersii*	220	240	92	M	R
1126	08-05-22	*Lates stappersii*	220	240	94	M	R
1127	08-05-22	*Lates stappersii*	220	240	89	M	R
1128	08-05-22	*Lates stappersii*	220	240	85	M	A
1129	08-05-22	*Lates stappersii*	220	240	95	M	A

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1130	06-05-22	*Lates stappersii*	230	250	108	M	RR
1131	06-05-22	*Lates stappersii*	230	250	106	M	R
1132	06-05-22	*Lates stappersii*	230	250	98	M	A
1133	06-05-22	*Lates stappersii*	230	250	124	M	R
1134	06-05-22	*Lates stappersii*	230	250	100	M	SP
1135	06-05-22	*Lates stappersii*	230	250	106	M	RR
1136	06-05-22	*Lates stappersii*	230	250	110	M	SP
1137	06-05-22	*Lates stappersii*	230	250	105	M	R
1138	07-05-22	*Lates stappersii*	230	250	97	M	R
1139	07-05-22	*Lates stappersii*	230	250	99	M	R
1140	08-05-22	*Lates stappersii*	230	250	102	M	RR
1141	08-05-22	*Lates stappersii*	230	250	95	M	R
1142	08-05-22	*Lates stappersii*	230	250	103	M	RR
1143	08-05-22	*Lates stappersii*	230	250	99	M	R
1144	08-05-22	*Lates stappersii*	230	250	113	M	R
1145	08-05-22	*Lates stappersii*	230	250	104	M	RR
1146	08-05-22	*Lates stappersii*	230	250	101	M	SP
1147	08-05-22	*Lates stappersii*	230	250	101	M	RR
1148	06-05-22	*Lates stappersii*	240	260	91	M	A
1149	06-05-22	*Lates stappersii*	240	260	113	M	R
1150	06-05-22	*Lates stappersii*	240	260	180	M	SP
1151	06-05-22	*Lates stappersii*	240	260	109	M	SP
1152	06-05-22	*Lates stappersii*	240	260	115	M	SP
1153	06-05-22	*Lates stappersii*	240	260	122	M	SP
1154	06-05-22	*Lates stappersii*	240	260	121	M	RR
1155	06-05-22	*Lates stappersii*	240	260	106	M	SP
1156	06-05-22	*Lates stappersii*	240	260	117	M	RR
1157	07-05-22	*Lates stappersii*	240	260	107	M	SP
1158	08-05-22	*Lates stappersii*	240	260	110	M	R
1159	08-05-22	*Lates stappersii*	240	260	113	M	RR
1160	08-05-22	*Lates stappersii*	240	260	118	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1161	08-05-22	*Lates stappersii*	240	260	107	M	R
1162	06-05-22	*Lates stappersii*	250	270	121	M	RR
1163	06-05-22	*Lates stappersii*	250	270	124	M	SP
1164	06-05-22	*Lates stappersii*	250	290	139	M	RR
1165	06-05-22	*Lates stappersii*	250	270	116	M	RR
1166	07-05-22	*Lates stappersii*	250	270	145	M	RR
1167	07-05-22	*Lates stappersii*	250	270	122	M	SP
1168	07-05-22	*Lates stappersii*	250	270	132	M	SP
1169	07-05-22	*Lates stappersii*	250	270	132	M	SP
1170	07-05-22	*Lates stappersii*	250	270	103	M	SP
1171	07-05-22	*Lates stappersii*	250	270	126	M	RR
1172	08-05-22	*Lates stappersii*	250	270	119	M	SP
1173	08-05-22	*Lates stappersii*	250	270	127	M	RR
1174	08-05-22	*Lates stappersii*	250	270	127	M	RR
1175	08-05-22	*Lates stappersii*	250	270	121	M	SP
1176	08-05-22	*Lates stappersii*	250	270	119	M	RR
1177	06-05-22	*Lates stappersii*	260	280	130	M	RR
1178	07-05-22	*Lates stappersii*	260	280	139	M	SP
1179	07-05-22	*Lates stappersii*	260	280	143	M	R
1180	07-05-22	*Lates stappersii*	260	280	153	M	SP
1181	07-05-22	*Lates stappersii*	260	280	143	M	R
1182	08-05-22	*Lates stappersii*	260	280	132	M	SP
1183	08-05-22	*Lates stappersii*	260	280	124	M	SP
1184	08-05-22	*Lates stappersii*	260	280	131	M	SP
1185	08-05-22	*Lates stappersii*	260	280	148	M	SP
1186	08-05-22	*Lates stappersii*	260	280	135	M	SP
1187	08-05-22	*Lates stappersii*	260	280	140	M	SP
1188	08-05-22	*Lates stappersii*	260	280	119	M	SP
1189	08-05-22	*Lates stappersii*	260	280	145	M	RR
1190	08-05-22	*Lates stappersii*	260	280	159	M	SP
1191	08-05-22	*Lates stappersii*	260	280	120	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1192	08-05-22	*Lates stappersii*	260	280	142	M	SP
1193	06-05-22	*Lates stappersii*	270	290	149	M	SP
1194	08-05-22	*Lates stappersii*	270	290	135	M	SP
1195	08-05-22	*Lates stappersii*	270	290	145	M	RR
1196	08-05-22	*Lates stappersii*	270	290	146	M	SP
1197	08-05-22	*Lates stappersii*	270	290	154	M	SP
1198	08-05-22	*Lates stappersii*	270	290	157	M	SP
1199	08-05-22	*Lates stappersii*	270	290	138	M	R
1200	08-05-22	*Lates stappersii*	270	290	131	M	SP
1201	08-05-22	*Lates stappersii*	270	290	177	M	SP
1202	07-05-22	*Lates stappersii*	280	300	148	M	SP
1203	07-05-22	*Lates stappersii*	280	300	188	M	RR
1204	07-05-22	*Lates stappersii*	280	300	182	M	SP
1205	07-05-22	*Lates stappersii*	280	300	180	M	SP
1206	07-05-22	*Lates stappersii*	280	300	165	M	RR
1207	08-05-22	*Lates stappersii*	280	300	153	M	SP
1208	08-05-22	*Lates stappersii*	280	300	170	M	SP
1209	08-05-22	*Lates stappersii*	280	300	163	M	SP
1210	08-05-22	*Lates stappersii*	280	300	163	M	RR
1211	08-05-22	*Lates stappersii*	280	300	165	M	SP
1212	08-05-22	*Lates stappersii*	280	300	179	M	RR
1213	08-05-22	*Lates stappersii*	280	300	195	M	SP
1214	06-05-22	*Lates stappersii*	290	310	170	M	R
1215	07-05-22	*Lates stappersii*	290	310	194	M	SP
1216	08-05-22	*Lates stappersii*	290	310	187	M	R
1217	08-05-22	*Lates stappersii*	290	310	189	M	SP
1218	08-05-22	*Lates stappersii*	290	310	169	M	RR
1219	07-05-22	*Lates stappersii*	300	320	215	M	SP
1220	08-05-22	*Lates stappersii*	300	320	188	M	RR
1221	08-05-22	*Lates stappersii*	300	320	175	M	RR
1222	07-05-22	*Lates stappersii*	430	460	536	M	SP

NSUMBU AREA							
No	Date	Species	FL (mm)	TL (mm)	Wgt (g)	Sex	Gonad state
1223	17-06-22	*Lates stappersii*	170	190	48	F	A
1224	16-06-22	*Lates stappersii*	180	200	58	F	R
1225	16-06-22	*Lates stappersii*	180	200	58	F	A
1226	16-06-22	*Lates stappersii*	180	200	53	F	A
1227	16-06-22	*Lates stappersii*	180	200	53	F	R
1228	17-06-22	*Lates stappersii*	180	200	56	F	A
1229	16-06-22	*Lates stappersii*	190	210	60	F	A
1230	16-06-22	*Lates stappersii*	190	210	66	F	R
1231	17-06-22	*Lates stappersii*	190	210	64	F	A
1232	17-06-22	*Lates stappersii*	190	210	59	F	A
1233	17-06-22	*Lates stappersii*	190	210	56	F	R
1234	17-06-22	*Lates stappersii*	190	210	58	F	A
1235	18-06-22	*Lates stappersii*	190	210	51	F	A
1236	16-06-22	*Lates stappersii*	200	220	70	F	SP
1237	16-06-22	*Lates stappersii*	200	220	64	F	A
1238	16-06-22	*Lates stappersii*	200	220	82	F	SP
1239	16-06-22	*Lates stappersii*	200	220	71	F	SP
1240	16-06-22	*Lates stappersii*	200	220	74	F	SP
1241	17-06-22	*Lates stappersii*	200	220	65	F	SP
1242	18-06-22	*Lates stappersii*	200	220	55	F	R
1243	18-06-22	*Lates stappersii*	200	220	59	F	R
1244	16-06-22	*Lates stappersii*	201	230	77	F	SP
1245	16-06-22	*Lates stappersii*	210	230	80	F	RR
1246	16-06-22	*Lates stappersii*	210	230	77	F	RR
1247	16-06-22	*Lates stappersii*	210	230	79	F	RR
1248	16-06-22	*Lates stappersii*	210	230	70	F	
1249	16-06-22	*Lates stappersii*	220	240	86	F	RR
1250	16-06-22	*Lates stappersii*	220	240	87	F	RR
1251	16-06-22	*Lates stappersii*	220	240	89	F	RR
1252	16-06-22	*Lates stappersii*	220	240	94	F	R
1253	16-06-22	*Lates stappersii*	220	240	95	F	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1254	16-06-22	*Lates stappersii*	220	240	91	F	RR
1255	16-06-22	*Lates stappersii*	220	240	93	F	R
1256	16-06-22	*Lates stappersii*	220	240	84	F	RR
1257	16-06-22	*Lates stappersii*	220	240	84	F	RR
1258	16-06-22	*Lates stappersii*	220	240	98	F	R
1259	16-06-22	*Lates stappersii*	220	240	92	F	RR
1260	16-06-22	*Lates stappersii*	220	240	86	F	SP
1261	17-06-22	*Lates stappersii*	220	240	102	F	RR
1262	18-06-22	*Lates stappersii*	220	240	80	F	SP
1263	18-06-22	*Lates stappersii*	220	240	81	F	SP
1264	16-06-22	*Lates stappersii*	230	250	96	F	RR
1265	16-06-22	*Lates stappersii*	230	250	91	F	RR
1266	16-06-22	*Lates stappersii*	230	250	95	F	R
1267	16-06-22	*Lates stappersii*	230	250	105	F	SP
1268	16-06-22	*Lates stappersii*	230	250	95	F	R
1269	16-06-22	*Lates stappersii*	230	250	102	F	SP
1270	16-06-22	*Lates stappersii*	230	250	99	F	R
1271	16-06-22	*Lates stappersii*	230	250	90	F	SP
1272	16-06-22	*Lates stappersii*	230	250	95	F	R
1273	16-06-22	*Lates stappersii*	230	250	94	F	RR
1274	16-06-22	*Lates stappersii*	230	250	107	F	RR
1275	16-06-22	*Lates stappersii*	230	250	102	F	RR
1276	16-06-22	*Lates stappersii*	230	250	91	F	SP
1277	16-06-22	*Lates stappersii*	230	250	100	F	RR
1278	16-06-22	*Lates stappersii*	230	250	98	F	SP
1279	16-06-22	*Lates stappersii*	230	250	104	F	RR
1280	17-06-22	*Lates stappersii*	230	250	104	F	R
1281	17-06-22	*Lates stappersii*	230	250	107	F	SP
1282	17-06-22	*Lates stappersii*	230	250	107	F	SP
1283	17-06-22	*Lates stappersii*	230	250	102	F	SP
1284	17-06-22	*Lates stappersii*	230	250	103	F	RR

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1285	17-06-22	*Lates stappersii*	230	250	102	F	SP
1286	17-06-22	*Lates stappersii*	230	250	102	F	SP
1287	16-06-22	*Lates stappersii*	240	260	109	F	SP
1288	16-06-22	*Lates stappersii*	240	260	108	F	R
1289	16-06-22	*Lates stappersii*	240	260	103	F	R
1290	16-06-22	*Lates stappersii*	240	260	113	F	SP
1291	16-06-22	*Lates stappersii*	240	260	112	F	R
1292	16-06-22	*Lates stappersii*	240	260	115	F	SP
1293	16-06-22	*Lates stappersii*	240	260	103	F	SP
1294	16-06-22	*Lates stappersii*	240	260	115	F	SP
1295	16-06-22	*Lates stappersii*	240	260	106	F	R
1296	16-06-22	*Lates stappersii*	240	260	109	F	SP
1297	16-06-22	*Lates stappersii*	240	260	111	F	R
1298	17-06-22	*Lates stappersii*	240	260	119	F	SP
1299	17-06-22	*Lates stappersii*	240	260	125	F	SP
1300	17-06-22	*Lates stappersii*	240	260	116	F	SP
1301	17-06-22	*Lates stappersii*	240	260	113	F	SP
1302	17-06-22	*Lates stappersii*	240	260	112	F	SP
1303	17-06-22	*Lates stappersii*	240	260	109	F	SP
1304	17-06-22	*Lates stappersii*	240	260	118	F	SP
1305	17-06-22	*Lates stappersii*	240	260	118	F	SP
1306	17-06-22	*Lates stappersii*	240	260	120	F	RR
1307	18-06-22	*Lates stappersii*	240	260	108	F	RR
1308	18-06-22	*Lates stappersii*	240	260	135	F	SP
1309	18-06-22	*Lates stappersii*	240	260	105	F	R
1310	18-06-22	*Lates stappersii*	240	260	116	F	SP
1311	16-06-22	*Lates stappersii*	250	270	119	F	SP
1312	16-06-22	*Lates stappersii*	250	270	112	F	SP
1313	16-06-22	*Lates stappersii*	250	270	126	F	SP
1314	17-06-22	*Lates stappersii*	250	270	118	F	SP
1315	17-06-22	*Lates stappersii*	250	270	122	F	SP

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1316	17-06-22	*Lates stappersii*	250	270	127	F	SP
1317	17-06-22	*Lates stappersii*	250	270	120	F	RR
1318	17-06-22	*Lates stappersii*	250	270	126	F	SP
1319	17-06-22	*Lates stappersii*	250	270	133	F	SP
1320	18-06-22	*Lates stappersii*	250	270	120	F	SP
1321	18-06-22	*Lates stappersii*	250	270	110	F	SP
1322	16-06-22	*Lates stappersii*	260	280	140	F	SP
1323	17-06-22	*Lates stappersii*	260	280	127	F	SP
1324	17-06-22	*Lates stappersii*	260	280	140	F	SP
1325	18-06-22	*Lates stappersii*	260	280	131	F	SP
1326	18-06-22	*Lates stappersii*	260	280	119	F	SP
1327	18-06-22	*Lates stappersii*	260	280	126	F	SP
1328	17-06-22	*Lates stappersii*	269	280	144	F	SP
1329	16-06-22	*Lates stappersii*	270	290	148	F	SP
1330	17-06-22	*Lates stappersii*	270	290	157	F	SP
1331	18-06-22	*Lates stappersii*	270	290	153	F	SP
1332	16-06-22	*Lates stappersii*	280	300	157	F	SP
1333	16-06-22	*Lates stappersii*	360	380	231	F	SP
1334	17-06-22	*Lates stappersii*	160	180	38	M	A
1335	16-06-22	*Lates stappersii*	170	190	50	M	A
1336	16-06-22	*Lates stappersii*	180	200	52	M	A
1337	16-06-22	*Lates stappersii*	180	200	55	M	A
1338	16-06-22	*Lates stappersii*	180	200	55	M	A
1339	16-06-22	*Lates stappersii*	180	200	54	M	A
1340	16-06-22	*Lates stappersii*	180	200	54	M	A
1341	16-06-22	*Lates stappersii*	190	210	55	M	A
1342	16-06-22	*Lates stappersii*	190	210	61	M	A
1343	16-06-22	*Lates stappersii*	190	210	64	M	R
1344	16-06-22	*Lates stappersii*	190	210	65	M	R
1345	16-06-22	*Lates stappersii*	190	210	56	M	R
1346	16-06-22	*Lates stappersii*	190	210	72	M	A

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1347	16-06-22	*Lates stappersii*	190	210	61	M	A
1348	16-06-22	*Lates stappersii*	190	210	58	M	A
1349	16-06-22	*Lates stappersii*	190	210	62	M	A
1350	16-06-22	*Lates stappersii*	190	210	61	M	A
1351	16-06-22	*Lates stappersii*	190	210	61	M	A
1352	16-06-22	*Lates stappersii*	190	210	58	M	A
1353	16-06-22	*Lates stappersii*	190	210	57	M	A
1354	16-06-22	*Lates stappersii*	190	210	66	M	A
1355	17-06-22	*Lates stappersii*	190	210	62	M	R
1356	17-06-22	*Lates stappersii*	190	210	62	M	A
1357	18-06-22	*Lates stappersii*	190	210	54	M	A
1358	16-06-22	*Lates stappersii*	200	220	64	M	SP
1359	16-06-22	*Lates stappersii*	200	220	71	M	SP
1360	16-06-22	*Lates stappersii*	200	220	79	M	R
1361	16-06-22	*Lates stappersii*	200	220	72	M	R
1362	16-06-22	*Lates stappersii*	200	220	69	M	R
1363	16-06-22	*Lates stappersii*	200	220	57	M	SP
1364	16-06-22	*Lates stappersii*	200	220	69	M	A
1365	16-06-22	*Lates stappersii*	200	220	62	M	A
1366	18-06-22	*Lates stappersii*	200	220	67	M	SP
1367	18-06-22	*Lates stappersii*	200	220	63	M	SP
1368	16-06-22	*Lates stappersii*	210	230	85	M	R
1369	16-06-22	*Lates stappersii*	210	230	90	M	R
1370	16-06-22	*Lates stappersii*	210	230	85	M	R
1371	16-06-22	*Lates stappersii*	210	230	80	M	R
1372	16-06-22	*Lates stappersii*	210	230	81	M	R
1373	16-06-22	*Lates stappersii*	210	230	85	M	R
1374	16-06-22	*Lates stappersii*	210	230	84	M	R
1375	16-06-22	*Lates stappersii*	210	230	80	M	R
1376	16-06-22	*Lates stappersii*	210	230	82	M	RR
1377	16-06-22	*Lates stappersii*	210	230	87	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1378	16-06-22	*Lates stappersii*	210	230	76	M	R
1379	16-06-22	*Lates stappersii*	210	230	75	M	SP
1380	16-06-22	*Lates stappersii*	210	230	82	M	RR
1381	16-06-22	*Lates stappersii*	210	230	87	M	R
1382	16-06-22	*Lates stappersii*	210	230	91	M	R
1383	16-06-22	*Lates stappersii*	210	230	81	M	SP
1384	17-06-22	*Lates stappersii*	210	230	88	M	SP
1385	16-06-22	*Lates stappersii*	220	240	89	M	R
1386	16-06-22	*Lates stappersii*	220	240	84	M	R
1387	16-06-22	*Lates stappersii*	220	240	102	M	SP
1388	16-06-22	*Lates stappersii*	220	240	86	M	RR
1389	16-06-22	*Lates stappersii*	220	240	82	M	RR
1390	16-06-22	*Lates stappersii*	220	240	83	M	R
1391	16-06-22	*Lates stappersii*	220	240	80	M	SP
1392	16-06-22	*Lates stappersii*	220	240	75	M	R
1393	16-06-22	*Lates stappersii*	220	240	84	M	R
1394	16-06-22	*Lates stappersii*	220	240	90	M	RR
1395	16-06-22	*Lates stappersii*	220	240	87	M	RR
1396	16-06-22	*Lates stappersii*	220	240	90	M	R
1397	16-06-22	*Lates stappersii*	220	240	87	M	R
1398	16-06-22	*Lates stappersii*	220	240	104	M	R
1399	16-06-22	*Lates stappersii*	220	240	94	M	RR
1400	16-06-22	*Lates stappersii*	220	240	92	M	R
1401	16-06-22	*Lates stappersii*	220	240	81	M	SP
1402	16-06-22	*Lates stappersii*	220	240	97	M	R
1403	16-06-22	*Lates stappersii*	220	240	92	M	SP
1404	16-06-22	*Lates stappersii*	220	240	99	M	SP
1405	16-06-22	*Lates stappersii*	220	240	99	M	R
1406	16-06-22	*Lates stappersii*	220	240	95	M	R
1407	16-06-22	*Lates stappersii*	220	240	89	M	R
1408	16-06-22	*Lates stappersii*	220	240	87	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1409	16-06-22	*Lates stappersii*	220	240	89	M	RR
1410	16-06-22	*Lates stappersii*	220	240	80	M	R
1411	16-06-22	*Lates stappersii*	220	240	98	M	RR
1412	16-06-22	*Lates stappersii*	220	240	89	M	R
1413	16-06-22	*Lates stappersii*	220	240	96	M	SP
1414	16-06-22	*Lates stappersii*	220	240	91	M	SP
1415	16-06-22	*Lates stappersii*	220	240	83	M	RR
1416	17-06-22	*Lates stappersii*	220	240	100	M	RR
1417	17-06-22	*Lates stappersii*	220	240	105	M	R
1418	17-06-22	*Lates stappersii*	220	240	92	M	SP
1419	17-06-22	*Lates stappersii*	220	240	97	M	R
1420	17-06-22	*Lates stappersii*	220	240	93	M	SP
1421	17-06-22	*Lates stappersii*	220	240	113	M	SP
1422	17-06-22	*Lates stappersii*	220	240	89	M	SP
1423	17-06-22	*Lates stappersii*	220	240	89	M	SP
1424	18-06-22	*Lates stappersii*	220	240	86	M	SP
1425	18-06-22	*Lates stappersii*	220	240	95	M	RR
1426	18-06-22	*Lates stappersii*	220	240	77	M	R
1427	18-06-22	*Lates stappersii*	220	240	87	M	RR
1428	16-06-22	*Lates stappersii*	230	250	98	M	R
1429	16-06-22	*Lates stappersii*	230	250	92	M	R
1430	16-06-22	*Lates stappersii*	230	250	97	M	RR
1431	16-06-22	*Lates stappersii*	230	250	97	M	R
1432	16-06-22	*Lates stappersii*	230	250	101	M	R
1433	16-06-22	*Lates stappersii*	230	250	99	M	RR
1434	16-06-22	*Lates stappersii*	230	250	90	M	RR
1435	16-06-22	*Lates stappersii*	230	250	108	M	SP
1436	16-06-22	*Lates stappersii*	230	250	107	M	SP
1437	16-06-22	*Lates stappersii*	230	250	100	M	RR
1438	16-06-22	*Lates stappersii*	230	250	92	M	SP
1439	16-06-22	*Lates stappersii*	230	250	106	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1440	16-06-22	*Lates stappersii*	230	250	101	M	SP
1441	16-06-22	*Lates stappersii*	230	250	102	M	R
1442	16-06-22	*Lates stappersii*	230	250	104	M	RR
1443	16-06-22	*Lates stappersii*	230	250	106	M	SP
1444	16-06-22	*Lates stappersii*	230	250	97	M	R
1445	16-06-22	*Lates stappersii*	230	250	97	M	R
1446	16-06-22	*Lates stappersii*	230	250	96	M	SP
1447	16-06-22	*Lates stappersii*	230	250	99	M	RR
1448	16-06-22	*Lates stappersii*	230	250	105	M	R
1449	16-06-22	*Lates stappersii*	230	250	97	M	R
1450	16-06-22	*Lates stappersii*	230	250	108	M	RR
1451	16-06-22	*Lates stappersii*	230	250	110	M	R
1452	16-06-22	*Lates stappersii*	230	250	113	M	R
1453	16-06-22	*Lates stappersii*	230	250	102	M	SP
1454	16-06-22	*Lates stappersii*	230	250	102	M	SP
1455	16-06-22	*Lates stappersii*	230	250	99	M	SP
1456	16-06-22	*Lates stappersii*	230	250	101	M	RR
1457	17-06-22	*Lates stappersii*	230	250	110	M	R
1458	17-06-22	*Lates stappersii*	230	250	92	M	R
1459	17-06-22	*Lates stappersii*	230	250	110	M	R
1460	17-06-22	*Lates stappersii*	230	250	105	M	RR
1461	17-06-22	*Lates stappersii*	230	250	112	M	RR
1462	17-06-22	*Lates stappersii*	230	250	107	M	SP
1463	18-06-22	*Lates stappersii*	230	250	88	M	R
1464	18-06-22	*Lates stappersii*	230	250	86	M	R
1465	16-06-22	*Lates stappersii*	240	260	96	M	SP
1466	16-06-22	*Lates stappersii*	240	260	112	M	SP
1467	16-06-22	*Lates stappersii*	240	260	99	M	R
1468	16-06-22	*Lates stappersii*	240	260	115	M	RR
1469	16-06-22	*Lates stappersii*	240	260	115	M	R
1470	16-06-22	*Lates stappersii*	240	260	116	M	SP

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1471	16-06-22	*Lates stappersii*	240	260	111	M	R
1472	16-06-22	*Lates stappersii*	240	260	96	M	R
1473	16-06-22	*Lates stappersii*	240	260	111	M	RR
1474	16-06-22	*Lates stappersii*	240	260	102	M	R
1475	16-06-22	*Lates stappersii*	240	260	109	M	SP
1476	16-06-22	*Lates stappersii*	240	260	109	M	SP
1477	16-06-22	*Lates stappersii*	240	260	115	M	R
1478	17-06-22	*Lates stappersii*	240	260	118	M	SP
1479	17-06-22	*Lates stappersii*	240	260	122	M	SP
1480	17-06-22	*Lates stappersii*	240	260	115	M	SP
1481	18-06-22	*Lates stappersii*	240	260	110	M	SP
1482	18-06-22	*Lates stappersii*	240	260	119	M	SP
1483	18-06-22	*Lates stappersii*	240	260	106	M	SP
1484	18-06-22	*Lates stappersii*	240	260	101	M	SP
1485	18-06-22	*Lates stappersii*	240	260	105	M	SP
1486	18-06-22	*Lates stappersii*	240	260	106	M	SP
1487	18-06-22	*Lates stappersii*	240	260	100	M	SP
1488	18-06-22	*Lates stappersii*	240	260	106	M	SP
1489	18-06-22	*Lates stappersii*	240	260	102	M	SP
1490	18-06-22	*Lates stappersii*	240	260	102	M	RR
1491	16-06-22	*Lates stappersii*	250	270	177	M	R
1492	16-06-22	*Lates stappersii*	250	270	130	M	SP
1493	16-06-22	*Lates stappersii*	250	270	123	M	SP
1494	16-06-22	*Lates stappersii*	250	270	116	M	R
1495	16-06-22	*Lates stappersii*	250	270	120	M	SP
1496	16-06-22	*Lates stappersii*	250	270	122	M	RR
1497	17-06-22	*Lates stappersii*	250	270	120	M	SP
1498	17-06-22	*Lates stappersii*	250	270	118	M	RR
1499	17-06-22	*Lates stappersii*	250	270	123	M	SP
1500	17-06-22	*Lates stappersii*	250	270	123	M	SP
1501	17-06-22	*Lates stappersii*	250	270	123	M	R

NSUMBU AREA							
No	**Date**	**Species**	**FL (mm)**	**TL (mm)**	**Wgt (g)**	**Sex**	**Gonad state**
1502	17-06-22	*Lates stappersii*	250	270	134	M	RR
1503	17-06-22	*Lates stappersii*	250	270	127	M	SP
1504	18-06-22	*Lates stappersii*	250	270	124	M	R
1505	18-06-22	*Lates stappersii*	250	270	121	M	SP
1506	18-06-22	*Lates stappersii*	250	270	109	M	R
1507	18-06-22	*Lates stappersii*	250	270	109	M	SP
1508	18-06-22	*Lates stappersii*	250	270	115	M	RR
1509	16-06-22	*Lates stappersii*	260	280	137	M	RR
1510	16-06-22	*Lates stappersii*	260	280	131	M	SP
1511	16-06-22	*Lates stappersii*	260	280	137	M	SP
1512	18-06-22	*Lates stappersii*	260	280	133	M	SP
1513	18-06-22	*Lates stappersii*	260	280	128	M	R
1514	18-06-22	*Lates stappersii*	260	280	134	M	SP
1515	18-06-22	*Lates stappersii*	260	280	136	M	SP
1516	18-06-22	*Lates stappersii*	260	280	136	M	SP
1517	16-06-22	*Lates stappersii*	270	290	138	M	SP
1518	18-06-22	*Lates stappersii*	270	290	154	M	SP
1519	18-06-22	*Lates stappersii*	270	290	134	M	SP
1520	18-06-22	*Lates stappersii*	270	290	146	M	SP
1521	18-06-22	*Lates stappersii*	270	290	139	M	SP
1522	18-06-22	*Lates stappersii*	270	290	145	M	RR
1523	18-06-22	*Lates stappersii*	280	300	147	M	SP
1524	16-06-22	*Lates stappersii*	290	310	180	M	SP
1525	17-06-22	*Lates stappersii*	360	380	230	M	SP
1526	16-06-22	*Lates stappersii*	220	240	90	M	R

Appendix C: The growth parameters

Data used for T-test analysis of slopes from Length-weight relationship (LWR) of *L. stappersii* at study sites from April to June, 2022.

a. Female *L. stappersii*

Month	Slopes of female *L. stappersii* in Mpulungu	Slopes of female *L. stapperii* in Nsumbu
April	2.94	2.54
May	2.91	2.74
June	2.50	2.68

Data used for T-test analysis of slopes from Length-weight relationship (LWR) of *L. stappersii* at study sites from April to June, 2022.

b) Male *L. stappersii*

Month	Slopes of male *L. stappersii* in Mpulungu	Slopes of male *L. stappersii* in Nsumbu
April	2.92	2.48
May	2.89	2.57
June	2.45	2.62

Data used for T-test statistics of asymptotic length (L_∞) of *L. stappersii* for Mpulungu and Nsumbu areas

(a) Female *L. stappersii*

Month	Asymptotic length (L_∞) of females in Mpulungu	Asymptotic length (L_∞) of females in Nsumbu
April	300	322
May	316	310
June	310	302

(b) Male *L. stappersii*

Month	Asymptotic length (L_∞) of males in Mpulungu	Asymptotic length (L_∞) of males in Nsumbu
April	320	314
May	342	317
June	318	320

Data used for T-test analysis of growth coefficients of *L. stappersii* for Mpulungu and Nsumbu areas

a) Female *L. stappersii*

Month	Growth coefficients (k) of females in Mpulungu	Growth coefficients (k) of females in Nsumbu
April	0.71	0.67
May	0.75	0.83
June	0.73	0.83

b) Male *L. stappersii*

Month	Growth coefficients (k) of males in Mpulungu	Growth coefficients of (k) males in Nsumbu
April	0.78	0.72
May	0.58	0.77
June	0.75	0.83

Data used for T-test analysis of growth performance index (Φ') of *L. stappersii* for Mpulungu and Nsumbu areas

a) Female *L. stappersii*

Month	Growth performance index (Φ') of females in Mpulungu	Growth performance index (Φ') of females in Nsumbu
April	4.81	4.84
May	4.87	4.94
June	4.84	4.88

b) Male *L. stappersii*

Month	Growth performance index(Φ') of males in Mpulungu	Growth performance index(Φ') of males in Nsumbu
April	4.90	4.85
May	4.83	4.89
June	4.88	4.93

Appendix D: The mortality rates

Data used for T-test analysis of total mortality coefficient of *L. stappersii* for Mpulungu and Nsumbu areas.

a) Female *L. stappersii*

Month	Total mortality coeffiecient (Z) of females in Mpulungu	Total mortality coeffiecient(Z) of females in Nsumbu
April	1.24	1.37
May	1.86	1.15
June	1.58	1.30

b) Male *L. stappersii*

Month	Total mortality coefficient (Z) of males in Mpulungu	Total mortality coeffiecient (Z) of males in Nsumbu
April	1.30	1.54
May	1.60	0.99
June	1.68	1.51

Data used for T-test analysis of natural mortality, M) of *L. stappersii* for Mpulungu and Nsumbu areas.

a) Female *L. stappersii*

Month	Natural mortality coeffiecient (M) of females in Mpulungu	Natural mortality coeffiecient (M) of females in Nsumbu
April	0.66	0.61
May	0.67	0.70
June	0.64	0.70

b) Male *L. stappersii*

Month	Natural mortality coefficient (M) of males in Mpulungu	Natural mortality coefficient (M) of males in Nsumbu
April	0.69	0.64
May	0.55	0.67
June	0.65	0.69

Data used for T-test analysis of fishing mortality F of *L. stappersii* for Mpulungu and Nsumbu areas.

a) Female *L. stappersii*

Month	Fishing mortality coeffiecient (F) of females in Mpulungu	Fishing mortality coeffiecient (F) of females in Nsumbu
April	0.59	0.76
May	1.19	0.45
June	0.93	0.60

b) Male *L. stappersii*

Month	Fishing mortality coefficient (F) of males in Mpulungu	Fishing mortality coeffiecient, (F) of males in Nsumbu
April	0.47	0.89
May	1.04	0.32
June	1.03	0.82

Appendix E: The exploitation ratios

Data used for T-test analysis of exploitation ratios of *L. stappersii* for Mpulungu and Nsumbu areas.

a) Female *L. stappersii*

Month	Exploitation rates (E) of females in Mpulungu	Exploitation rates (E) of females in Nsumbu
April	0.47	0.56
May	0.64	0.39
June	0.59	0.46

b) Males *L. stappersii*

Month	Exploitation rates (E) of males in Mpulungu	Exploitation rates (E) of males in Nsumbu
April	0.47	0.58
May	0.65	0.33
June	0.61	0.54

Appendix F: Environmental water quality parameters

Data used for T-test analysis of water quality parameters for Mpulungu and Nsumbu study sites from April to August, 2022.

a. Water transparency (m)

Month	Water transparency in Mpulungu	Water transparency in Nsumbu
April	4.16	4.67
May	7.33	8.14
June	4	5.33
July	7.65	7.58
August	9.20	10.90

b. Dissolved oxygen (mgL^{-1})

Month	Dissolved oxygen of surface Water in Mpulungu	Dissolved oxygen of surface Water in Nsumbu
May	4.49	5.68
June	6.67	6.50
July	6.85	7.59
August	8.68	8.98

c. Temperature (^{o}C)

Month	Surface water temperature in Mpulungu	Surface water temperature in Nsumbu
April	28.00	27.06
May	28.00	26.80
June	26.59	25.73
July	24.36	23.08
August	24.54	25.12

Appendix G: Landing sites/fishing villages in Mpulungu area.

Fishermen at Ngwenya landing site, Mpulungu disembarking light boats from the fishing unit

Landing sites in Mpulungu part of Lake Tanganyika, Zambia

(b) Fishers disembarking light boats off the fishing vessel at Ngwenya landing site,

(c) Traders at Ngwenya landing site buying fish from landing boats,

(d) Togwa fishing village,

(e) Kapembwa fishing village

Appendix H: Landing sites / fishing villages in Nsumbu area.

(a)

(b)

Landing sites on the SW part of Lake Tanganyika Nsumbu, Zambia: **(a)** Muchanga landing site, Nsumbu, **(b)** Worker sorting out a ring net in readiness for night fishing.

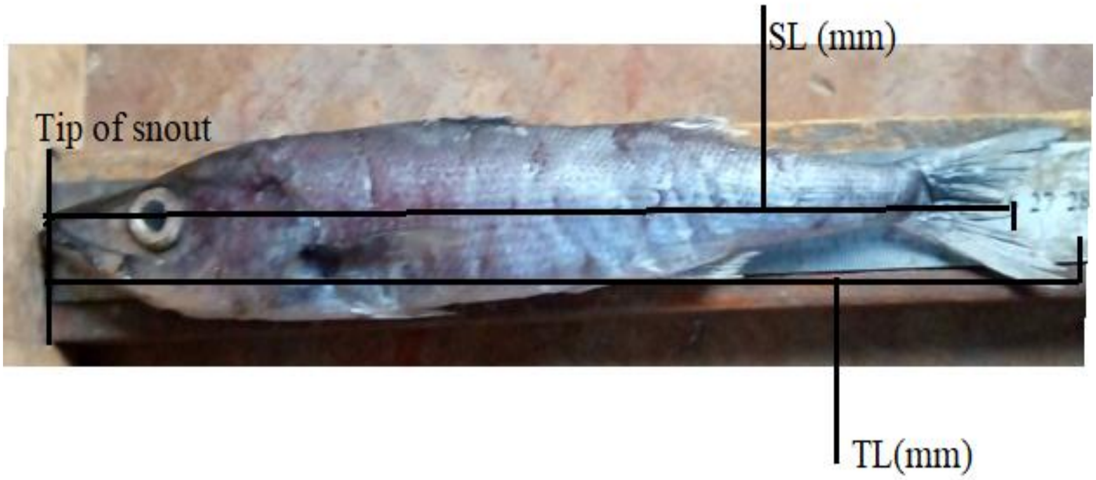
(c)

(d)

(c) Small fishing light boats used together with a fishing vessel.

(d) Lupili landing site, Nsumbu

Appendix I: Recording Fork and Total Length and Weight of L. stappersii

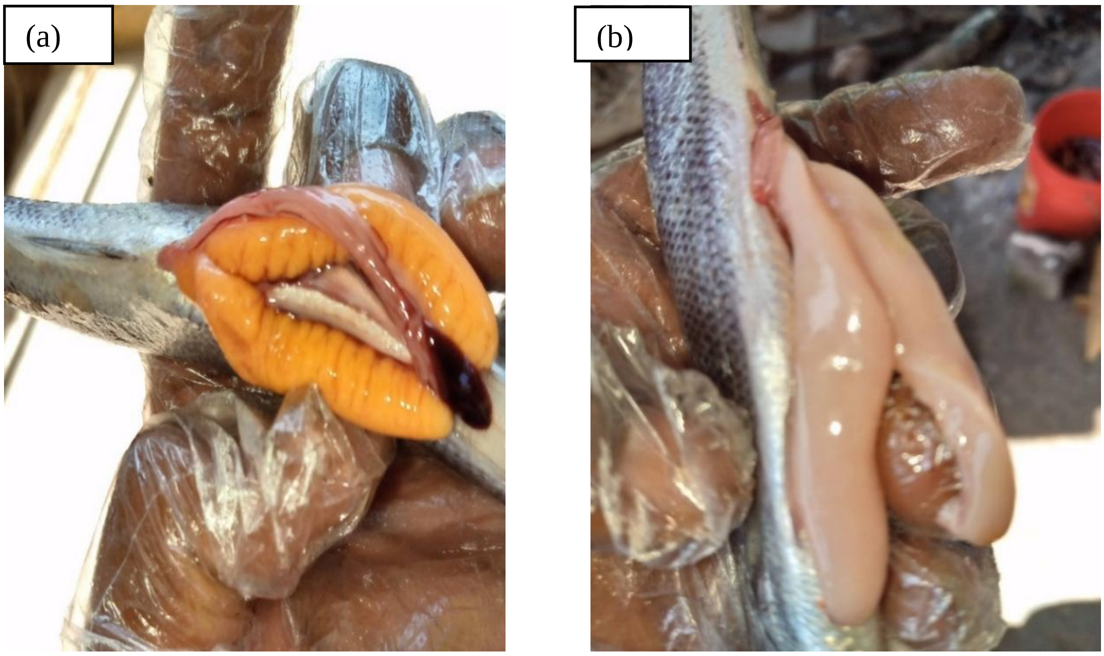


Measurement of *L. stappersii* total length (TL) and standard length (SL), using a measuring-board

Measurement of weight using digital electronic scale.

Appendix J: Determination of sex and water quality data.

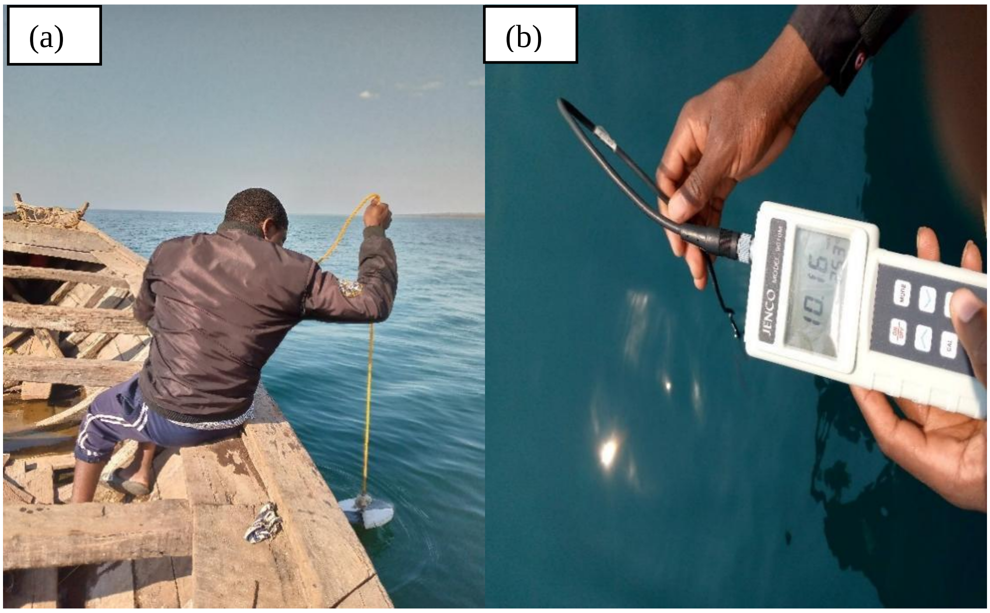
i)



Determination of gonad state and sex determination in *L. stappersii*

(a) Showing ripe running (RR); female **(b)** showing ripe running (RR). male

ii)

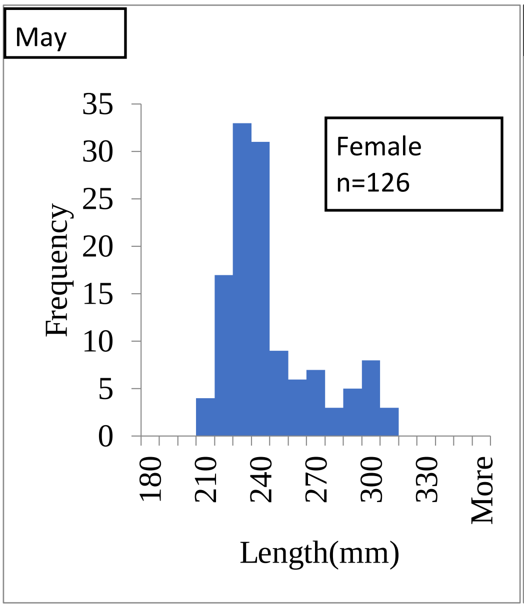


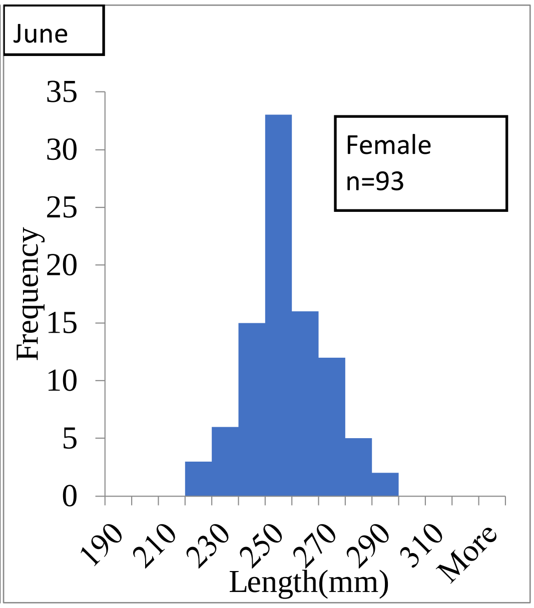
Determination of water quality parameters

(a) water transparency, **(b)** Measuring Dissolved oxygen & Temperature.

Appendix K: Length-Frequency Histograms for Mpulungu and Nsumbu

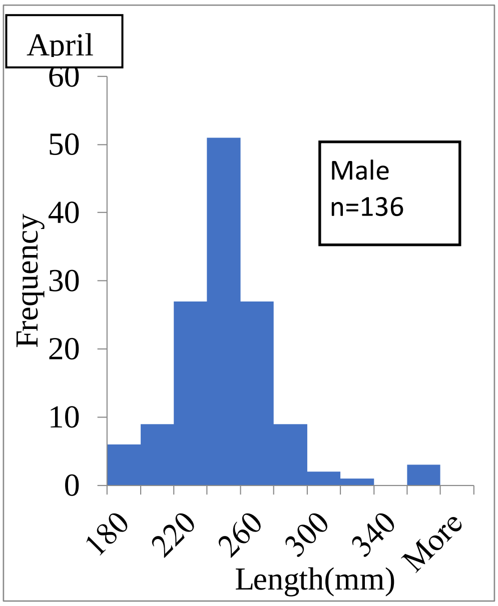
i) Female *L. stappersii*

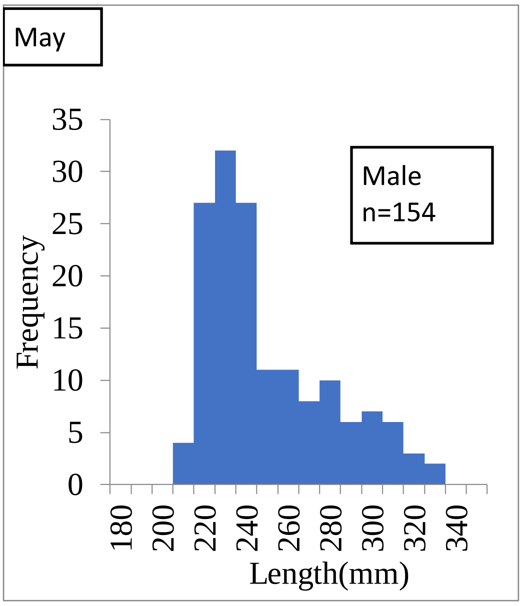


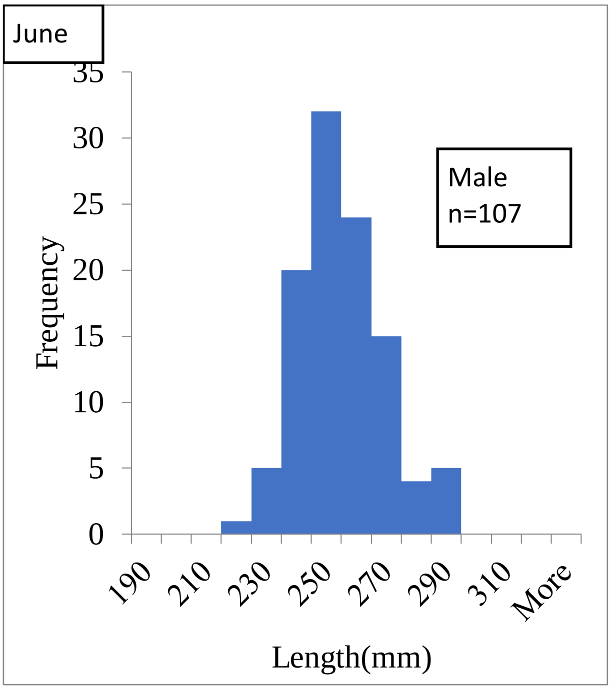


Length- Frequency Histograms of female *L. stappersii* for Mpulungu area for May and June, 2022

ii) Male *L. stappersii*

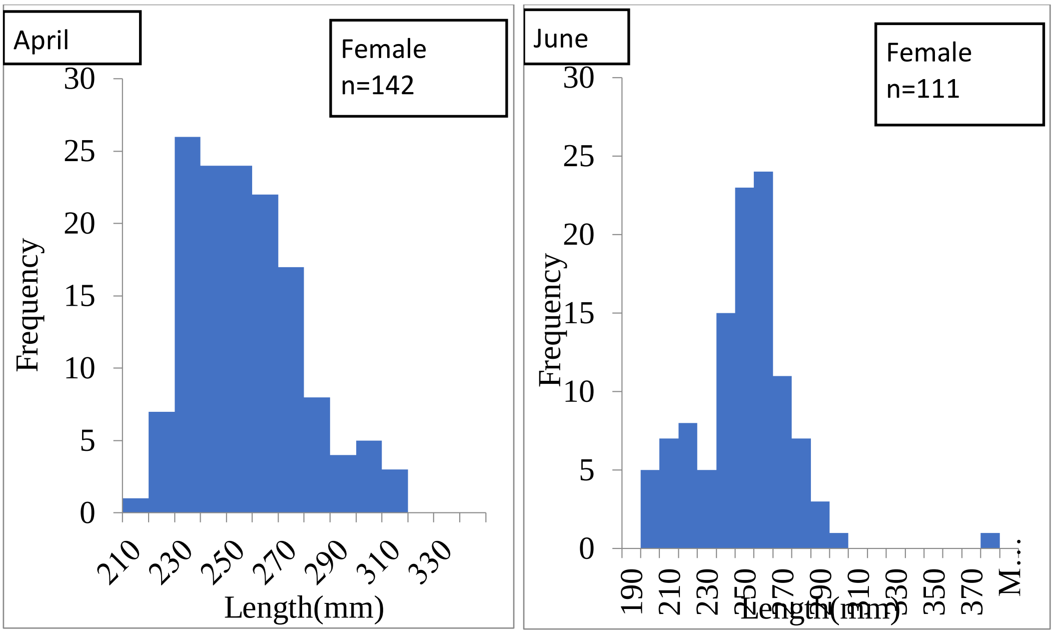






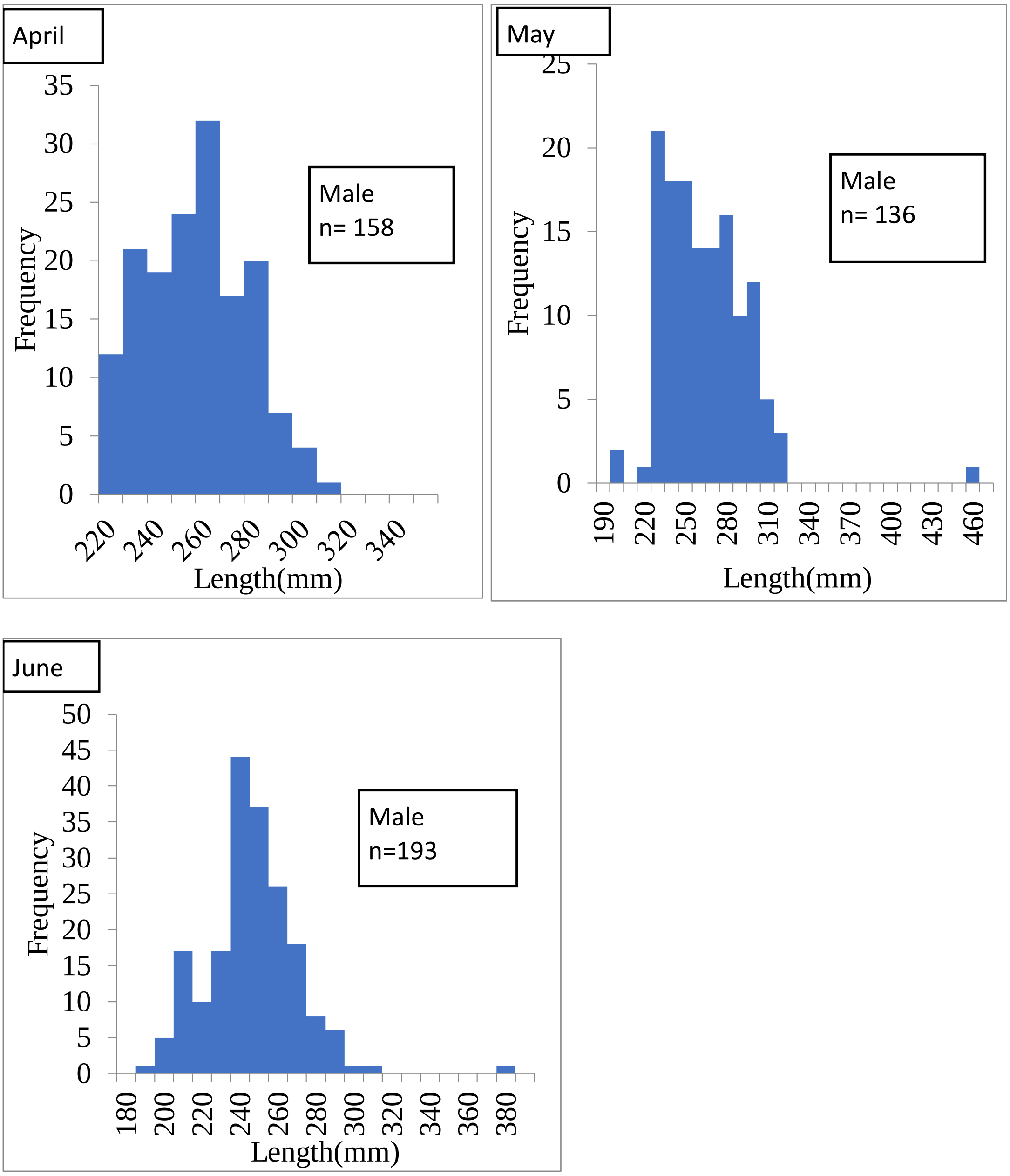
Length- Frequency Histograms of male *L. stappersii* for Mpulungu area from April to June, 2022

iii) Female *L. stappersii* for *Nsumbu* area



Length- Frequency Histograms of female *L. stappersii* for Nsumbu area for April and June, 2022.

iv) Male *L. stappersii* for Nsumbu area



Length- Frequency Histograms of male *L. stappersii* for Nsumbu area from April to June, 2022.