

# An investigation of the effect of zooplankton abundance on the fish catches, Lake Tanganyika (Kigoma, Tanzania)

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## Introduction

The main pelagic fishery of Lake Tanganyika is composed of centropomid species *Lates stappersi* (Boulenger) and two sardines *Stolothrissa tanganyicae* (Regan) and *Limnothrissa miodon* (Boulenger) (Coulter, 1991). These pelagic fish rely heavily on zooplankton as a source of their food during part of their life cycle. Thus the understanding of zooplankton dynamics and their role in the energy transfer through the food chain is necessary for estimates of the potential production of the fishery (Bosma *et al.* 1997). Fishing is the main economic activity in Lake Tanganyika. Its effectiveness depends probably on limnological characteristics of the Lake.

This study intended to determine the trend of fish catches and possibly correlate them with zooplankton abundance and stomach contents. I wanted to investigate possible relationship with the changes in limnological parameters.

## Materials and Methods

The experiment involved one research vessel R.V Echo and one fishermen unit (Catamaran). The five night trips took place on July 16<sup>th</sup> (04° 58' 00" S, 029° 33' 41" E), 19<sup>th</sup> July (04° 47' 36.6" S, 029° 30' 60.9" E), 24<sup>th</sup> July (04° 53' 20.9" S, 029° 31' 30.7" E), 26<sup>th</sup> July (04° 51' 27.2" S, 029° 30' 28" E) and 30<sup>th</sup> July (04° 49' 28" S, 029° 31' 20" E). Those nights were used to collect fish, zooplankton and water samples in the pelagic zone. Fishing was conducted by local fishermen's using two-canoe catamaran. Upon reaching the site of their choice the fishermen lit their lanterns to attract the fish for more than 30min. After attracting the fish they then joined the two canoes and the lift net was lowered to about 70 –120 m, then waited for one and half hours or more before they hauled their net. After hauling, fish total catch was recorded and the fishes were sorted by species. A subsample was taken for length-frequency and stomach content analysis. The gutting procedure was done immediately after the hauling and the digestive tract (stomach) removed and preserved in 4% formalin. In the laboratory the relative fullness was determined by giving ranks from 0 indicating emptiness to 5 for fullness. Stomach contents were examined using numerical analysis method whereby the samples examined at several levels of magnification for food items present were identified and counted. Composition of the gut contents was also recorded and where possible counting of the individuals and weighing was done. Data obtained were used to calculate the index of occurrence, abundance and weight according to Plisnier *et al* (1988) where by:

Index of occurrence  $I_o = NA/NT \times 100 \%$

NA = number of stomach in with food category A (A = Shrimps or fish or Zooplankton)

NT = Total number of stomach 'not empty' analyzed.

Index of abundance  $I_{ab} = NX/NXT \times 100 \%$

NX = Number of individual of food category A ( X= Number of shrimps or fish .....etc)

NXT = The total number individuals of different food category obtained in the sample

Index of weight  $I_w = (wX * NX) / WT \times 100 \%$

wX = average weight of food category A

NX= number of individuals of food category A

WT= The total weight of different food category obtained in the sample

Zooplankton and water samples were also taken in the same night fishing trips. The detailed information on the zooplankton abundance and other limnological parameters may be found in the reports by other Nyanza 2001 participants (Allgeier, 2001; Nzinza 2001, this publication).

## Results

### 1. Catches

During the five sampling trips, the species caught were *Lates stappersi*, *Stolothrissa tanganyicae* and *Limnothrissa miodon*. In this study *L. stappersi* were grouped into two categories: “juveniles” (0-15cm total length) and “adults” (16-48cm). Total catch weights were between 2.1 kg and 180 kg for the first haul sampled (Table 1). “Adults” *L. stappersi* were major contributors in the total catches with peaks on 16<sup>th</sup> July (99.4%) and 24<sup>th</sup> July (100%). *S. tanganyicae* was the 2<sup>nd</sup> contributor to the total catches with peaks on 19<sup>th</sup> July (40.9%) and 26<sup>th</sup> July (91.7%). *L. miodon* did not make a great contribution on the total catches and was only caught on July 26<sup>th</sup> (7.6%) and 30<sup>th</sup> July (4.7%) (Figure 1). In comparing with data from Tanzania Fisheries Research Institute (TAFIRI) for Lake Tanganyika monitoring programme on the two stations Kibirizi and Katonga, *S. tanganyicae* composed large value of the total catches per unit boat (1180 kg) on 18<sup>th</sup> July, while *L. stappersi* reached the maximum on 25<sup>th</sup> July (1600 kg) and on July 31<sup>st</sup> only *S. tanganyicae* was caught with the value of total catch per unit boat of 315 kg (Figure 3a).

The average total length (TL) of *L. stappersi* “adults” increased on July 24 while “juveniles” *L. stappersi* increased on July 16<sup>th</sup> (Fig 2a). *S. tanganyicae* on the other side showed an increase on the average total length on July 16 and decreased on July 30<sup>th</sup> (Fig 2b). In the TAFIRI statistics *L. stappersi* also shows an increase on the average total length on July 24<sup>th</sup> at Katonga station (Fig 4a.). *S. tanganyicae* at Kibirizi on July 18 and Katonga July 31<sup>st</sup> shows double peaks on the average total length (Figure 3b and Figure 4b).

The limnological parameters which related to the trends of catches during the study period are summarized in Table 1 below:

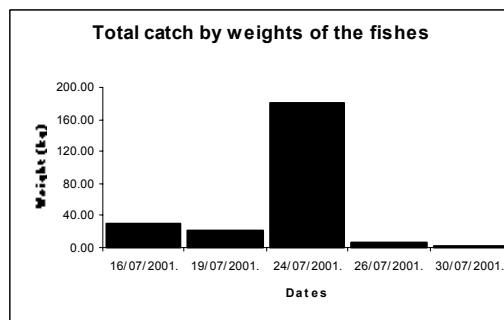
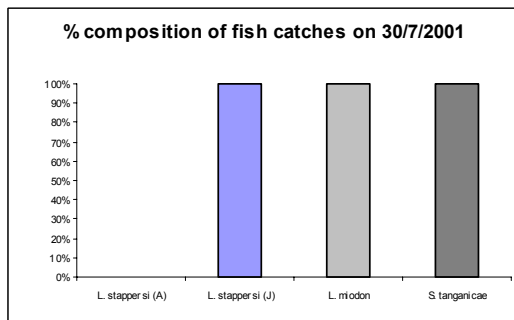
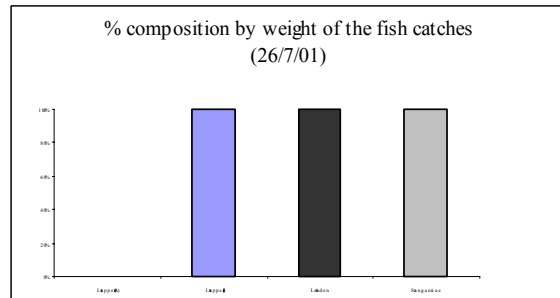
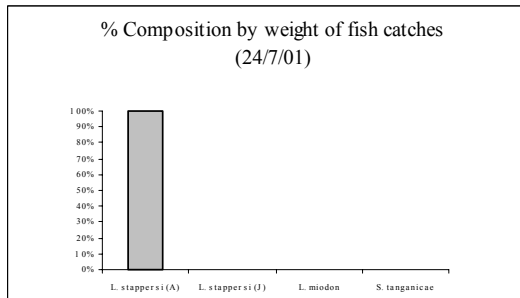
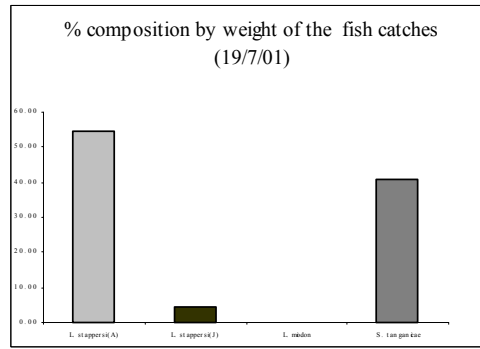
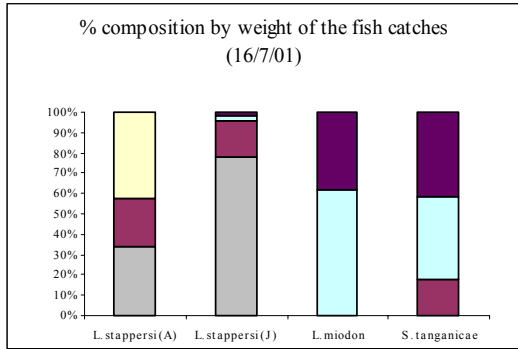
Table 1. Summary of the sampling results

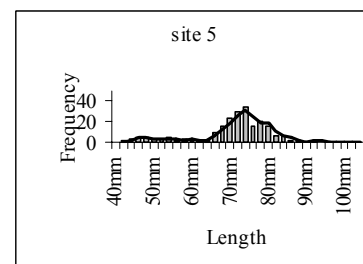
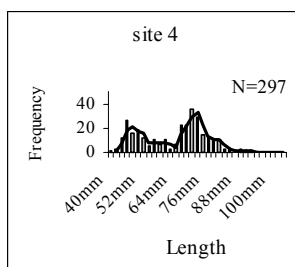
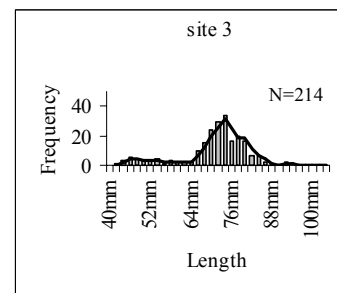
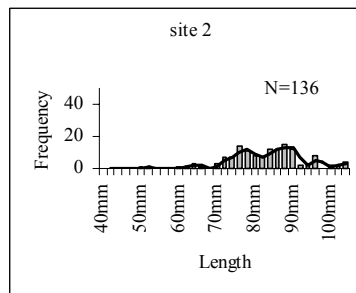
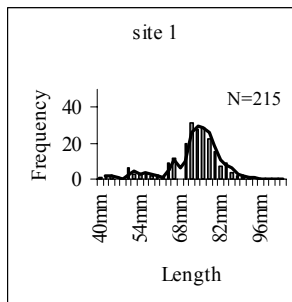
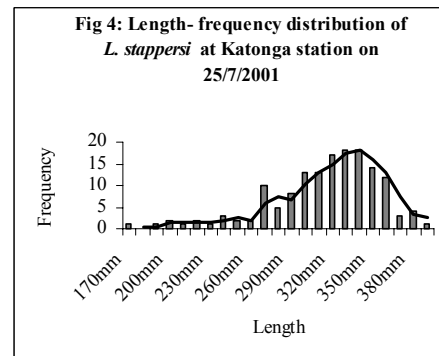
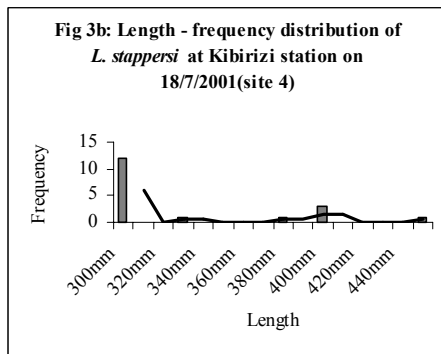
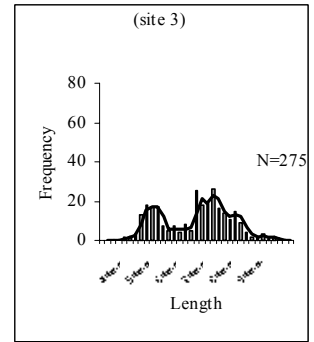
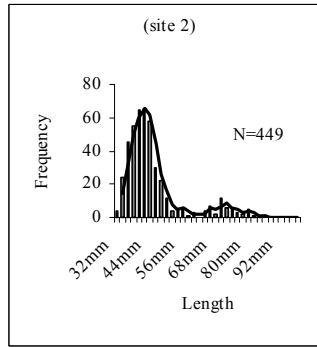
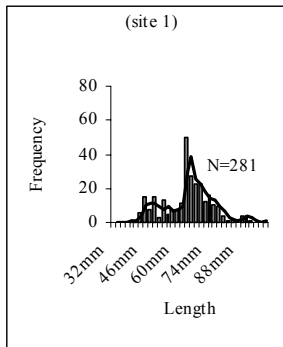
Date	16July 2001	19 July 2001	24 July 2001	26 July 2001	30 July, 2001	
Lake condition	Little Calm	Calm	slight winds	Little calm	Slight winds	
Moon condition	New moon		Half moon		Full moon	
Surface Temperature	25.8°C	26.0°C	25.6°C	25.5°C	25.5°C	
Thermocline depth	70m	70m	80m	75m	75m	
Turbidity (NTU) average.	0.40	0.37	0.36	0.43	0.41	
Maximum	0.45 (0m)	0.54 (20m)	0.6 (0m)	0.57 (60m)	0.45 (0- 40m)	
Chlorophyll a ug/l average.	0.753	No data	0.433	1.033	0.828	
Maximum	0.82(20-40m)		0.51 (40m)	1.07(20-40m)	0.92(20m)	
Zooplankton abundance (n/m <sup>3</sup> x 10 <sup>3</sup> )	0-15m	23.3	28.8	42.7	32.2	90.6
	15-30m	14.9	17.2	32.6	24.1	53.3
	30-45m	12.4	27.8	18.1	27.8	26.6
	45-60m	23.4	6.07	18.1	43.4	31.7
	60-90m	9.2	1.6	2.2	4.3	13.2
Fish catches (kg)						
<i>Lates stappersi</i> (A)	24.0	12.0	180.0	0.0	0.0	
<i>Lates stappersi</i> (J)	6.0	1.0	0.0	0.04	0.01	
<i>Stolothrissa tanganyicae</i>	0.2	9.0	0.0	6.0	0.1	
<i>Limnothrissa miodon</i>	0.0	0.0	0.0	0.5	2.0	
<b>Total catches (kg)</b>	<b>30.2</b>	<b>22.0</b>	<b>180.0</b>	<b>6.5</b>	<b>2.1</b>	

### 2. Stomach contents

A total number of 123 stomachs were examined of which 35 were of *L. stappersi* adults, 26 *L. stappersi* juveniles, 48 *S. tanganyicae* and 14 *L. miodon*. The levels of stomach fullness of the analyzed samples were between empty and half full (50.4% empty and 17.1% half full). Very few were full (4.1%). There were three main food items observed: shrimps, fish and zooplankton.

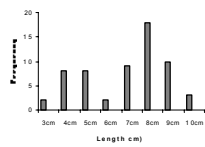
The “adults” *L. stappersi* were found to feed mainly on shrimps and fish (*S. tanganyicae*). In only a few cases zooplankton were observed. “Juveniles” *L. stappersi* were feeding mainly on shrimps and copepods. The index of occurrence for shrimp as prey was between 60% and 84% during the study period. Fish prey was between 23% and 50%, and zooplanktons were only 20% and 37%. The



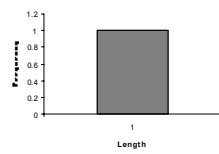


Length frequency distribution of *S. tanganicae* at Katonga on 31/7/01 on 5 different units.

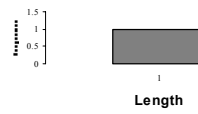
Length-Frequency distribution of *Stotothriassa tanganicae* on 16/7/01



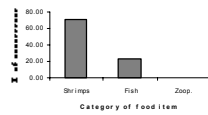
Length frequency distribution of juveniles *Lates stappersi* on 16/7/2001



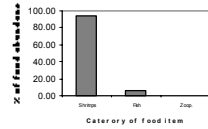
Length frequency distribution of adults *Lates stappersi* on 16/7/2001



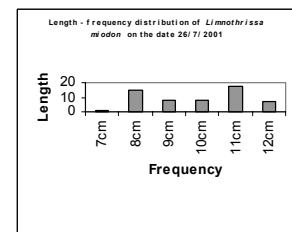
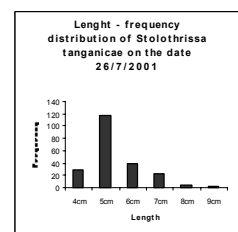
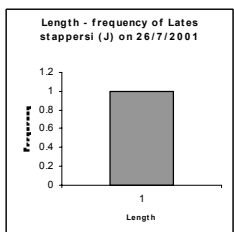
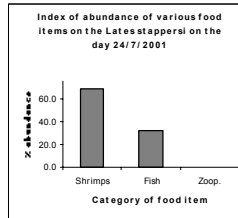
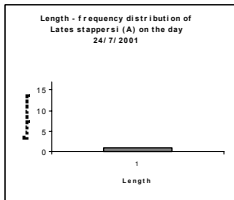
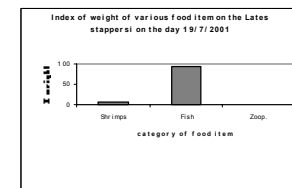
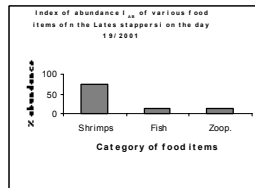
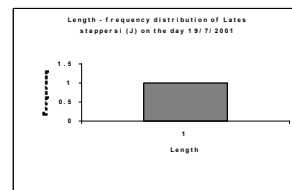
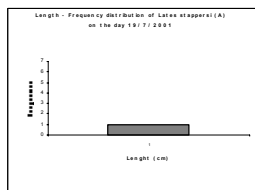
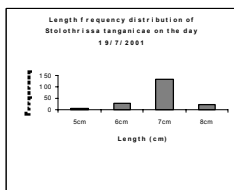
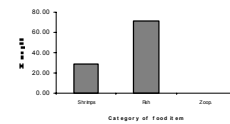
Index of occurrence for various food items in the *Lates stappersi* on 16/7/2001



Index of abundance of various food items on the *Lates stappersi* on 16/7/2001



Index of weight of various food items on the *Lates stappersi* on the day 16/7/2001



abundance were: shrimps: 68% to 94%, fish: 5%-32% and zooplankton: 14% -20%. The weight indices for shrimps were between 5% and 28% while for fish they were between 17% and 95 % (Figure 6).

The Clupeid *Stolothrissa* were found to feed mostly on shrimps and zooplankton (copepods). The occurrence of shrimps as prey was 90 – 100%, with abundance of 20%. The other clupeid samples for *Limnothrissa* were found to be empty. It was thus not possible to establish their diet composition although several papers indicate that shrimps and zooplankton are found to be important diet of the two clupeids *S. tanganyicae* and *L. miodon* (Kurki *et al.*, 1999)

## Discussion

The trend of fish catches in the present study was dominated by *L. stappersi* in percent composition for the first three sampling nights followed by domination of *S. tanganyicae* in the last two nights of the study period (Figure 1). The same trend was also depicted by statistics taken from TAFIRI on the dates close to our study period. Such types of information suggest several predator-prey interactions or movements of fishes for limnological reasons.

There was a large percentage of the “adult” *L. stappersi* caught on July 24. This value corresponds with the low turbidity level of 0.36 NTU in average on that day. The two first sampling nights led to low turbidity levels in average compared to two last sampling days (Table 1). The data obtained throughout the study period suggest that there is inversely relationship between turbidity and the catches of “adult” *L. stappersi*, while there is positive relation between turbidity and catches of “juvenile” *L. stappersi* and *Stolothrissa*. When there is decrease in turbidity level, an increase of *L. stappersi* is observed. Therefore, turbidity seems inversely related to *L. stappersi* catches (Plisnier, 1997).

The trend of zooplankton abundance was increasing in the water column at the depth of 0-45m and decreasing at the depth between 45-90m almost throughout the study period (Table 1). The trend does not correlate with the trends of fish catches, as they were different in various days. Coulter (1991) observed that there is spatial distribution when fish were abundant, zooplankton abundance was lower and nannoplankton abundances were higher. He also noted that there is an inverse relationship between fish abundance and the abundance of crustacean's zooplankton.

The diet of the "adult" *L. stappersi* from the stomach contents analysis was based mainly on the shrimps and in few cases clupeid *Stolothrissa* (Figure 5) although the abundance of them in the water column was lower than those of copepods (Allgeier 2001 this report). The "juvenile" *L. stappersi* were found to feed on shrimps and copepods. This may suggest that the feeding ecology of the *L. stappersi* depends on the availability of the food and the size of the fish itself or probably related to limnological conditions.

Chlorophyll a was much higher on July 19<sup>th</sup> and July 26<sup>th</sup>. This indicates a high abundance of phytoplankton which might lead into higher abundance on the zooplankton on the following sampling nights on July 24 and July 30<sup>th</sup> respectively (Table 1).

There were significant changes in the water movements occurring during the sampling period. The thermocline depth was constant for the first two nights followed by changes on the third night (Table 1). The third night followed a strong west wind on July 23. The movement of water probably led to mixing of nutrients from the deep water toward upper layer and this may also have contributed into the high fish catches on July 24.

## Conclusion

The data collected during the study period does not depict the direct effect of zooplankton abundance on the fish catches. The number of zooplankton found in the water column does not seem to be the only factor contributing to the fish catches. There might be other limnological factors together with the abundance of zooplankton that determine the trends of the fish catches. Sometimes size of the prey rather than their abundance appears to be more determining factor of prey selection. Thus adult *L. stappersi* were found to prey almost entirely upon fishes, all of which found to be *S. tanganyicae*, while juvenile *L. stappersi* were found to eat shrimps and copepods. The catch effort including the number of lamps, mesh size, time taken for attracting fishes or position of the moon can also be questioned if they contribute to trend of fish catches. A better understanding of the effect of zooplankton abundance on fish

catch may be obtained by conducting day fishing because night fishing seem to be biased by light attraction of the plankton rather than it is in the natural situation.

### **Acknowledgements**

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